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

DATE: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	68,642	66,404	69,080	63,945	69,011	72,252	73,426	75,576	Continuing	TBD
1123	Warfighter Training	16,385	11,846	14,594	11,182	12,722	13,531	14,525	14,957	Continuing	TBD
1710	Deployment and Sustainment	5,651	6,308	8,052	7,468	7,345	7,507	7,708	7,930	Continuing	TBD
1900	Environmental Quality Technology	2,704	0	0	0	0	0	0	0	0	TBD
7184	Crew System Interface & Protection	35,624	37,708	34,124	32,954	37,226	39,194	39,671	40,826	Continuing	TBD
7757	Directed Energy Bioeffects	8,278	10,542	12,310	12,341	11,718	12,020	11,522	11,863	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2000, studies in support of Distributed Mission Training moved from Project 7184 to Project 1123, and the Toxicology Hazards Research program moved from Project 7757 to Project 1710. In FY 2001, efforts in Project 1900 were terminated due to higher Air Force priorities. In FY 2001, Congress added $1.0M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for detection of nosocomial infections. The funding was realigned to PE 0602202F, Project 7757, to align the funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312, Defense Research Sciences. However, the effort is described in PE 0602202F, Project 7757. FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.

(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 crew systems interface, crew protection, warfighter training, and deployment and sustainment of forces. 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 Environmental Quality Technology project develops technologies to characterize the chemistry of Air Force-generated pollutants and toxic materials, assesses their interaction with the environment, and develops reduction/destruction and control techniques. The Crew System Interface and Protection project develops and evaluates technologies that will increase the performance

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(U) A. Mission Description Continued

of humans. The Directed Energy Bioeffects project develops technologies to protect humans from, and enable the military use of, electromagnetic radiation. Note: In FY 2001, Congress added $4.0 million for Solid Electrolyte Oxygen Separator research and $0.4 million for Altitude Protection.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	70,494	62,619	60,301	
(U)	Appropriated Value	71,012	67,019		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-13			
	b. Small Business Innovative Research	-1,674			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-155			
	e. Rescissions	-528	-615		
(U)	Adjustments to Budget Years Since FY 2001 PBR			8,779	
(U)	Current Budget Submit/FY 2002 PBR	68,642	66,404	69,080	TBD

(U) Significant Program Changes:

Increase in FY 2002 is due to increased emphasis on agile laser eye protection.

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DATE: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1123

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1123 Warfighter Training	16,385	11,846	14,594	11,182	12,722	13,531	14,525	14,957	Continuing	TBD

Note: In FY 2000, studies in support of Distributed Mission Training (DMT) moved from Project 7184 to Project 1123.

(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 in the areas of aircrew training; technical training; logistics training; mission rehearsal; training in support of complex decision making; space operations training; 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 2000 ($ in Thousands)

(U) $4,927 Researched new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Research will increase and enhance the quality of training and mission rehearsal for the warfighter. Developed cockpit sensors, which replicate real world responses to outside stimuli. Explored requirements for long-haul networking in the areas of computer bandwidth to see how many moving models can be on the database without causing performance degradation and latency, and to see how distance between simulators will affect performance. Completed the development of the threat library, which covers all known threats.

(U) $10,599 Developed Air Force training guidelines, instructional scenarios, and techniques by transitioning combat aerial training technologies and performance measurement systems into aircrew, space, and information operations environments. Methods and technologies will significantly improve the effectiveness and efficiency of aerospace operations, command and control, training development, mission rehearsal, and refresher training. Began to develop an internet-based integrated team decision support system. Performed detailed task and functional analyses to specify the information requirements, sources, and levels of interoperability necessary to develop an integrated space mission control training and rehearsal system. Identified key training and operational knowledge, skills, and tasks, and developed specifications for competency-based training and rehearsal for both DMT and operational flight training.

(U) $859 Developed concepts and technologies to enable a Warfare Operations Center (WOC) by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Implemented a deployable personal agent into an existing distributed

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PROJECT: 1123	

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

command and control simulation for training, assessment, and aiding the warfighter.

(U) $16,385 Total

(U) FY 2001 ($ in Thousands)

(U) $5,933 Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Conduct experiments to determine the extent to which various cues provided by simulator visual systems contribute to the effectiveness of the display imagery. Complete feasibility study and begin the establishment of a DMT networking standard to be employed by the entire DoD modeling and simulation community. Investigate new computer architectures and data manipulation to provide real-time modeling of multi-sensor imagery.

(U) $5,125 Develop tools and strategies for identifying and improving combat mission training and rehearsal and for distributing training and performance support to operational forces. Begin feasibility study to embed and evaluate instructional principles in DMT simulations. Begin feasibility study of integrated intelligence, surveillance, and reconnaissance (ISR) data utility for aircrew mission planning, mission operations, and evaluation. Conduct knowledge engineering for ground-based satellite controller training and develop recommendations and a satellite control station exemplar for space-system operator training and performance support, and continue studies to validate integrated command and control aerospace operations centers with the DMT environment.

(U) $788 Develop Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. Develop and implement tools and simulation for training and assessment of performance in two separate command and control information systems. Develop new training and team dynamic protocols to operational users.

(U) $11,846 Total

(U) FY 2002 ($ in Thousands)

(U) $5,028 Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Explore federation connectivity options for training systems operating at different levels of security classification. Develop behavioral models to simulate the threat operators in the command and control chain. Explore PC-based, high-resolution, real-time image generator and ultra-high resolution laser projector concept for DMT simulators.

(U) $6,566 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 will produce the empirical and analytical basis for better training guidelines when warfighters train in DMT environments. Complete development of methods to identify and validate mission essential competencies for air superiority and global attack, and begin extending methods to new domains of space operations, information warfare,

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PROJECT: 1123	

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

information operations, and command and control. Develop and validate curriculum for Air Superiority Distributed Mission Training implementation at operational mission training centers, and within large-scale exercises at command and control simulation facilities. Conduct usability assessments of enhanced instructor operator station tools to embed instructional principles in DMT simulations, and complete 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) $3,000 Develop training technologies in command and control centers that support theatre air operations centers. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. Develop tools that will provide real-time performance support with automated remediation leading to a reduction in training costs with no reduction in training effectiveness. Integrate command and control systems into the DMT environment. Develop embedded training tools and simulations for command and control information systems.

(U) $14,594 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602233N, Mission Support Technology: Personnel, Training, and Simulation Technology Area.
(U) PE 0602716A, Human Factors Engineering Technology Development.
(U) PE 0602727A, Non-System Training Devices Technology.
(U) PE 0602785A, Manpower, Personnel, and Training Technology.
(U) PE 0603106F, Logistics Systems Technology.
(U) PE 0603227F, Personnel, Training, and Simulation Technology
(U) PE 0604227F, Distributed Mission Training (DMT).
(U) PE 0604243F, Manpower, Personnel, and Training Development.
(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

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PROJECT: 1123	

(U) E. Schedule Profile Continued

(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1710

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1710	Deployment and Sustainment	5,651	6,308	8,052	7,468	7,345	7,507	7,708	7,930	Continuing	TBD

Note: In FY 2000, the Toxicology Hazards Research program moved from Project 7757 to Project 1710.

(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 health risks and mission impact to DoD personnel from exposure to hazardous chemicals, while also reducing weapon system life cycle cost.

(U) FY 2000 ($ in Thousands)

(U) $300 Developed technologies for improved cargo handling and improved support of space assets to better support weapon systems and reduce logistics support costs. Completed feasibility analyses and development of initial technology concepts for improved cargo handling at aerial ports and deployed locations and for improved space systems supportability.

(U) $2,926 Developed logistics readiness and sustainment technology options and performed feasibility studies to support large-scale advanced technology development programs. These experiments provide critical information for technology integration and application to advanced technology developments which support AEF initiatives. Identified diagnostic strategies and data requirements to support the advanced prognostic and diagnostic program which will reduce aircraft down time. Developed enabling technology for innovative software architectures for more accurate representation of human behavior in synthetic environments.

(U) $2,425 Demonstrated and applied predictive human health assessment models to accurately characterize the human health risk associated with exposure to operational compounds and materials for force protection. Characterized the health hazard to flight operations personnel exposed to jet fuels (JP-8) and various additive compounds. Developed a science-based standard that accurately reflects the human health consequences of widespread contamination by solvent compounds used in maintenance processes.

(U) $5,651 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 2001 ($ in Thousands)

(U) $1,788 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 software to transform procedural maintenance instructions into graphic-oriented computer simulations for validation analysis. Develop neural network concepts for application to high-leverage areas of depot repair parts demand and resource forecasting.

(U) $1,746 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 (AEF) operations. Investigate various technologies to retrofit aircraft with automated sensors to collect and record system performance data for enhanced capability to diagnose and predict component failures. Explore technology to automatically collect asset status information to provide real-time information for management of logistics processes and support of deployment operations.

(U) $2,774 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Establish a health-based exposure standard for an Air Force missile fuel oxidizer. Apply predictive tools to assist fuels developers in rapidly screening various additives for toxicity.

(U) $6,308 Total

(U) FY 2002 ($ in Thousands)

(U) $2,020 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 software tools to automatically generate maintenance procedures from weapon system design descriptions. Define functional requirements for theater sustainment and distribution decision support tools. Develop artificial intelligence software architectures for improved depot repair forecasting and more timely efficient home-based support for the warfighter. Develop advanced computer models for representing human cognition in simulations.

(U) $2,130 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. Conduct feasibility studies and devise preliminary plans for presenting various types of information to maintenance and logistics personnel, such as aircraft status, supply status, and diagnostics data. The focus will be on display techniques for the support of the logistics commanders and their staff. Begin investigating the feasibility of developing a distributed logistics training capability to support the logistics community.

(U) $3,902 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Demonstrate and apply methods to quantify skin toxicity risks from fuels and solvents used in flight operations and maintenance processes. Develop a biologically-based model for validation of exposure standards for Air Force

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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 2002 ($ in Thousands) Continued

missile fuel oxidizer.

(U) $8,052 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0602233N, Mission Support Technology: Personnel, Training, and Simulation Technology Area.

(U) PE 0602716A, Human Factors Engineering Technology Development.

(U) PE 0603106F, Logistics Systems 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: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1900

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1900 Environmental Quality Technology	2,704	0	0	0	0	0	0	0	0	TBD

Note: In FY 2001, efforts in Project 1900 were terminated due to higher Air Force priorities.

(U) A. Mission Description

This project develops technologies to characterize the chemistry of Air Force-generated pollutants and toxic materials, assesses their interaction with the environment, and develops reduction/destruction and control techniques. The objective is to reduce the cost and increase the effectiveness of technologies that protect the environment; emphasis is placed on pollution prevention technologies. New Air Force fuels and chemicals are analyzed to identify and prevent possible environmental problems. Materials are investigated and new processes explored to assess and reduce environmental risks. Monitoring and control technologies are developed for Air Force operations by using novel instrumentation, characterization, and modeling techniques

(U) FY 2000 ($ in Thousands)

(U) $945 Developed filtration materials and processes to protect U.S. forces from long-term health consequences from exposure to hazardous materials. Developed advanced filter materials and processes to remove and destroy operationally generated hazardous organic materials and particulate contaminants. Defined warfare agent interaction with Air Force unique materials.

(U) $1,086 Developed integrated materials technologies that demonstrate the capability to identify, monitor, and mitigate/neutralize toxic risks. Developed sensor materials for detection, mitigation, avoidance, and warning of operational toxic materials. Identified tracer emissions for detection and modeling of chemically-based atmospheric threats.

(U) $673 Discovered and characterized novel enzymatic reactions for applications in biotransformations and biocatalytic synthesis of high-performance materials. Explored biotransformation and biocatalytic generation of Air Force unique materials.

(U) $2,704 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

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PROJECT: 1900	

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0601102F, Defense Research Sciences
(U) PE 0602102F, Materials
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0603112F, Advanced Materials for Weapon Systems.
(U) PE 0603211F, Aerospace Structure
(U) PE 0603723F, Environmental Engineering Technology.
(U) PE 0603716D, Strategic Environmental Research and Development Program.
(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: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 7184

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
7184	Crew System Interface & Protection	35,624	37,708	34,124	32,954	37,226	39,194	39,671	40,826	Continuing	TBD

Note: In FY 2000, studies in support of Distributed Mission Training moved from Project 7184 to Project 1123.

(U) A. Mission Description

This project develops the technology required to improve human performance, protection, 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, sustained acceleration, spatial disorientation, altitude, workload, and sustained operations; 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 warfare, team communications, and crew scheduling and fatigue management. It conducts experiments and evaluations of control interfaces, crew station layout and functional integration, emergency escape, crash protection, aircrew oxygen systems, acceleration protection, and aircrew life support.

(U) FY 2000 ($ in Thousands)

(U) $3,841 Developed interface technologies for crew station and equipment accommodation, multi-sensory displays, adaptive controls, and performance metrics. Interface technologies promote cognitive and physical fit with air and ground control stations to enhance effectiveness and safety. Continued to develop reliable workload predictors and a near-real-time classification of crew overload and demonstrate a next generation crew station under joint Air Force-France agreement. Demonstrated improved control station for uninhabited aerial vehicles. Planned validation of inventory cockpit accommodation maps and complete data analysis of U.S. part of multi-national whole-body three-dimensional survey.

(U) $2,913 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. Completed a cognitive task analysis and identified information requirements for an Information Warfare Watch Center. Demonstrated high-accuracy speech recognition in a fighter test aircraft and demonstrated speech countermeasures in an operational exercise. Integrated and demonstrated voice recognition and laser pointer/tracker technologies with large screen interactive display for command center operations.

(U) $3,712 Developed concepts for integrating human computer interface technologies, human performance modeling tools, and real-time simulations to affordably quantify operational benefit from new interface technologies. Explored new human-computer interface options for future unmanned vehicle control stations. Advanced integrated control and display concepts for air operations, concentrating on effectively melding on-board data with off-board data, and on flight displays that support complex landing approaches. Began drafting a design notebook for tactical re-supply crew stations.

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PROJECT 7184	

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $4,297 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. Visual display interface technologies enhance situational awareness, warfighter performance, combat effectiveness, and survivability. Conducted studies to understand the trade off of night vision goggle optical resolution with field-of-view. Identified ways to increase sunlight readable display efficiency. Conducted study of helmet-mounted display contrast requirements for color recognition.

(U) $2,259 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. Conducted a feasibility demonstration of an integrated three-dimensional audio headset with noise reduction and CD quality digital audio. Demonstrated the ability to reduce the acoustic signature for special operations aircraft. Began a program to exploit the use of audio signals to add a new capability for remote threat detection in perimeter defense.

(U) $1,538 Conducted altitude protection and acceleration physiology research to maximize warfighter survivability and combat effectiveness in the aerospace flight environment. Research will define life support equipment design concepts and procedures to enable safe flight operations at high altitudes and high sustained accelerations. Determined risks for aircrews engaged in unpressurized flight at high altitude for extended periods of time. Investigated performance and comfort issues associated with pressure breathing technology for tactical aviators.

(U) $5,528 Developed human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Defined human impact tolerance limits, and used these to design and validate mathematical or physical models of human response to impact environments. Research focused on full aircrew accommodation issues, including definition of ejection seat haulback/retraction criteria and spinal injury criteria to minimize probability of injury. Evaluated multi-axis head and neck response for the development of tolerance and injury criteria to minimize injury risk during ejection with helmet-mounted devices. Evaluated helmet biodynamic properties in the sustained acceleration environment and assessed the physiological effects of multi-axis maneuvering.

(U) $2,596 Conducted warfighter fatigue and spatial disorientation countermeasures research. Results will extend and enhance cognitive performance during long-range deployment, global attack, and around the clock surge operations and explore ways to reduce aircraft mishaps due to spatial disorientation. Established feasibility of using newly developed alertness enhancing stimulants in Air Force missions and developed fatigue avoidance mission planning technologies. Characterized spatial disorientation problems related to helmet-mounted displays, night vision goggles, and agile aircraft flight profiles.

(U) $1,634 Developed technologies to self-produce, liquefy, store, and deliver both nitrogen enriched air and high purity oxygen for application on-board airlift aircraft. Technologies will enhance the inert gas fuel tank fire suppression system and improve capability to meet life support oxygen requirements during high altitude parachute operations. Developed miniaturized distillation column air separation techniques and cryogenic refrigeration technology and combined designs to generate both nitrogen and oxygen in a single integrated package.

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PROJECT: 7184	

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,884	Developed solid state electrolyte oxygen generation technologies for aircraft on-board oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Pursued improvements to increase oxygen flow rates, reduce power consumption, and decrease operating temperatures of existing ion conducting ceramics technology. Investigated requirements for utilization and integration of solid state electrolyte oxygen generators as on-board systems.
(U)	$3,461	Provided human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.
(U)	$961	Conducted international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Joint demonstration determines feasibility and matures technology for a class of affordable crew stations common to airborne early warning, attack aircraft, and unmanned vehicles by exploiting virtual controls and displays. Established common environment between Australia's airborne early warning and control simulator and the Air Force Research Laboratory's synthesized immersion research simulator for joint experiments. Began to develop an integrated multi-sensory crew station to demonstrate the virtual air commander concept.
(U)	$35,624	Total

(U) FY 2001 ($ in Thousands)

(U)	$4,188	Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Complete multi-sensory control station and operator workload classification algorithm and incorporate into laboratory demonstration of unmanned aerial vehicle control. Validate cockpit accommodation maps of inventory aircraft. Begin to develop an intelligent, on-line physical accommodation information system to optimize equipment fit, and include Dutch anthropometric data from multi-national survey.
(U)	$3,280	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 to improve decision-making. Develop and demonstrate new user-computer interface for all-source intelligence analysts for faster and more accurate decision-making. Continue research on speech signal processing and speech-based countermeasures for information operations.
(U)	$4,377	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. Complete a feasibility evaluation of an integrated control interface for unmanned vehicles, demonstrating multi-vehicle per mission operation. Develop integrated flight path and synthetic terrain concept for primary flight reference on heads-up displays.

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $4,367 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. Establish helmet-mounted display symbology specifications for strike missions. Conduct study to determine the influence of helmet visor transmissivity and reflectivity on visual target detection.

(U) $2,618 Develop advanced audio displays including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Complete a feasibility demonstration of an integrated 3-D audio headset with noise reduction and CD quality digital audio. Develop acoustic processing algorithms and an intuitive human centered interface to add a new capability for remote threat detection in perimeter defense. Develop preliminary auditory symbology design criteria for improving situational awareness using 3-D audio displays.

(U) $3,448 Develop human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including emergency escape and crashes. Incorporate tolerance and injury criteria into the development of mathematical models to be used for injury assessment. Continue study to define multi-axis head and neck response during impact. Define male and female tolerance standards to improve injury prediction in dynamic environments and to optimize restraint concepts. Refine biodynamic performance assessment of helmet-mounted devices to optimize safe helmet-mounted system concepts.

(U) $6,419 Develop aviation safety enhancing technologies to alleviate warfighter fatigue, counter spatial disorientation, and improve pilot performance under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions, reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Expand the capabilities of the fatigue avoidance scheduling tool to predict the effects of pharmaceutical countermeasures on fatigue, and initiate efforts to extend the management of fatigue so as to apply its impact on decision making as a component of Information Warfare strategy. Evaluate effectiveness of candidate techniques to improve spatial orientation capabilities in aircrew wearing night vision goggles. Evaluate feasibility of employing innovative pressure application techniques and advanced materials to improve pilot performance by reducing the bulk, weight, and thermal burden of existing acceleration protection ensembles.

(U) $3,963 Develop solid state electrolyte oxygen generation technologies for aircraft and ground-based oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Continue research to improve oxygen production efficiency, lower power consumption, lower operating temperature, and improve thermal management concepts. Design, fabricate, and conduct laboratory testing of solid state electrolyte oxygen generator concepts.

(U) $3,165 Provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.

(U) $1,487 Conduct international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Perform international laboratory experiment in each country using real-time simulators employing distributed interactive simulation technology. Demonstrate feasibility of an integrated multi-sensory crew station for virtual air commanders tailored for early warning and control mission.

(U) $396 Conduct altitude protection research to maximize warfighter survivability and combat effectiveness in the aerospace flight environment. Research will define life support equipment design concepts and procedures to enable safe flight operations at high altitudes. Continue studies to quantify altitude decompression sickness risk for special operations and combat search and rescue missions in unpressurized aircraft.

(U) $37,708 Total

(U) FY 2002 ($ in Thousands)

(U) $4,231 Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Determine the feasibility of extending real-time workload classification technology into unmanned combat aerial vehicle operations, and evaluate reduced crew operation in a multi-sensory unmanned aerial vehicle control station. Complete 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. Perform laboratory experiments using a virtual air command station to determine human interface design requirements for airborne early warning and control.

(U) $5,237 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 to improve decision-making. Continue to devise user-computer interface concepts for intelligence analysts, investigate a display interface for integrated asset management, analyze decision-support aids for Air Operations Centers, and provide a laboratory demonstration of a rapid shared display for command center situation awareness. Begin analysis and definition of human-machine interfaces and decision support tools for global attack. Begin development of operator interface concepts and descriptive performance metrics in support of the Targets Under Trees program. Continue research on speech signal processing and speech-based countermeasures for information operations, including a concept demonstration of an intelligent voice jammer.

(U) $4,424 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. Produce design guidelines for an integrated control interface for unmanned

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

vehicles. Continue to develop operator-vehicle interface concepts for exploiting real-time, off-board data and demonstrate payoffs for mobility/special operations missions in laboratory simulations. Complete a feasibility evaluation for validating a digital model of human decision-making behavior.

(U) $4,412 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. Conduct study on replacing the heads-up display with a helmet-mounted display, establish color contrast guidelines, and develop frames of reference and symbology for attitude displays. Establish design guides for windscreens and night vision displays. Determine resolution and brightness requirements for large flat-panel displays.

(U) $2,837 Develop advanced audio displays including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Plan system integration and laboratory test as initial implementation for an acoustic remote threat detection in perimeter defense. Conduct research on (50 dB) hearing protection technologies for improved performance in high performance aircraft. Develop human performance standards for helmet-mounted cueing systems in vibratory environments.

(U) $1,400 Complete human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.

(U) $1,000 Develop 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 will provide 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 will model effects of cross-cultural communications on human decision-making behavior. Auditory and visual technologies will be applied to develop perception management tools for offensive counter-information applications.

(U) $3,306 Develop human injury and protective systems design criteria for use against hazards encountered in crash environments and emergency escape. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including crashes, emergency escape, and parachute opening shock. Begin developing injury assessment toolbox to be used in conducting injury risk assessment on personal protection and life support equipment, and seat and cockpit systems. Develop analysis techniques for evaluating data from ejection seat recorder. Conduct laboratory studies on adaptable restraint system technologies for application across Air Force airlift aircraft.

(U) $7,277 Develop aviation safety technologies to alleviate/mitigate warfighter fatigue, counter spatial disorientation, and improve pilot performance under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

global attack missions. This research will also reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Extend fatigue management technologies to provide operational commanders and mission planners with the capability to evaluate effects of alternative applications of performance enhancing pharmacological agents and non-pharmacological fatigue countermeasures on crew performance and mission effectiveness. Conduct 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. Focus acceleration protection research efforts on defining physiological and performance effects of thrust-vectored flight and assessing the effects of pharmaceutical fatigue countermeasures and current and emerging operational biological prophylactic agents on flight safety and pilot effectiveness in the high performance/high demand cockpit of modern fighter aircraft.

(U) $34,124 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 0602702F, Command, Control, and Communications
(U) PE 0603205F, Aerospace Vehicle Technology.
(U) PE 0603227F, Personnel, Training and Simulation Technology.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) PE 0603245F, Flight Vehicle Technology Integration.
(U) PE 0604227F, Distributed Mission Training (DMT).
(U) PE 0604703F, Aeromedical/Casualty Care Systems Development.
(U) PE 0604706F, Life Support Systems.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

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(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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BUDGET ACTIVITY: 02 - Applied Research

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PROJECT: 7757

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
7757	Directed Energy Bioeffects	8,278	10,542	12,310	12,341	11,718	12,020	11,522	11,863	Continuing	TBD

Note: In FY 2000, the toxicology hazards research program moved from Project 7757 to project 1710. In FY 2001, Congress added $1.0M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for detection of nosocomial infections. The funding was realigned to PE 0602202F, Project 7757, to align the funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312, Defense Research Sciences. However, the effort is described in PE 0602202F, Project 7757.

(U) A. Mission Description

This project enables the safe operational use of Air Force directed energy weapon systems through technology development related to the biological effects of electromagnetic radiation used in, or resulting from, Air Force operations. The project identifies and mitigates the biological effects of exposure to radio frequency radiation, high power pulsed microwaves, lasers, broad band devices, and ultra-wide band pulsed fields by addressing areas such as safety, risk assessment, mission planning, and countermeasures. The project also assesses the bioeffects of non-lethal directed energy technologies for special operations, missions other than war, and peacekeeping applications. Finally, this project provides technical consultative support to other DoD programs to assess and counter optical and radio frequency radiation hazards and threats.

(U) FY 2000 ($ in Thousands)

(U) $3,136 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. Pursued assessments/evaluations of foreign directed energy weapons to better define threats and countermeasures. Initiated experiments with Federal Aviation Administration to introduce safe active lasing into aircrew operational environments to assess impact, improve tactics development, and define specific mission training requirements. Explored optical technologies to achieve information warfare dominance.

(U) $4,611 Conducted radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy weapons, communications, and radar. Provided data on cancer development and birth defects for revised human exposure standard for ultra-wide band pulsed microwaves. Began Air Expeditionary Force Agile Combat Support Initiative for portable High Energy Microwave Active Denial Technology. Conducted wave propagation modeling for information warfare applications.

(U) $531 Evaluated Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collected and analyzed first year post-operative data.

(U) $8,278 Total

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$4,123	Conduct 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. Initiate work with the United States Marine Corps Joint Non-Lethal Weapons Directorate to develop non-lethal laser use guidelines in compliance with DoD/International Policy while enhancing effectiveness. Complete the personnel biological effects model to assess combat vulnerability to emerging optical threats. Develop and demonstrate technology to produce a safe, active lasing experience into aircrew simulators, leading to development and refinement of engagement tactics, countermeasures, and training requirements. Expand research in optical technology development for information warfare. Complete experiments with Federal Aviation Administration on safe active lasing.
(U)	$5,923	Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy weapons and radar. Continue Air Expeditionary Force Agile Combat Support initiative for portable High Energy Microwave Active Denial Technology. Complete studies of millimeter effects on skin cancer and corneal eye damage for DoD exposure guidance. Continue wave propagation modeling for information warfare applications.
(U)	$496	Evaluate Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collect and analyze second year post-operative data.
(U)	$0	Develop rapid diagnostic and fingerprintion techniques along with molecular monitoring systems for the detection of noscomial infections.
(U)	$10,542	Total

(U) FY 2002 ($ in Thousands)

(U)	$5,614	Conduct 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. Assess bioeffects of agile laser technologies. Provide guidance for non-lethal laser illuminator employment. Demonstrate technologies for safe, active lasing in aircrew simulators, supporting improved engagement tactics, countermeasures, and laser safety training requirements.
(U)	$5,848	Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of electromagnetic energy for directed energy weapons, non-lethal weapons, communications, and radar. Evaluate celluar damage and behavioral/cognitive disruption from pulsed radio frequency emitters. Continue health and safety studies on millimeter waves. Improve technology and models for radio frequency exposure prediction, assessment, and hazard warning.
(U)	$300	Conclude post-operative evaluation and issue interim recommendations on the study of Photorefractive Keratectomy as a surgical method to reduce aircrew need for glasses or contact lenses.
(U)	$548	Develop safety design criteria for portable Active Denial Technology in support of the Air Expeditionary Force/Agile Combat Support initiative,

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602202F Human Effectiveness Applied Research	7757

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

enabling safe exploitation of directed energy weapons. Research and resolve human safety, control, and pointing and tracking issues of directed energy. Verify the non-harmful effects of the active denial technology. Develop safety design criteria for directed energy systems using validated computer model.

(U) $12,310 Total

(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 0602777A, Systems Health Hazard Prevention Technology.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology
(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.