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

DATE: February 2003

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

	COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	67,740	76,707	66,795	68,693	73,776	85,902	78,012	79,399	Continuing	TBD
1123	Warfighter Training	13,601	10,921	10,627	11,053	12,873	18,165	14,604	14,966	Continuing	TBD
1710	Deployment and Sustainment	8,814	9,752	7,680	7,692	8,859	8,717	9,637	9,855	Continuing	TBD
7184	Crew System Interface & Biodynamics	30,965	29,478	33,830	35,424	38,832	45,421	38,383	38,820	Continuing	TBD
7757	Bioeffects and Protection	14,360	26,556	14,658	14,524	13,212	13,599	15,388	15,758	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2003, the protection program at Brooks City-Base, TX, moves 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 will be transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description

This program establishes technical feasibility and develops the technology base 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 2003, Congress added $2.5 million for Biotechnology - Cellular Dynamics and Engineering, $1.0 million for Three-Dimensional (3-D) Audio Display Technology, $4.3 million for Rapid Detection of Biological Weapons of Mass Destruction, and $7.0 million for Solid Electrolyte Oxygen Separator.

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(U) B. Budget Activity Justification

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.

(U) C. Program Change Summary ($ in Thousands)

		FY 2002	FY 2003	FY 2004	Total Cost
(U)	Previous President's Budget	70,155	66,000	75,500	
(U)	Appropriated Value	70,480	80,800		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-325	-3,802		
	b. Small Business Innovative Research	-2,085			
	c. Omnibus or Other Above Threshold Reprogram		-291		
	d. Below Threshold Reprogram				
	e. Rescissions	-330			
(U)	Adjustments to Budget Years Since FY 2003 PBR			-8,705	
(U)	Current Budget Submit/FY 2004 PBR	67,740	76,707	66,795	TBD

(U) Significant Program Changes:

Decrease in FY 2004 is to fund higher priority Air Force programs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2003
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 1123

COST ($ in Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
1123	Warfighter Training	13,601	10,921	10,627	11,053	12,873	18,165	14,604	14,966	Continuing	TBD

(U) A. Mission Description

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; logistics 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 develops and evaluates desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation-based systems to determine how to achieve maximum learning effectiveness for specific needs at minimum cost. Technologies developed in this project will increase operational readiness by providing more effective methods and approaches to train and assess personnel. This project will contribute to a more highly trained and flexible cadre of personnel at a reduced cost.

(U) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $4,686 Researched new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Explored High-Level Architecture federation connectivity options for training systems operating at different levels of security classification. Developed behavioral models to simulate the threat operators in the command and control chain. Explored PC-based, high-resolution, real-time image generator and ultrahigh resolution laser projector concept for DMT simulators.

(U) $6,119 Developed tools and strategies for identifying and improving combat mission training, rehearsal, and operations for distributing training and performance support methods and technology exemplars to operational forces. Research produced the empirical and analytical basis for better training guidelines when warfighters train in DMT environments. Completed development of methods to identify and validate mission essential competencies for air superiority and global attack, and began extending methods to new domains of space operations, information warfare, information operations, and command and control. Developed and validated curriculum for Air Superiority DMT implementation at operational mission training centers and within large-scale exercises at command and control simulation facilities. Conducted usability assessments of enhanced instructor operator station tools to embed instructional principles in DMT simulations and completed a first look assessment of operational deployment impacts on retention and decay of mission essential competencies and potential contributions of specific curricula for refresher training in pre- and post-deployment applications at mission training centers.

(U) $2,796 Developed training technologies in command and control centers that support theater air operations centers. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. Developed tools that provide real-time

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

performance support with automated remediation leading to a reduction in training costs with no reduction in training effectiveness. Integrated command and control systems into the Distributed Mission Training (DMT) environment. Developed embedded training tools and simulations for command and control information systems.

(U) $13,601 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $1,597 Research perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Research identifies the visual cues necessary for realistic aircrew training and mission rehearsal, allowing Air Force warfighters to train as they intend to fight. Assess technical performance of advanced ultrahigh resolution image generation, ultrahigh resolution projector and collimating display screen technologies. Determine feasibility of these technology developments for the next generation DMT simulator.

(U) $2,084 Research new computer representation technologies for the synthetic environment used in simulation-based training within a distributed mode to enhance the integrated DMT environment. Research includes representation of the visual, electronic, and sensor world, the weather, the behavior of computer-generated forces, threats, and larger wargaming models. Improve rate of learning by developing pilot performance diagnostics for end game tactical engagements for use in mission debrief. Determine feasibility of using large constructive wargaming model as a manager of all participating entities in distributed combat exercises. Assess existing high-fidelity weather models as weather servers for all players in a distributed training exercise. Analyze methods for eliminating undesirable artifacts from the satellite source data used to build visualization tools and databases.

(U) $5,951 Develop tools and strategies for identifying and improving combat mission training, rehearsal, and operations for distributing training and performance support methods and technology exemplars to operational forces. Research provides the combat air forces with the empirical data and guidelines for improving the quality and effectiveness of both DMT and live flight training environments. Complete validation of tools to facilitate continuous learning for critical air combat skills and link these tools to skills in domains such as intelligence, surveillance, and reconnaissance, and information operations. Complete 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. Identify mission essential competencies underlying air superiority and global attack skills. Begin development of DMT content and scenarios for expeditionary force spin-up training and rehearsal.

(U) $1,289 Develop training technologies in command and control centers that support theater air operations centers. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. Validate mission essential competencies for selected air

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(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

operations center individuals and teams. Determine feasibility of using enhanced performance assessment tools in command and control training exercises.

(U) $10,921 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $1,685 Research perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Research identifies the visual cues necessary for realistic aircrew training and mission rehearsal, allowing Air Force warfighters to train as they intend to fight. 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) $7,840 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 DMT and live flight training environments. 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) $1,102 Develop training technologies and methods that support aerospace operations. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. 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) $10,627 Total

(U) B. Project Change Summary

Not Applicable.

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PROJECT: 1123	

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

(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.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE: February 2003

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1710

COST ($ in Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
1710	Deployment and Sustainment	8,814	9,752	7,680	7,692	8,859	8,717	9,637	9,855	Continuing	TBD

(U) A. Mission Description

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 with the potential to reduce the time required for units to plan, pack up, and deploy, and to reduce airlift requirements while enhancing deployed capability. 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) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $2,187 Developed logistics sustainment technology options and performed feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs. Developed software tools to automatically generate maintenance procedures from weapon system design descriptions. Defined functional requirements for theater sustainment and distribution decision support tools. Developed artificial intelligence software architectures for improved depot repair forecasting and more timely and efficient home-based support for the warfighter. Developed advanced computer models for representing human cognition in simulations.

(U) $2,337 Developed logistics readiness technology options and performed feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for AEF operations. Conducted feasibility studies and devised preliminary plans for presenting various types of information to maintenance and logistics personnel, such as aircraft status, supply status, and diagnostics data. The focus was on display techniques for the support of the logistics commanders and their staff. Investigated the feasibility of developing a distributed logistics training capability to support the logistics community.

(U) $4,290 Demonstrated and applied predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Demonstrated and applied methods to quantify skin toxicity risks from fuels and solvents used in flight operations and maintenance processes. Developed a biologically-based model for validation of exposure standards for Air Force missile fuel oxidizer. Began to develop innovative biotechnology techniques.

(U) $8,814 Total

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 1710

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$1,864	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. Develop transformation algorithms and interface requirements for virtual validation of maintenance technical order data. Develop artificial intelligence software components to realistically model team decision-making in synthetic environments.
(U)	$1,770	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 Air Expeditionary Force operations. Continue to conduct feasibility studies and devise 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. Begin work to define the technology requirements and component research areas to support a completely automated maintenance environment.
(U)	$3,641	Develop, demonstrate, and apply predictive assessment models to accurately characterize the toxicological risks associated with exposure to operational compounds and materials for force protection. Establish biologically-based approach for predicting skin irritation from dermal contact with fuels, solvents, and other hazardous chemicals used in the DoD. Develop innovative biotechnology techniques employing genomics and proteomics to identify exposure of animals to toxic substances and begin to employ that information to develop human biologically-based toxicity models.
(U)	$2,477	Perform biotechnology cellular dynamics research through a not-for-profit collaboration with industry and affiliated universities within the facilities of the Air Force Research Laboratory. Research and develop principles of integrated cellular control systems for use in innovative, cell-based technologies for Air Force applications.
(U)	$9,752	Total

(U) FY 2004 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$2,183	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. Continue to develop 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)	$1,652	Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands) Continued

programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force operations. Continue to conduct feasibility and usability studies 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. Continue work to define the technology requirements and component research areas 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) $3,845 Develop, demonstrate, and apply predictive assessment models to accurately characterize the toxicological risks to warfighters associated with exposure to operational compounds and material for force protection. 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 prototype simulation models to predict the effects upon the warfighter in different exposure situations.

(U) $7,680 Total

(U) B. Project Change Summary

Not Applicable.

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

(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.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE: February 2003

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 7184

COST ($ in Thousands)		FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
7184	Crew System Interface & Biodynamics	30,965	29,478	33,830	35,424	38,832	45,421	38,383	38,820	Continuing	TBD

Note: In FY 2003, the protection program at Brooks City-Base, TX, moves 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 will be transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description

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) FY 2002 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $3,763 Developed interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Determined the feasibility of extending real-time workload classification technology into unmanned combat air vehicle operations, and evaluated reduced crew operation in a multi-sensory unmanned air vehicle control station. Completed databases for cockpit accommodation and NATO three-dimensional human population as core elements for an intelligent, on-line physical accommodation information system to optimize equipment fit. Performed laboratory experiments using a virtual air command station to determine human interface design requirements for airborne early warning and control.

(U) $5,248 Developed cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Continued to devise user-computer interface concepts for intelligence analysts, investigated a display interface for integrated asset management, analyzed decision-support aids for air operations centers, and provided a laboratory demonstration of a rapid shared display for command center situation awareness. Began analysis and definition of human-machine interfaces and decision support tools for global attack. Began development of operator interface concepts and descriptive performance metrics in support of the Targets Under Trees program. Continued research on speech signal processing and speech-based countermeasures for information operations, including a concept demonstration of an intelligent voice jammer.

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $3,483 Developed concepts for integrating human-computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefit from new interface technologies. Produced design guidelines for an integrated control interface for unmanned vehicles. Continued to develop operator-vehicle interface concepts for exploiting real-time, off-board data and to demonstrate payoffs for mobility/special operations missions in laboratory simulations. Completed a feasibility evaluation for validating a digital model of human decision-making behavior.

(U) $4,123 Developed visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat-panel displays, and developed an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Conducted study on replacing the heads-up display with a helmet-mounted display, established color contrast guidelines, and developed frames of reference and symbology for attitude displays. Established design guides for windscreens and night vision displays. Determined resolution and brightness requirements for large flat-panel displays.

(U) $2,703 Developed advanced audio displays including three-dimensional audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Planned system integration and laboratory test as initial implementation for an acoustic remote threat detection in perimeter defense. Conducted research on (50 dB) hearing protection technologies for improved performance in high performance aircraft. Developed human performance standards for helmet-mounted cueing systems in vibratory environments.

(U) $918 Developed integrated human-centered information warfare technologies to assess and predict human performance under information warfare conditions and to influence an adversary's decision-making function. This research provided information warriors with human perception management tools and the means to evaluate the effectiveness of information warfare strategies on the human target set. Cognitive modeling efforts modeled effects of cross-cultural communications on human decision-making behavior. Auditory and visual technologies were applied to develop perception management tools for offensive counter-information applications.

(U) $3,023 Developed human injury and protective systems design criteria for use against hazards encountered in crash environments and emergency escape. Research developed technologies to improve full aircrew population safety during all phases of aircraft and vehicle operations including crashes, emergency escape, and parachute opening shock. Began developing injury assessment toolbox to be used in conducting injury risk assessment on personal protection and life support equipment, and seat and cockpit systems. Developed analysis techniques for evaluating data from ejection seat recorder. Conducted laboratory studies on adaptable restraint system technologies for application across Air Force airlift aircraft.

(U) $7,704 Developed aviation safety technologies to alleviate/mitigate warfighter fatigue, counter spatial disorientation, and improve pilot performance at high altitude and under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions. This research will reduce mishaps due to spatial disorientation and minimize adverse impacts of acceleration stresses on combat effectiveness. Extended fatigue management technologies to provide operational commanders and

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

mission planners with a limited capability to evaluate effects of alternative schedules on crew performance and mission effectiveness. Conducted fatigue countermeasures research to evaluate the operational efficacy of emerging alertness enhancing medications such as modafinil. Conducted spatial disorientation countermeasures research efforts to improve primary flight displays and reduce pilot workload through development of more intuitive symbology and improve pilot training through development of ground-based and flight-based spatial orientation training practices. Focused acceleration protection research efforts on defining physiological and performance effects of thrust-vectored flight and assessing the effects of pharmaceutical fatigue countermeasures on flight safety and pilot effectiveness in the high performance/high demand cockpit of modern fighter aircraft.

(U) $30,965 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $4,372 Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Evaluate 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. Develop concept for intelligent, on-line physical accommodation tools to optimize equipment fit, enabling future crew stations and equipment to adapt to human variability. Complete laboratory experiments exploring crew interface concepts for airborne command and control, demonstrate an advanced crew station for airborne early warning, and explore interface technologies for supervision of multiple autonomous unmanned air vehicles.

(U) $4,411 Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and improve decision-making and predictive battlespace awareness. Explore conceptual design options for a cognitive interface and knowledge repository to support information operations in the future air operations center. Continue to support the Targets Under Trees program by improving the ability to fuse imagery and signals intelligence. Continue research on speech signal processing and speech-based countermeasures for information operations and commence a multi-year program to demonstrate a robust stressed-speech identification capability including foreign language speech recognition.

(U) $3,548 Develop concepts for integrating human-computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefits from new interface technologies. Continue simulation software for an integrated, unmanned air vehicle crew station. Continue to develop operator-vehicle interface concepts for mobility using real-time, off-board data to assure tactical information dominance with minimum crew size. Explore control-display technology options for unmanned reconnaissance vehicles and begin to explore human performance requirements and fusion of on-board and off-board sensor data with imagery in a single display. Aggregate models of

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(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

human perception, decision-making, and control in selected military combat scenarios.

(U) $4,324 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat-panel displays, and develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Demonstrate the ability to calibrate color displays in the field environment to permit evaluating operational system displays, and develop an approach to model image quality. Begin to quantify the effects of binocular disparity and distortion, which negatively affect vision through helmet transparencies and windscreens. Determine feasibility and technical approach for exploiting color night vision in helmet-mounted displays. Develop testing standards for large flat-panel displays.

(U) $992 Develop low-cost PC-based three-dimensional (3-D) audio display system for enhancing the safety of general aviation aircraft. Develop spatial audio symbology for increasing the situational awareness of general aviation pilots. Demonstrate benefits of 3-D audio cueing in general aviation flight operations using immersive flight simulations and/or tests.

(U) $3,282 Develop advanced audio displays including 3-D audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Demonstrate feasibility of 3-D audio for security forces to localize threats and speed acoustic remote threat detection in perimeter defense. Recommend technologies, assess technology risk, and plan to develop a high performance (50 dB) hearing protection system. Begin 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) $788 Develop integrated human-centered information operations technologies to assess and predict human performance under information operations conditions to provide improved displays for quicker, more intuitive access to information to enhance decision-making capabilities, to improve situational and predictive battlespace awareness, and to provide more effective training procedures and fatigue management techniques. This research will provide information operations warriors with human perception management tools and the means to evaluate the effectiveness of information operations strategies on the human target set. Human perception management tools will be refined for potential weaponization in offensive and defensive counter-information operations. Concepts of operation for effects-based planning, demonstrations of prototypes for next-generation planning, and decision aids and warfighter-tailored information visualizations that specifically focus on information operations will be developed.

(U) $5,691 Develop human injury criteria and protective system technologies for use against hazards encountered in crash and other hazardous environments. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including maneuvering acceleration, crashes, emergency escape, extended missions, and parachute opening shock. Revise injury criteria based on data from actual mishaps with ejection seat data recorder. Develop adaptable restraint system technologies, ensuring safety and expedient

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	PROJECT: 7184

(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

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 will provide 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) $2,070 Develop technologies to counter spatial disorientation and improve pilot performance. Research will explore the feasibility of integrating emerging technologies such as three-dimensional audio, tactile situation awareness suit, pathway-in-the-sky displays, and night vision devices to improve pilots' ability to maintain spatial orientation and to aid recognition and recovery from spatial disorientation if it should occur.

(U) $29,478 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $4,523 Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. 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. Continue to develop intelligent, on-line decision aiding and prediction tools to optimize equipment fit, by developing metrics that relate the quality of equipment fit to warfighter effectiveness. 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.

(U) $4,253 Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and improve decision-making and predictive battlespace awareness. Perform laboratory and field evaluations of a cognitive interface and knowledge repository to support information operations in the future air operations center. 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. Continue research on speech signal processing and speech-based countermeasures for information operations and explore the concept of a robust stressed-speaker identification capability.

(U) $3,482 Develop concepts for integrating human-computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefit from new interface technologies. 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 models of human

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands) Continued

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

(U) $4,366 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. 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) $3,332 Develop advanced audio displays including three-dimensional audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Continue exploratory 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) $5,999 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. 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) $5,575 Develop human injury criteria and protective system technologies for use against hazards encountered in crash and other hazardous environments. Research will continue to develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including maneuvering acceleration, crashes, emergency escape, extended missions, and parachute opening shock. 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 HMD systems based on crew performance in operational maneuvering environments. Human information processing in the dynamic environment will be quantified and applied to models that can be incorporated in wargaming and simulation-based acquisition models.

(U) $2,300 Develop technologies to counter Spatial Disorientation (SD) and improve pilot performance, resulting in increased mission effectiveness and decreased loss of aircraft and lives due to SD mishaps. Pathway-in-the-sky symbology will be transitioned from a Head-Up Display format to Helmet-Mounted Display (HMD) simulator trials, ground-based spatial disorientation 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 three-dimensional

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(U) A. Mission Description Continued

(U) FY 2004 ($ in Thousands) Continued

audio, tactile stimulation, and intuitive flight displays will be integrated in motion-based flight simulator testing.

(U) $33,830 Total

(U) B. Project Change Summary

Not Applicable.

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

(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 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.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2003
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COST ($ in Thousands)	FY 2002 Actual	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
7757 Bioeffects and Protection	14,360	26,556	14,658	14,524	13,212	13,599	15,388	15,758	Continuing	TBD

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

(U) A. Mission Description

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) FY 2002 ($ in Thousands)

(U)	$0	Accomplishments/Planned Program
(U)	$5,802	Conducted laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while researching countermeasures for optical hazards/threats with and without laser eye protection. Assessed bioeffects of agile laser technologies. Provided guidance for non-lethal laser illuminator employment. Demonstrated technologies for safe, active lasing in aircrew simulators, supporting improved engagement tactics, countermeasures, and laser safety training requirements.
(U)	$6,044	Conducted radio frequency bioeffects laboratory experiments to enable safe exploitation of electromagnetic energy for directed energy weapons, non-lethal weapons, communications, and radar. Evaluated cellular damage and behavioral/cognitive disruption from pulsed radio frequency emitters. Continued health and safety studies on millimeter waves. Improved technology and models for radio frequency exposure prediction, assessment, and hazard warning.
(U)	$294	Concluded post-operative evaluation and issued interim recommendations on the study of Photorefractive Keratectomy as a surgical method to reduce aircrew need for glasses or contact lenses.
(U)	$567	Developed 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. Researched human safety, control, and pointing and tracking issues of directed energy. Verified the non-harmful effects of the active denial technology. Developed safety design criteria for directed energy systems using validated computer model.
(U)	$1,653	Designed and developed probe kits to rapidly detect and identify biological weapons of mass destruction.

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $14,360 Total

(U) FY 2003 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $5,312 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. Begin evaluation of eye protection technologies to counter the agile laser threat. Investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-materiel and non-lethal weapons applications. Explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Expand research in optical technology development for information warfare and perception management applications.

(U) $5,625 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy. Expand laboratory assessment of biological effects of high power microwave and nanosecond pulse emissions. Evaluate cellular effects of radio frequency energy. Complete updated laboratory and field Radio Frequency Radiation (RFR) dosimetry tools for assessment of RFR exposure dose assessments by bioenvironmental engineering and occupational health personnel. Develop radio frequency and optical radiosensitive biotechnology tools to counter the proliferation of biological weapons of mass destruction.

(U) $1,102 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. Complete laboratory assessment of portable active denial technology. Assess cognitive and psychosocial effects of non-lethal applications while attending to needs of the intelligence community.

(U) $3,312 Develop aviation safety enhancing technologies to alleviate warfighter fatigue, counter physiological effects of high altitude flight, and improve pilot performance under high, rapid-onset gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions, and minimize adverse impacts of altitude and acceleration stresses on combat effectiveness. Sustained operations research will continue development and validation of quantitative models describing 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) $4,265 Design and develop improved probe kits to rapidly detect and identify an expanded category of biological warfare agents.

(U) $6,940 Develop 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. Advance 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

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(U) A. Mission Description Continued

(U) FY 2003 ($ in Thousands) Continued

reducing the size, weight, and power requirements of those devices.

(U) $26,556 Total

(U) FY 2004 ($ in Thousands)

(U) $0 Accomplishments/Planned Program

(U) $5,414 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. Continue evaluating eye protection technologies to counter the agile laser threat. 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) $4,638 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy. 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 radio frequency radiation 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) $1,856 Develop simulants for biological weapons with internal tracing and tracking (biosensor) technologies for support of development and evaluation of technologies for counterforce and neutralization of biological agents. Self-tracking and tracing biological simulants will enable assessment of the efficacy of counterforce and neutralization concepts more accurately and affordably than current methods. 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) $2,750 Develop aviation safety enhancing technologies to alleviate warfighter fatigue, counter physiological effects of high altitude flight, and improve pilot performance under high, rapid-onset gravitational forces. Results will extend and enhance cognitive performance during Global Strike/Global Mobility operations and minimize adverse impacts of altitude and acceleration stresses on combat effectiveness. 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 investigation of effects of 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) $14,658 Total

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	PROJECT: 7757

(U) B. Project Change Summary

Not Applicable.

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

(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.

(U) E. Schedule Profile

(U) Not Applicable.