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

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BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	85.883	85.128	79.442	87.812	78.843	82.083	82.540	82.504	Continuing	TBD
1123	Warfighter Training	8.668	12.504	12.120	14.581	13.352	14.021	14.097	14.147	Continuing	TBD
1710	Deployment and Sustainment	8.006	9.783	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
7184	Decision Effectiveness & Biosciences	37.867	38.679	51.326	53.567	48.122	50.409	50.782	50.817	Continuing	TBD
7757	Bioeffects and Protection	31.342	24.162	15.996	19.664	17.369	17.653	17.661	17.540	Continuing	TBD

Note: In FY 2006, Deployment and Sustainment efforts will move from Project 1710 to Project 7184.

(U) A. Mission Description and Budget Item Justification

This program establishes technical feasibility and develops technology for protecting and enhancing human effectiveness for Air Force weapon systems and for operational readiness. The program addresses warfighter training, deployment and sustainment of forces, crew system interface, biodynamic response, directed energy bioeffects, crew performance and protection, and counterproliferation. 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 supportability of the force and weapon systems. The Decision Effectiveness and Biosciences project develops and evaluates technologies that will improve human performance and combat effectiveness. The Bioeffects and Protection project develops technologies to predict and mitigate the biological effects of aerospace stressors, directed energy, and other threats on personnel and mission performance. Note: In FY 2005, Congress added $1.1 million for Networked Warfighter Decision Support, $1.1 million for AFSOC Battlefield Air Operations Kit, $1.0 million for Bio Medical DNA Program, $1.5 million for IMPRINT for UAVs, $1.0 million for Photovoltaic Hydrogen and Flexible PV for Portable Power (transferred to PE 0602203F for execution), $1.4 million for Laser Bioeffects, $1.4 million for Special Operations Target Acquisition and Control Suite, and $6.9 million for Solid Electrolyte Oxygen Separator. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	87.143	71.483	74.724	86.961
(U)	Current PBR/President's Budget	85.883	85.128	79.442	87.812
(U)	Total Adjustments	-1.260	13.645		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.755		
	Congressional Increases		14.400		
	Reprogrammings				
	SBIR/STTR Transfer	-1.260			
(U)	Significant Program Changes:				

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Not Applicable.

C. Performance Metrics
Under Development.

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PROJECT NUMBER AND TITLE: 1123 Warfighter Training

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
1123	Warfighter Training	8.668	12.504	12.120	14.581	13.352	14.021	14.097	14.147	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project identifies and analyzes new methods and technologies to improve Air Force training and education. The research focuses on aircrew training; technical training; mission rehearsal; training in support of complex decision-making; information warfare training; and warfighter 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 combines fundamental knowledge from the cognitive and neural sciences with information technology to create desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation technologies to achieve maximum learning effectiveness for specific needs at minimum cost. These technologies and methods will increase operational readiness by providing more effective methods and approaches to train and assess personnel. This project contributes to a more highly trained and flexible cadre of personnel at a reduced cost.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Research perceptual issues involving the development of new visual technologies to enhance Distributed Mission Operations (DMO) environments. Research identifies the visual requirements necessary for realistic aircrew training and mission rehearsal, allowing Air Force warfighters to train as they intend to fight.	1.277	1.620	1.597	2.281

(U) In FY 2004: Identified requirements for and evaluated the capabilities and performance of various visual system technologies. Defined the visual requirements relevant to performing the Distributed Mission Training (DMT) tasks, identified which visual system characteristics and parameters have significant perceptual effects, and determined how the visual system can be optimized to minimize artifacts and to maximize image quality. Identified functional requirements for deployable and helmet-mounted display technologies for fast jet visual simulation. Quantified the effect network time delays have on aircrew visual-task performance.

(U) In FY 2005: Develop and apply techniques and devices to evaluate projector displays and visual system components. Evaluate existing and proposed Helmet-Mounted Displays (HMD) and deployable display technologies for use in visual simulation and training. Identify specifications of the functional requirements for deployable displays and HMDs for training and recommend features required beyond those in commercially available devices.

(U) In FY 2006: Research and analyze human factor and perceptual issues for off-boresight targeting simulation in DMO multifaceted simulator displays. Evaluate and research techniques for cockpit, helmet-mounted, and out-the-window visual simulation systems for air-to-ground and composite force training. Identify, research, and resolve head-mounted and deployable display issues for next generation

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deployable visual simulation systems. Conduct engineering and human factors analyses of display devices.

(U) In FY 2007: Research and specify key perceptual performance parameters for deployable visual display systems including resolution, image stability, target tracking accuracy, and transport delay. Assist in the development of head-mounted and deployable display proof-of-concepts that meet these specifications. Continue research and evaluation of visual system requirements for air-to-ground and composite force training. Conduct engineering and human factors analyses of display devices.

(U)

(U) MAJOR THRUST: Research and analyze 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 through the identification of competency-based training methods.	6.395	7.788	8.585	8.823

(U) In FY 2004: Completed specifications of mission essential competencies for operators in major air operations center divisions and teams. Completed preliminary training effectiveness evaluations with the Air Force Weapons School and an operational mission training center. Developed a study plan for dynamic aerospace control training incorporating command and control, air combat, and coalition entities.

(U) In FY 2005: Complete guidelines for applying DMT to the Air Combat Command Ready Aircrew Program training and mission objectives based on identified competencies. Complete specification of mission essential competencies for operators in Air Operations Center (AOC) specialty teams and unique positions. Develop competency-based behavioral models and representations of select operators for use in simulation-based training systems. Complete development of specification tools for coalition training and collaborative mission planning.

(U) In FY 2006: Evaluate integrated learning and readiness assessment models, data, and specifications. Assess usability of exemplar DMO training scenario design tool. Explore and evaluate virtual environment training syllabi capable of tailoring to individual needs. Investigate fully immersive training environments, with realistic, interactive visual scenery that can be adapted by multiple platforms. Analyze how spin-up time after brief and extended delays can be reduced with virtual reality training.

(U) In FY 2007: Evaluate capability to assess proficiency within operational contexts. Identify guidelines for refresher and continuation training and rehearsal. Analyze and review instructional designs for common training requirements across airframes. Begin development of a fully immersive training environment, with realistic, interactive visual scenery, that can be adapted for multiple platforms. Develop a migration transition plan from hardware-dependent training simulators to software-dependent

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	training environments.				
(U)					
(U)	MAJOR THRUST: Explore performance improvement techniques to enhance aerospace operational training in realistic mission training environments. Research provides enabling technologies for improving readiness across an assortment of Air Force career fields, from air combat forces to command and control personnel.	0.996	1.596	1.938	3.477
(U)	In FY 2004: Utilized quantitative data collection techniques to analyze the overall functional process, as well as individual component tasks. Devised techniques to overcome training process shortfalls or inefficiencies.				
(U)	In FY 2005: Enhance air and space operations through the investigation of training principles, guidelines, and criteria for use in synthetic training environments. Explore application of cognitive science principles for use in preparing and sustaining aerospace expeditionary forces.				
(U)	In FY 2006: Create a communication model through cognitive science principles and techniques to improve the training of AOC airmen. Establish computational techniques to predict how the distribution of training opportunities influences the acquisition and long-term retention of complex skills by verifying and validating predictive skill acquisition and decay models with DMO data.				
(U)	In FY 2007: Integrate the communication model into a proof-of-concept synthetic communication agent for AOC training. Verify and validate the performance moderator prediction system and integrate with mission essential competencies to predict training requirements for airmen and demonstrate ability to produce individualized training programs.				
(U)					
(U)	CONGRESSIONAL ADD: Improved Performance Research Integration Tool (IMPRINT) for Unmanned Aerial Vehicles (UAVs).	0.000	1.500	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Design and implement an enhancement to IMPRINT that could create the capability to estimate the impact of how initial training, subsequent non-use, and recovery of knowledge and skills affect performance in a system/mission context.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	8.668	12.504	12.120	14.581

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602233N, Human Systems Technology.										
(U) PE 0602716A, Human Factors Engineering Technology.										
(U) PE 0602785A, Personnel Performance and Training Technologies.										
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.										
(U) PE 0604227F, Distributed Mission Training (DMT).										
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

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BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT NUMBER AND TITLE: 1710 Deployment and Sustainment

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
1710 Deployment and Sustainment	8.006	9.783	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, Deployment and Sustainment efforts will move from Project 1710 to Project 7184.

(U) A. Mission Description and Budget Item Justification

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

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs.	2.087	2.025	0.000	0.000
(U) In FY 2004: Completed development of transformation algorithms and interface requirements for virtual validation of maintenance technical order data. Developed software components to realistically model human interaction with synthetic team members. Developed advanced human-computer interface technology for logistics and control systems.				
(U) In FY 2005: Conduct research to establish the science base for simulation of cognitive behavior. Develop algorithms and interface requirements for logistics reachback in support of contingency operations. Develop software components to accurately model mixed initiative (human and synthetic actor) decision-making support.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for AEF operations.	3.583	1.559	0.000	0.000
(U) In FY 2004: Continued 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. Continued work to define the technology requirements and component research areas necessary to support a completely automated maintenance environment. Identified advanced				

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simulation requirements and technology options for Air Force units to select the best options for using limited logistics resources in crisis action circumstances.

(U) In FY 2005: Examine new techniques to identify both functional and system requirements, as well as new information presentation techniques for future logistics and maintenance software tools. Continue working to define the requirements and component technologies necessary to support a more automated and responsive maintenance environment. Design foundational models for advanced simulation capabilities that optimize limited logistics resources during operations. Begin work on defining "sense-respond" capabilities which will promote effects-based logistics through a common operating picture.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) MAJOR THRUST: Develop, demonstrate, and apply predictive assessment models to determine the toxicological risks to airmen if exposed to operational compounds and materials. This will improve commanders' decision-making ability to properly balance mission and force protection requirements.	1.111	0.862	0.000	0.000

(U) In FY 2004: Investigated the use of genomics, proteomics, and metabonomics to predict toxic combinations of chemicals and to measure exposures of airmen to toxic chemicals before any adverse health effects occur. Developed simulation models to predict the effects on operational forces in different exposure situations.

(U) In FY 2005: Develop biotechnology procedures and computer simulation models to predict effects of toxic exposure on airmen and improve the protection of Air Force personnel. Develop and demonstrate algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bio-electromechanical capability for Air Force systems.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) MAJOR THRUST: Develop nuclear magnetic resonance (NMR) technologies that will identify warfighter exposure to toxic chemicals before they result in illness or a reduction in mission performance, thus greatly improving force protection and the probability of mission success.	1.225	4.337	0.000	0.000

(U) In FY 2004: Initiated genomic and NMR studies to identify target-organ biomarkers in body fluids of the deployed warfighter exposed to hazardous agents. Validated target-organ NMR pattern recognition algorithms for early detection of the effects of unknown hazardous agents on Air Force personnel.

(U) In FY 2005: Conduct genomic and NMR studies and initiate proteomic and metabolite studies to identify target-organ biomarkers in body fluids of the deployed warfighter exposed to hazardous agents.

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Assess target-organ response biomarker patterns for early detection of the effects of unknown hazardous agents on Air Force personnel.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Bio Medical DNA Program.	0.000	1.000	0.000	0.000

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Initiate Congressionally-directed effort for Bio Medical DNA Program.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U) Total Cost	8.006	9.783	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602233N, Human Systems Technology.										
(U) PE 0602716A, Human Factors Engineering Technology.										
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.										
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

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BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT NUMBER AND TITLE: 7184 Decision Effectiveness & Biosciences

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
7184	Decision Effectiveness & Biosciences	37.867	38.679	51.326	53.567	48.122	50.409	50.782	50.817	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, Deployment and Sustainment efforts will move from Project 1710 to Project 7184.

(U) A. Mission Description and Budget Item Justification

This project develops the technology required to enhance deployment capabilities, human performance, biodynamic response, and survivability in all operational environments. By investigating the technologies to enhance deployment capabilities this program seeks to improve logistical support for peacetime and combat operations. This research further defines 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, workload and optimizing the human-machine interface. It produces human-centered design criteria, guidelines, and design tools for developing effective human-system interfaces. It develops and assesses technologies for information display, human-centered information operations, team communications, modeling and simulation, and human-centered Intelligence, Surveillance, and Reconnaissance operations. It conducts experiments and evaluations of control interfaces, crew station layout and functional integration, aircrew information processing, crash protection, and emergency escape technologies. It also develops biotechnologies and tools to minimize the risks and mission impact to DoD personnel from exposure to hazardous chemicals, while also reducing weapon systems life cycle cost.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop interface technologies that enhance human-human and human-machine collaboration in network-centric warfare environments. These technologies will enable the common operational understanding and shared, distributed decision making required on the modern battlefield.	4.428	4.949	5.038	4.992

(U) In FY 2004: Demonstrated a real-time ability to use on-line estimates of crew workload and situational awareness to adjust automation during future unmanned combat air vehicle missions. Performed 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. Performed research on speech signal processing and speech-based countermeasures for information operations, and explored the concept of a robust stressed-speaker identification capability.

(U) In FY 2005: Demonstrate the feasibility of a situational awareness estimator to improve real-time task sharing during multi-platform unmanned combat air vehicle missions. Continue to explore the decision support benefits of multi-sensory controls and displays for intelligent autonomous air vehicles and for multi-mission command and control aircraft, and demonstrate a common functionality for ground control centers and for airborne control platforms. Perform laboratory simulations to determine strike chain efficiencies achievable from network-centric interfaces that span airborne controllers, unmanned

vehicles, and special forces on the ground. Continue research on speech signal processing and speech-based countermeasures for information operations and demonstrate a multimedia speech extraction interface.

(U) In FY 2006: Begin spiral development of a laboratory prototype of a speech recognizer/synthesizer based on multilingual phoneme acoustic models designed to enhance collaboration between multinational forces. Complete development of human-machine interface style guide and begin development of a collaboration toolkit, both essential for developing effective warfighter interfaces for air battle management command and control (BMC2). Complete development of an operator cognitive state assessment package that enables real-time human-machine collaboration.

(U) In FY 2007: Determine the risk and benefit of adding language, accent, and domain models into the laboratory speech recognizer/synthesizer, and continue to develop advanced speech processing technology. Complete development of a collaboration toolkit for BMC2. Develop and evaluate BMC2 decision support technologies, and plan to demonstrate operational benefits in an advanced technology program.

(U)

(U) MAJOR THRUST: Develop cognitive system interface technologies to achieve common understanding at all echelons of operations and to improve decision-making and predictive battlespace awareness. These technologies offer breakthrough potential for understanding and modeling human behavior, in order to assure timely and effective decisions, while also providing context-sensitive human-computer interfaces that support decision effectiveness.	3.409	2.559	3.576	3.510

(U) In FY 2004: Performed laboratory and field evaluations of a cognitive interface and knowledge repository to support information operations in the future air operations center. Began exploration of information, display, and course-of-action aids by analyzing information needs and by developing a combat operations visualization concept. Supported the Targets Under Trees program by evaluating target nomination advances in a field exercise.

(U) In FY 2005: Transition to advanced development a cognitive interface and knowledge repository to support decision making in the future AOC. Continue a multi-year exploration of information, display, and course-of-action aids by demonstrating a multi-mode information interface to speed air tasking orders.

(U) In FY 2006: Identify and develop software design patterns that enable the standardization and reuse of human-computer interface elements in Command and Control Intelligence, Surveillance, and Reconnaissance systems. Begin to develop collaboration techniques that enable diverse users to share a common object representation of the problem domain. Perform laboratory research on the cultural and ethnic bases of human decision-making. Develop methods to represent knowledge about adversaries as a

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key technology in overcoming barriers that limit effects-based operations.

(U) In FY 2007: Continue development and begin the transition to advanced development of software design patterns that enable the standardization of human-computer interface elements in Command and Control Intelligence, Surveillance, and Reconnaissance systems. Continue to develop collaboration techniques and methods to embed them in command and control systems. Continue researching the cultural and ethnic bases of human decision making and begin to develop human performance models that reflect these differences to enable effects-based operations.

(U)

(U) MAJOR THRUST: Establish the technology base for a decision support environment that enables the Joint Forces Commander (JFC), Joint Force Air Component Commander (JFACC), and command staffs to interrelate the past, present, and future battlefield mission states and to predict the intent and actions of adversaries during Joint Operations. Note: In FY 2006, this increase in funding is due to greater emphasis on commanders decision aids.	0.000	0.000	4.250	3.750

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Begin developing advanced visualization techniques that enable the uncertainty associated with information to be incorporated into the iconic or graphic portrayal scheme for command center display. Begin to develop methods to simulate enemy potential courses of action. Begin the development of “sensemaking” tools for dynamic battlefields. Begin research toward developing knowledge representation techniques to model potential adversaries and complex systems of systems. Begin research to develop an integrated set of work aids that will support a commander's decision-making in a future environment of continuous Anticipatory Planning and Operations (APO).

(U) In FY 2007: Continue developing advanced visualization techniques that enable the uncertainty associated with information to be incorporated into the iconic or graphic portrayal scheme for command center display. Continue to develop, and begin to transition to advanced development, needed methods to simulate enemy potential courses of action, beginning with simple models of adversary behavior. Conduct laboratory experiments to evaluate “sensemaking” tools and displays for dynamic battlefields. Continue to develop knowledge representation techniques to model potential adversaries and complex systems of systems. Continue to develop an integrated set of APO work aids to achieve persistent operational planning, persistent prediction, and focused execution even as military and broad national security objectives are dynamically changing.

(U)

(U) MAJOR THRUST: Develop system control interface concepts enabling full operator exploitation of all platform capabilities. Identify the best mix of intelligent methods and traditional design to	3.187	3.661	4.664	4.873

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unambiguously direct the operator's attention, which is critical for net-centric operations. Employ real-time and wargaming simulations to quantify operational benefits from new information portrayal concepts.

(U) In FY 2004: Demonstrated an operator-vehicle interface for mobility using real-time, off-board data to assure tactical information dominance with minimum crew size. Demonstrated a control-display interface to reduce task load and channelized attention for single operator control of multiple unmanned combat air vehicles. Continued to evolve new models of human perception, decision-making, and control, and explored model validation strategies.

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

(U) In FY 2006: Using virtual simulation, evaluate decision support interface concepts to enable single operator supervision of multiple semi-autonomous unmanned systems. For unmanned combat air vehicles, evaluate first generation control-display concepts that reduce operator task load and mitigate channelized attention. Continue to develop fusion algorithms that combine on-board and off-board sensor data with imagery. Begin to explore the integration of computer-generated pictures with sensor images to enable autonomous approach and landing.

(U) In FY 2007: Demonstrate real-time assessment tools and advanced decision support interfaces, including prediction capability, for maximizing single operator supervision of multiple highly autonomous unmanned aerial vehicles within net-centric environments. Begin design and development of second generation control-display concepts that reduce operator task load and mitigate channelized attention. Begin algorithm development to blend display imagery with computer-generated graphical representations of terrain and real-time data to conduct autonomous landing and ground operations at night and during adverse weather.

(U)

(U)	MAJOR THRUST: Develop visual display interface technologies, specifically Helmet-Mounted Displays (HMDs), night vision technologies, and large flat-panel displays. Develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Task optimized visualization and vision enhancement using these technologies enable higher information consumption rates day and night across mission applications.	3.745	4.980	5.292	5.113

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

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

(U) In FY 2006: Continue development of algorithms to electronically enhance vision when using head-mounted solid state imagers. Evaluate those algorithms using realistic simulations of warfighter visual tasks. Begin development of methods to depict command and control and other complex types of information in intuitive, easy to understand ways.

(U) In FY 2007: Continue to evaluate and improve algorithms to electronically enhance vision when using head-mounted solid state imagers. Continue development of methods to depict command and control and other complex types of information in intuitive, easy to understand ways. Evaluate the methods using realistic simulations of the targeted combat environments.

(U)

(U) MAJOR THRUST: Develop advanced audio display technologies for human-to-human collaboration including three-dimensional audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance and information processing in the operational environment. In particular, these battlespace acoustic interfaces will integrate with warfighter equipment and amplify information throughout.	3.267	2.888	4.051	3.929

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

(U) In FY 2005: Complete technology assessment of acoustic remote threat detection in perimeter defense,

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and explore the use of acoustic detection capabilities by special tactics forces. Demonstrate the feasibility of combining active noise reduction with three-dimensional (3-D) audio communications for a high performance (50 dB) hearing protection system. Identify a concept to validate the dynamic noise model in terms of lowering the cost of collecting acoustic data, and explore acoustic modeling for operational analysis. Begin to analyze how to minimize acoustic detection of vectored thrust aircraft. Begin to develop virtual audio interface technology using dynamic audio/visual interaction for use with HMDs.

(U) In FY 2006: Begin to research acoustic signal control to improve human-to-human communications through noise reduction systems and improved acoustic signal processing. Continue to explore the value of acoustic modeling for operational analysis. Continue to analyze how to minimize acoustic detection of vectored thrust aircraft. Begin to develop auditory information aiding technologies for improving collaboration in operational command and control environments. Explore how the novel use of ultrasonic auditory projection can enhance command and control operations.

(U) In FY 2007: Continue to research acoustic signal control to improve human-to-human communications in operational environments by improving noise reduction technologies and use of acoustic signal processing to improve information gathering for security forces. Begin to research methods to incorporate weather effects on noise propagation and ways to represent weather effects in dynamic noise models. Continue to develop auditory information aiding technologies for remote collaboration. Explore how to improve audio symbology for streamlining command and control operations including 3-D audio symbology. Begin to explore the human processes that lead to communication breakdown.

(U)

(U) MAJOR THRUST: Develop integrated human-centered information operations and Intelligence, Surveillance, and Reconnaissance (ISR) technologies to provide quicker and more intuitive access to information, enhanced decision-making capabilities, and more effective training procedures.	5.723	5.945	9.212	11.065

(U) In FY 2004: Conducted 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. Determined feasibility and technical approach for developing adversary cultural decision models, and development of training techniques and tools for information warriors.

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

(U) In FY 2006: Conduct research to develop better visualization for spectral data exploitation and to improve predictive battlespace awareness capabilities. Continue next stage of developing

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proof-of-concept technologies to specify, measure, and model key parameters.

(U) In FY 2007: Conduct research and implementation of models for ISR and information operations. Develop conceptual human system interfaces for additional Measurement and Signatures Intelligence capabilities, specifically in the spectral area. Complete development of proof-of-concept technologies to specify, measure, and model key parameters.

(U)

(U)	MAJOR THRUST: Develop human injury criteria and protective system technologies to provide sanctuary from injury causing threats to military personnel. Research will develop technologies to ensure full aircrew population accommodation and safety during military operations including vibration, crashes, emergency escape, extended missions, and parachute opening shock.	6.330	4.204	5.641	5.610

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

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

(U) In FY 2006: Using available safety and medical databases, evaluate and begin addressing primary Air Force injury and physical health effects causes. Define criteria functions to relate seat cushion comfort to measurable parameters for use in seating requirements. Develop initial collaborative information system for analyzing environmental threats and developing immunity strategies. Begin determining the effects and interrelationships between equipment fit, workload, marginal anthropometry, and physical capability.

(U) In FY 2007: Develop injury criterion for multi-axial dynamic neck loading and standards for gender and demographics. Determine the effects and interrelationships between equipment fit, workload, marginal anthropometry, physical capability, cognitive capability, and increased equipment loads on pilot crew performance. Formulate design guidelines for helmet-mounted systems to optimize performance in operational vibration environments.

(U)

(U)	MAJOR THRUST: Quantify and model the effects of aerospace stressors on pilot performance,	0.000	3.193	1.651	1.508

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	cognitive function, and safety in dynamic flight environments. Develop design criteria to ensure effectiveness and safety of helmet-mounted systems and other protective technologies during maneuvering acceleration. Note: Broken out from previous major thrust in FY 2005 to separate distinct technology areas.				
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Continue development of protective technologies and helmet-mounted systems design criteria for the full aircrew population based on crew performance in operational maneuvering environments. Refine models for human information processing in the dynamic environment and initiate incorporation into wargaming and simulation-based acquisition.				
(U)	In FY 2006: Investigate asymmetric helmet loads in high-G environment and assess effects on helmet aiming and pointing. Continue cognitive model incorporation into wargaming scenarios and simulation-based acquisition.				
(U)	In FY 2007: Demonstrate technologies to reduce effects of heavy flight helmets in the high-G environment. Complete validation and transition of high-G cognitive model for simulation-based acquisition.				
(U)					
(U)	MAJOR THRUST: Develop technologies to counter Spatial Disorientation (SD) and improve pilot performance, resulting in increased mission effectiveness and decreased loss of lives and aircraft due to SD mishaps. Note: This effort completes in FY 2005.	1.416	2.700	0.000	0.000
(U)	In FY 2004: Pathway-in-the-sky symbology was transitioned from a head-up display format to a HMD for simulator trials. Ground-based SD training criteria was developed to better define training devices that can be procured for training purposes. Alternative HMD off-boresight flight symbology was flight-tested, and 3-D audio, tactile stimulation, and intuitive flight displays were integrated in motion-based flight simulator testing.				
(U)	In FY 2005: Complete flight-testing of Pathway-in-the-sky utilizing a HMD to complete the transition from Head-Up Display to HMD. Develop a syllabus for SD countermeasure training for the Integrated Panoramic Night Vision Goggles and specific recommendations for the optimum mix of visual, audio, and tactile cueing to avoid spatial disorientation.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop, demonstrate, and apply predictive assessment models and create in-house and fielded methods to determine the toxicological risks to airmen if exposed to operational compounds and materials. Improve commanders' decision-making ability to properly balance mission and force	0.000	0.000	0.895	1.021

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protection requirements. Note: In FY 2006, this effort moved from Project 1710.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Develop procedures and computer simulation models to predict effects of toxic compound and nanomaterial exposure on Air Expeditionary Forces and improve the protection of Air Force personnel in operational environments. Continue development and demonstration of algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bioelectromechanical capability for Air Force systems.

(U) In FY 2007: Apply procedures and computer simulation models to predict effects of toxic compound and nanomaterial exposure on Air Expeditionary Forces and improve the protection of Air Force personnel in operational environments. Further develop and demonstrate algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bioelectromechanical capability for Air Force systems.

(U)

(U) MAJOR THRUST: Develop biotechnologies to identify warfighter exposures to hazardous agents before they result in illness or a reduction in mission performance, thus greatly improving force protection and the probability of mission success. Note: In FY 2006, this effort moved from Project 1710.	0.000	0.000	5.053	6.190

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Conduct genomic, proteomic and metabolite studies to identify target-organ biomarkers in body fluids of the deployed airmen exposed to hazardous agents. Assess kidney and liver organ response biomarker patterns for early detection of the effects of unknown hazardous agents on Air Force personnel.

(U) In FY 2007: Continue to conduct genomic, proteomic and metabolite studies to identify target-organ biomarkers in body fluids of the deployed airmen exposed to hazardous agents. Complete kidney and assess liver organ response biomarker patterns for early detection of the effects of unknown hazardous agents on Air Force personnel.

(U)

(U) MAJOR THRUST: Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force operations. Note: In FY 2006, this effort moved from Project 1710.	0.000	0.000	2.003	2.006

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

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(U)	In FY 2006: Complete examination of new techniques to identify both functional and system requirements. Continue to investigate and apply new information presentation techniques for future logistics and maintenance software tools. Continue work on defining "sense-respond" capabilities which will promote effects-based logistics through a common operating picture. Begin to develop methods of quantifying levels of success of logistics and maintenance operations in support of flying missions.				
(U)	In FY 2007: Complete examination of new techniques to identify both functional and system requirements. Continue to investigate and apply new information presentation techniques for future logistics and maintenance software tools. Continue work on defining "sense-respond" capabilities which will promote effects-based logistics through a common operating picture. Begin to develop methods of quantifying levels of success of logistics and maintenance operations in support of flying missions.				
(U)					
(U)	CONGRESSIONAL ADD: 3-D Auditory Display.	1.370	0.000	0.000	0.000
(U)	In FY 2004: Conducted flight demonstration of low-cost 3-D audio technology usable for collision avoidance, navigation, and situational awareness enhancement in general aviation aircraft. Developed improved audio icons permitting recognition of multiple, simultaneous, spatially localized warning sounds in tactical military aircraft. Conducted virtual simulations to explore when, where, and how 3-D audio technology should be used in conjunction with visual displays in fast jet aircraft.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Flexible Display and Integrated Communication Device for the Battlefield Air Operations (BAO).	1.468	0.000	0.000	0.000
(U)	In FY 2004: Initiated development of flexible display and integrated communications device technology for BAO. Formulated and developed a technology concept that extends the capabilities of special tactics/special forces units that operate on the ground in forward areas of battle in their role supporting close air support, air traffic control, and target identification/designation. Analyzed and identified critical functions and their rollout priority using a series of proof-of-principle experimental systems. Fabricated breadboard components and commenced validation in a laboratory environment.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Direct Liquid Ethanol Delivery System (DLEDS) for USAF Special	1.762	0.000	0.000	0.000

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	Operations Forces (SOF) Combat Control Team Battlefield Air Operations (BAO) Kit.				
(U)	In FY 2004: Demonstrated the feasibility of a DLEDS to enhance the effectiveness of SOF combat control teams in battlefield air operations. Included are radical extensions to battery life for wearable computers and peripheral equipment by means of fuel cells or other electrical power storage mechanisms. Explored lightweight and durable technologies to curtail stray electromagnetic emissions from wearable computers on the battlefield, and developed custom design options for wearable computers that are tailored for the warfighter.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Special Operations Target Acquisition and Control Suite.	1.762	1.400	0.000	0.000
(U)	In FY 2004: Applied knowledge management software and displayed aids to improve target identification, analysis, and prosecution of time-sensitive fixed and mobile targets by special forces while improving situational awareness. This included custom software to simplify manual threat recognition and situation assessment. Research was integrated into sensor data with intelligence inputs, communication links, and computer equipment to rapidly determine threat level and priority.				
(U)	In FY 2005: Continue developing knowledge management tools to improve mission planning for special tactics operators. Explore enhanced methods for target identification using synthetic overlays and virtual comparisons in day and night settings. Assess the value of onboard hyperlinked reference files to improve operator performance. Devise an improved moving map display for better situational awareness. Evaluate predicted battle effects to improve battle damage and threat assessment.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Networked Warfighter Decision Support.	0.000	1.100	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop algorithms and control/display technologies that enhance the UAV operator's anticipatory decision making to include generating multiple courses of action, predicting target location, and identifying the likely adversary reactions. Develop robust and intuitive methods for the UAV crew to rapidly sort and evaluate multiple courses of action. Integrate and evaluate UAV console concepts in virtual simulation, culminating with full mission simulation using the most appropriate Air Force facilities.				
(U)	In FY 2006: Not Applicable.				

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(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: AFSOC Battlefield Air Operations Kit.	0.000	1.100	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate Congressionally-directed effort for AFSOC Battlefield Air Operations Kit.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	37.867	38.679	51.326	53.567

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602201F, Aerospace Flight Dynamics.										
(U) PE 0602204F, Aerospace Sensors.										
(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.										

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(U) D. Acquisition Strategy

Not Applicable.

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Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
7757 Bioeffects and Protection	31.342	24.162	15.996	19.664	17.369	17.653	17.661	17.540	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project predicts and mitigates the effects of exposure to directed energy, 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, directed energy, and other threats. It addresses areas such as safety, risk assessment, mission planning, countermeasures, personnel protection, and counterproliferation research, technology development, and validation. The project also assesses the bioeffects of directed energy technologies for force protection, special operations, military operations other than war, and peacekeeping applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Conduct laboratory experiments and field research on laser bioeffects, enabling military exploitation of laser technology while providing countermeasures for optical hazards/threats.	6.792	5.886	5.658	6.420

(U) In FY 2004: Began development of technologies to evaluate human vision impacts of multi-wavelength lasers. Continued to investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-materiel and non-lethal weapons applications. Continued to explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Continued development of bioeffects-based safety criteria for test, deployment, and use of high-energy laser systems. Compiled the first application of statis bi-directional reflectivity distribution function to model target laser scatter from high-energy laser interaction.

(U) In FY 2005: Continue developing technologies to evaluate human vision impacts of multi-wavelength lasers. Begin developing technologies to objectively determine the components of combat vision when laser eye protection, along with other technologies, are used in an integrated concept. Continue to investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for directed energy weapons applications. Continue to explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Continue to develop bioeffects-based safety criteria for test, deployment, and use of high-energy laser systems.

(U) In FY 2006: Continue developing technologies to evaluate human vision impacts of multi-wavelength lasers. Continue developing technologies to improve combat vision, including laser eye protection, in an integrated concept. Complete bioeffects studies and advocate revisions to national and international safety standards in the near infrared based on laboratory data and validated models. Explore the use of biotechnology (pharmacological hardening) as an adjunct to human protection from certain laser exposures.

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(U)	In FY 2007: Continue developing technologies to improve combat vision and provide laser eye protection in an integrated concept. Continue developing technologies to evaluate human vision impacts of multi-wavelength lasers. Develop robust modeling and simulation programs and first approximations of near real-time probabilistic risk assessment tools. Further develop the use and application of biotechnology to evaluate human health in response to high power lasers.				
(U)					
(U)	MAJOR THRUST: Conduct electromagnetic (EM) field bioeffects laboratory experiments and field research to enable the safe exploitation of directed energy technologies for communication, target identification, and weapons development while identifying countermeasures to EM hazards/threats.	5.430	4.076	5.282	6.163
(U)	In FY 2004: Extended radio frequency dosimetry model to millimeter range. Evaluated bioeffects of high peak power and ultra-wideband microwaves on neural processing and performance. Completed evaluation of radio frequency radiation (RFR) personal recording device. Enhanced and applied laboratory techniques and models to evaluate and optimize the safety and effectiveness of directed energy for non-lethal applications.				
(U)	In FY 2005: Enhance and apply laboratory and field assessment techniques and models for efficient evaluation of human health and performance impact of exposure to high peak power and ultra-wideband microwaves being developed for anti-electronic and advanced radar applications. Use bioassessment techniques to reveal possible low-level and non-thermal effects of RFR. Integrate energy-deposition model with energy-distribution model for advanced dosimetry tools to assess human hazards to microwave exposure. Continue to conduct research to support scientifically-based effectiveness, hazard, and safety criteria for EM fields, including millimeter waves, in military applications.				
(U)	In FY 2006: Develop methods to evaluate the bioeffects of directed energy weapons. Extend laboratory and field assessment techniques into the terahertz range. Develop modeling and simulation tools to evaluate the human health, behavior, and performance impact of high frequency EM systems. Evaluate human health in response to high power and high peak power EM systems using biotechnology. Continue to conduct research to support scientifically-based human exposure standards.				
(U)	In FY 2007: Further refine methods to evaluate the bioeffects of directed energy weapons. Continue to extend laboratory and field assessment techniques into the terahertz range. Continue to enhance modeling and simulation tools to evaluate the human health, behavior, and performance impact of high frequency EM systems. Continue to evaluate human health in response to high power and high peak power EM systems using biotechnology. Continue to conduct research to support scientifically-based human exposure standards.				
(U)					
(U)	MAJOR THRUST: Develop biotechnologies for Air Force counterproliferation to accurately and	1.915	2.882	3.315	5.408

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affordably support the identification, neutralization, and assessment of agents. Perform counterproliferation research to enable air operations to continue in the most efficient manner.

(U) In FY 2004: Conducted feasibility study, including scalability, of biological self-tracking and tracing simulants. Began design of specific category simulants (i.e., bacterial, viral, and toxin), laboratory tests, and scale-up process.

(U) In FY 2005: Conduct feasibility studies investigating biological counterproliferation. Continue design and development of innovative counterproliferation technologies.

(U) In FY 2006: Develop technologies to identify the production source of threat agents. Develop methods to assess the viability and activity of threat agents and continue counterproliferation research to predict and minimize collateral damage before and after agent neutralization.

(U) In FY 2007: Continue to develop technologies to identify the production source of threat agents. Continue to develop and validate methods to assess the viability and activity of threat agents after active countermeasures have been employed. Refine counterproliferation research to better predict and further minimize collateral damage before and after agent neutralization to enable air operations to continue in the most efficient manner.

(U)

(U) MAJOR THRUST: Develop technologies to alleviate the detrimental effects of fatigue on human performance. Results will extend and enhance vigilance, cognitive and physical performance, and survivability in sustained and continuous (24/7) mission environments.	2.916	2.289	1.349	1.327

(U) In FY 2004: Continued development of model-based quantitative fatigue management capabilities for operational mission planning and performance assessment. Initiated assessment of chemical contaminant penetration in aircrew breathing gases produced by an onboard oxygen generation system that has a partially deactivated molecular sieve. Continued investigating the effects of a break in oxygen prebreathe time on altitude decompression sickness risk. Quantified acceleration-induced degradation in pilot performance that can occur prior to reaching actual loss of consciousness.

(U) In FY 2005: Continue development of counter-fatigue strategies to sustain human performance during extended missions and continuous operations. Expand development of model-based quantitative fatigue management capabilities to include tactics, techniques, and procedures to reduce fatigue-induced errors in vigilance-demanding command and control and information operations tasks.

(U) In FY 2006: Refine and test fatigue model to expand performance predictions for additional air and space applications. Identify and assess novel fatigue countermeasures and associated delivery mechanisms to improve human performance in specific operational aerospace environments. Develop and demonstrate modeling of fatigue interventions.

(U) In FY 2007: Investigate individual differences in fatigue vulnerability and in response to fatigue

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	countermeasures. Identify and validate methods for real-time fatigue assessment. Develop methodology to incorporate individual differences in fatigue vulnerability and response to fatigue countermeasures into a fatigue management capability.				
(U)					
(U)	MAJOR THRUST: Develop technologies and procedures to counter physiological effect of high altitude flight, improve pilot performance under high, rapid-onset gravitational forces, and deliver oxygen. Research will enhance airman safety during global attack, global mobility, and special operations missions. Note: Breaks out from previous major thrust in FY 2005 to separate distinct technology areas.	0.000	0.729	0.392	0.346
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Complete investigation of effects of break in oxygen prebreathe time on altitude decompression sickness risk. Explore emerging technologies and alternative G-protection concepts for their potential to improve performance, comfort, and operator acceptability of life support equipment. Continue assessment of chemical contaminant penetration in aircrew breathing gases produced by onboard oxygen generation system (OBOGS) technologies. Continue quick-turn scientific consultations to resolve aircrew protection issues in ongoing flight operations such as altitude and acceleration protection.				
(U)	In FY 2006: Evaluate advanced materials and innovative design concepts to reduce bulk and thermal burden of aircrew protective equipment. Quantify performance characteristics of oxygen systems technologies for multiple special operations scenarios.				
(U)	In FY 2007: Evaluate ability of candidate integrated aircrew ensemble technology components to address identified life support equipment deficiencies. Complete assessment of molecular sieve oxygen systems technology effectiveness in a chemical environment.				
(U)					
(U)	CONGRESSIONAL ADD: Integrated Medical Information Technology System (IMITS) Initiative.	9.982	0.000	0.000	0.000
(U)	In FY 2004: Continued IMITS development and expanded into Air Force clinics in the Pacific Rim.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Thermal Protection Systems (ATPS).	0.979	0.000	0.000	0.000
(U)	In FY 2004: Initiated Congressionally-directed effort for ATPS.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

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(U)					
(U)	CONGRESSIONAL ADD: Nanoparticles for the Detection and Neutralization of Bioterrorist Agents.	0.979	0.000	0.000	0.000
(U)	In FY 2004: Developed nanoparticles directed to specifically detect and facilitate neutralization of potential bioterrorist agents. Applied Deoxyribonucleic Acid (DNA) capture element technology to enable nanoparticles to track, recover, identify, and neutralize biological agents. Linked DNA capture elements and nanoparticles and developed analytical methods to assure tagging of material even if the original biological agent is destroyed.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Mobile Molecular Test Laboratory.	0.979	0.000	0.000	0.000
(U)	In FY 2004: Initiated Congressionally-directed effort for Mobile Molecular Test Laboratory.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Solid Electrolyte Oxygen Separator (SEOS).	1.370	6.900	0.000	0.000
(U)	In FY 2004: Advanced SEOS technologies for aircraft and ground-based oxygen generating systems to provide an oxygen source free of chemical and biological contaminants, while reducing the deployment footprint associated with the current liquid oxygen infrastructure. Developed next generation (thin film) multi-cell electrolyte stacks and investigated their operating current and pressure limits. Incorporated upgraded components into a solid electrolyte oxygen separator technology breadboard device, increasing oxygen production to 33 liters per minute.				
(U)	In FY 2005: Develop, characterize, and model planar, multi-cell, solid electrolyte membrane stacks to validate oxygen separator performance. Develop, miniaturize, and analyze advanced SEOS breadboard devices designed for potential Air Force applications. Develop and evaluate next generation solid electrolyte stack designs to obtain radical improvements in SEOS performance.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Laser Bioeffects.	0.000	1.400	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop integrated technology concepts that enhance visual performance and enable				

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application of non-lethal force during force protection operations. Further refine protection against laser injuries from unconventional weapons.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U) Total Cost	31.342	24.162	15.996	19.664

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602720A, Environmental Quality Technology.										
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.										
(U) PE 0604617F, Agile Combat Support.										
(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.