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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

| | COST ($ in Thousands) | FY 2001 Actual | 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 | 65,810 | 70,155 | 66,000 | 75,500 | 78,337 | 80,164 | 82,068 | Continuing | TBD |
| 1123 | Warfighter Training | 11,561 | 14,528 | 11,606 | 13,672 | 13,988 | 14,832 | 15,475 | Continuing | TBD |
| 1710 | Deployment and Sustainment | 6,471 | 8,016 | 7,735 | 8,495 | 8,418 | 9,703 | 9,581 | Continuing | TBD |
| 7184 | Crew System Interface & Biodynamics | 36,494 | 33,673 | 30,323 | 37,189 | 40,114 | 41,142 | 42,092 | Continuing | TBD |
| 7757 | Bioeffects and Protection | 11,284 | 13,938 | 16,336 | 16,144 | 15,817 | 14,487 | 14,920 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2003, the protection program at Brooks AFB moves from Project 7184 to project 7757 to align resources with the Air Force Research Laboratory organization. In FY 2003, space unique tasks in Project 7184 will be transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This program establishes technical feasibility and develops the technology base for protecting and enhancing human effectiveness for Air Force weapon systems and for operational readiness. The program addresses warfighter training, deployment and sustainment of forces, crew system interface, biodynamic response, directed energy bioeffects, and crew protection. The Warfighter Training project focuses on the development and evaluation of new methods and technologies to enhance Air Force training and education. The Deployment and Sustainment project develops and evaluates technologies that will increase weapon systems and force supportability. The Crew System Interface and Biodynamics project develops and evaluates technologies that will increase the performance of humans. The Bioeffects and Protection project develops technologies to predict and mitigate the biological effects of aerospace stressors and directed energy on personnel and mission performance. Note: In FY 2002, Congress added $1.7 million for Rapid Detection of Biological Weapons of Mass Destruction and $1.1 million for Fatigue Countermeasures Research.

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**(U) B. Budget Activity Justification**

This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies.

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 66,404 | 69,080 | 63,945 | |
| (U) | Appropriated Value | 67,019 | 70,480 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -325 | | |
| | b. Small Business Innovative Research | -1,590 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | 996 | | | |
| | e. Rescissions | -615 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 2,055 | |
| (U) | Current Budget Submit/FY 2003 PBR | 65,810 | 70,155 | 66,000 | TBD |

(U) Significant Program Changes:

Increase in FY 2003 is due to legislative proposal in which AF pays the Government share of health care and life insurance premiums for future civilian retirees (previously funded by the General Fund of the Treasury).

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1123

| COST ($ in Thousands) | FY 2001 Actual | 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 | 11,561 | 14,528 | 11,606 | 13,672 | 13,988 | 14,832 | 15,475 | Continuing | TBD |

**(U) A. Mission Description**

This project develops and evaluates new methods and technologies in support of Air Force training and education requirements. The efforts focus 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 2001 ($ in Thousands)

(U) $5,790 Researched new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Conducted experiments to determine the extent to which various cues provided by simulator visual systems contribute to the effectiveness of the display imagery. Completed feasibility study and began the establishment of a DMT networking standard to be employed by the entire DoD modeling and simulation community. Investigated new computer architectures and data manipulation to provide real-time modeling of multi-sensor imagery.

(U) $5,002 Developed tools and strategies for identifying and improving combat mission training and rehearsal and for distributing training and performance support to operational forces. Began feasibility study to embed and evaluate instructional principles in DMT simulations. Began feasibility study of integrated intelligence, surveillance, and reconnaissance data utility for aircrew mission planning, mission operations, and evaluation. Conducted knowledge engineering for ground-based satellite controller training and developed recommendations and a satellite control station exemplar for space-system operator training and performance support, and continued studies to validate integrated command and control aerospace operations centers with the DMT environment.

(U) $769 Developed Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. Developed and implemented tools and simulation for training and assessment of performance in two separate command and control information systems. Developed new training and team dynamic protocols to operational users.

(U) $11,561 Total

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| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 1123 |

**(U) A. Mission Description Continued**

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $5,006 | Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (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) | $6,536 | 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, information operations, and command and control. Develop and validate curriculum for Air Superiority DMT 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) | $2,986 | 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) | $14,528 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,838 | Research perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Identifies the visual cues necessary for realistic aircrew training and mission rehearsal, allowing Air Force warfighters to train as they intend to fight. Assess technical performance of advanced ultra-high resolution image generation, ultra-high resolution projector and collimating display screen technologies. Determine feasibility of these technology developments for the next generation DMT simulator. |
| (U) | $2,291 | Research new computer representation technologies for the synthetic environment used in simulation-based training within a distributed mode to enhance the integrated DMT environment. Research includes representation of the visual, electronic, and sensor world, the weather, the behavior of computer generated forces, threats, and larger wargaming models. Improve rate of learning by developing pilot performance |

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| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 1123 |

**(U) A. Mission Description Continued**

(U) FY 2003 ($ in Thousands) Continued

diagnostics for end game tactical engagements for use in mission debrief. Determine feasibility of using large constructive wargaming model as a manager of all participating entities in distributed combat exercises. Assess existing high fidelity weather models as weather servers for all players in a distributed training exercise. Analyze methods for eliminating undesirable artifacts from the satellite source data used to build visualization tools and databases.

(U) $3,038 Develop tools and strategies for identifying and improving combat mission training, rehearsal, and operations for distributing training and performance support methods and technology exemplars to operational forces. Research provides the Combat Air Forces with the empirical data and guidelines for improving the quality and effectiveness of both Distributed Mission Training (DMT) and live flight training environments. Complete validation of tools to facilitate continuous learning for critical air combat skills and link these tools to skills in domains such as intelligence, surveillance, and reconnaissance and information operations. Complete operational validation studies of metrics that identify and prioritize mission essential content that can be delivered in deployable, desktop training environments located in field settings. Identify mission essential competencies underlying air superiority and global attack skills. Begin development of DMT content and scenarios for expeditionary force spin-up training and rehearsal.

(U) $3,439 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. Validate mission essential competencies for selected Air Operations Center individuals and teams. Determine feasibility of using enhanced performance assessment tools in command and control training exercises.

(U) $11,606 Total

**(U) B. Project Change Summary**

Not Applicable.

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

(U) Related Activities:

(U) PE 0602233N, Human Systems Technology.

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

(U) PE 0602785A, Personnel Performance and Training Technologies.

(U) PE 0603227F, Personnel, Training, and Simulation Technology.

(U) PE 0603231F, Crew Systems and Personnel Protection Technology.

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| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602202F Human Effectiveness Applied Research | 1123 |

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

(U) PE 0604227F, Distributed Mission Training (DMT).

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1710

| COST ($ in Thousands) | FY 2001 Actual | 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 | 6,471 | 8,016 | 7,735 | 8,495 | 8,418 | 9,703 | 9,581 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $1,835 Developed logistics sustainment technology options and performed feasibility studies to support large-scale advanced technology development programs. These technologies lead to more supportable weapon systems at reduced logistics support costs. Developed software to transform procedural maintenance instructions into graphic-oriented computer simulations for validation analysis. Developed neural network concepts for application to high-leverage areas of depot repair parts demand and resource forecasting.

(U) $1,791 Developed logistics readiness technology options and performed feasibility studies to support large-scale advanced technology development programs. These technologies lead to more efficient utilization of logistics resources for AEF operations. Investigated various technologies to retrofit aircraft with automated sensors to collect and record system performance data for enhanced capability to diagnose and predict component failures. Explored technology to automatically collect asset status information to provide real-time information for management of logistics processes and support of deployment operations.

(U) $2,845 Demonstrated and applied predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Established a health-based exposure standard for an Air Force missile fuel oxidizer. Applied predictive tools to assist fuels developers in rapidly screening various additives for toxicity.

(U) $6,471 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 2002 ($ in Thousands)

(U) $1,989 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) $2,126 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. 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. Investigate the feasibility of developing a distributed logistics training capability to support the logistics community.

(U) $3,901 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 missile fuel oxidizer. Begin to develop innovative biotechnology techniques.

(U) $8,016 Total

(U) FY 2003 ($ in Thousands)

(U) $1,953 Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs. Develop transformation algorithms and interface requirements for virtual validation of maintenance technical order data. Develop artificial intelligence software components to realistically model team decision making in synthetic environments.

(U) $1,837 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. Continue to conduct feasibility studies and devise preliminary plans for the presentation of various types of information to maintenance and logistics personnel to include both the information presented and the platforms to be used. Begin work to define the technology requirements and component research areas to support a completely automated maintenance environment.

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

**(U) A. Mission Description Continued**

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $3,945 | Develop, demonstrate, and apply predictive assessment models to accurately characterize the toxicological risks associated with exposure to operational compounds and materials for force protection. Establish biologically based approach for predicting skin irritation from dermal contact with fuels, solvents, and other hazardous chemicals used in the DoD. Develop innovative biotechnology techniques employing genomics and proteomics to identify exposure of animals to toxic substances and begin to employ that information to develop human biologically based toxicity models. |
| (U) | $7,735 | Total |

**(U) B. Project Change Summary**

Not Applicable.

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

(U) Related Activities:
(U) PE 0602233N, Human Systems Technology.
(U) PE 0602716A, Human Factors Engineering Technology.
(U) PE 0603106F, Logistics Systems Technology.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 7184

| COST ($ in Thousands) | FY 2001 Actual | 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 & Biodynamics | 36,494 | 33,673 | 30,323 | 37,189 | 40,114 | 41,142 | 42,092 | Continuing | TBD |

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

**(U) A. Mission Description**

This project develops the technology required to improve human performance, biodynamics response, and survivability in operational environments. This is accomplished by defining the physical and cognitive parameters, capabilities, and limits of systems operators; determining human responses to operational stresses such as noise, impact, vibration, sustained acceleration, spatial disorientation, and workload; and optimizing the human-machine interface. The project produces human-centered design criteria, guidelines, and automated design tools for the development of effective crew-systems interface. It develops and assesses technologies for information display, human-centered information operations, team communications, and modeling and simulation. It conducts experiments and evaluations of control interfaces, crew station layout and functional integration, aircrew information processing, crash protection, and emergency escape. Note: In FY 2002, Congress added $1.1 million for Fatigue Countermeasures Research.

(U) FY 2001 ($ in Thousands)

(U) $4,053 Developed interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Completed multi-sensory control station and operator workload classification algorithm and incorporated into laboratory demonstration of unmanned aerial vehicle control. Validated cockpit accommodation maps of inventory aircraft. Began to develop an intelligent, on-line physical accommodation information system to optimize equipment fit, and include Dutch anthropometric data from multi-national survey.

(U) $3,175 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. Developed and demonstrated new user-computer interface for all-source intelligence analysts for faster and more accurate decision-making. Continued research on speech signal processing and speech-based countermeasures for information operations.

(U) $4,236 Developed concepts for integrating human computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefit from new interface technologies. Completed a feasibility evaluation of an integrated control interface for unmanned vehicles, demonstrating multi-vehicle per mission operation. Developed integrated flight path and synthetic terrain concept for

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**(U) A. Mission Description Continued**

(U) FY 2001 ($ in Thousands) Continued

primary flight reference on heads-up displays.

(U) $4,227 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. Established helmet-mounted display symbology specifications for strike missions. Conducted study to determine the influence of helmet visor transmissivity and reflectivity on visual target detection.

(U) $2,533 Developed 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. Completed a feasibility demonstration of an integrated 3-D audio headset with noise reduction and CD quality digital audio. Developed acoustic processing algorithms and an intuitive human-centered interface to add a new capability for remote threat detection in perimeter defense. Developed preliminary auditory symbology design criteria for improving situational awareness using 3-D audio displays.

(U) $3,337 Developed human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Research develops technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including emergency escape and crashes. Incorporated tolerance and injury criteria into the development of mathematical models to be used for injury assessment. Continued study to define multi-axis head and neck response during impact. Defined male and female tolerance standards to improve injury prediction in dynamic environments and to optimize restraint concepts. Refined biodynamic performance assessment of helmet-mounted devices to optimize safe helmet-mounted system concepts.

(U) $6,213 Developed 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. Expanded the capabilities of the fatigue avoidance scheduling tool to predict the effects of pharmaceutical countermeasures on fatigue, and initiated efforts to extend the management of fatigue so as to apply its impact on decision making as a component of Information Warfare strategy. Evaluated effectiveness of candidate techniques to improve spatial orientation capabilities in aircrew wearing night vision goggles. Conducted evaluation of 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) $3,835 Progressed 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. Continued research to improve oxygen production efficiency, lower

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**(U) A. Mission Description Continued**

(U) FY 2001 ($ in Thousands) Continued

power consumption, lower operating temperature, and improve thermal management concepts. Designed, fabricated, and conducted laboratory testing of solid state electrolyte oxygen generator concepts.

(U) $3,063 Provided human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle program. The Unmanned Combat Air Vehicle (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) $1,439 Conducted international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Performed international laboratory experiment in each country using real-time simulators employing distributed interactive simulation technology. Demonstrated feasibility of an integrated multi-sensory crew station for Virtual Air Commanders tailored for early warning and control mission.

(U) $383 Conducted altitude protection research to maximize warfighter survivability and combat effectiveness in the aerospace flight environment. Research defined life support equipment design concepts and procedures to enable safe flight operations at high altitudes. Continued studies to quantify altitude decompression sickness risk for special operations and combat search and rescue missions in unpressurized aircraft.

(U) $36,494 Total

(U) FY 2002 ($ in Thousands)

(U) $4,093 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) $5,707 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

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**(U) A. Mission Description Continued**

(U) FY 2002 ($ in Thousands) Continued

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) $3,788 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 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) $4,484 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) $2,939 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) $996 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) $3,288 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.

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**(U) A. Mission Description Continued**

(U) FY 2002 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $8,378 | Develop aviation safety technologies to alleviate/mitigate warfighter fatigue, counter spatial disorientation, and improve pilot performance at high altitude and under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions. This research will 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 schedules on crew performance and mission effectiveness. Conduct fatigue countermeasures research to evaluate the operational efficacy of emerging alertness enhancing medications such as modafinil. 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 on flight safety and pilot effectiveness in the high performance/high demand cockpit of modern fighter aircraft. |
| (U) | $33,673 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,147 | Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Evaluate methods for employing real-time measurement of crew workload, as it changes with mission events, to adjust automation and decision support in multi-ship unmanned air vehicle missions. Demonstrate proof-of-concept for intelligent, on-line physical accommodation to optimize equipment fit, enabling future crew stations and equipment to adapt to human variability. Complete laboratory experiments exploring crew interface concepts for airborne command and control, demonstrate an advanced crew station for airborne early warning, and explore interface technologies for supervision of multiple autonomous unmanned air vehicles. |
| (U) | $4,631 | 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. Explore conceptual design options for a cognitive interface and knowledge repository to support information operations in the future aerospace operations center. Continue to support the Targets Under Trees program by improving the ability to fuse imagery and signals intelligence. Continue research on speech signal processing and speech-based countermeasures for information operations and commence a multi-year program to demonstrate a robust stressed-speech identification capability including foreign language speech recognition. |
| (U) | $4,208 | Develop concepts for integrating human computer interface technologies, models of human behavior, and real-time simulations to affordably |

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**(U) A. Mission Description Continued**

(U) FY 2003 ($ in Thousands) Continued

quantify operational benefits from new interface technologies. Continue simulation software for an integrated, unmanned air vehicle crew station. Continue to develop operator-vehicle interface concepts for mobility using real-time, off-board data to assure tactical information dominance with minimum crew size. Explore control-display technology options for unmanned reconnaissance vehicles, and begin to explore human performance requirements and fusion of on-board and off-board sensor data with imagery in a single display. Aggregate models of human perception, decision-making, and control in selected military combat scenarios.

(U) $5,030 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Demonstrate the ability to calibrate color displays in the field environment to permit evaluating operational system displays, and develop an approach to model image quality. Begin to quantify the effects of binocular disparity and distortion, which negatively affect vision through helmet transparencies and windscreens. Determine feasibility and technical approach for exploiting color night vision in helmet-mounted displays. Develop testing standards for large flat-panel displays.

(U) $3,293 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. Demonstrate feasibility of 3-D audio for security forces to localize threats and speed acoustic remote threat detection in perimeter defense. Recommend technologies, assess technology risk, and plan to develop a high performance (50 dB) hearing protection system. Begin to develop a dynamic noise model that can be integrated with real-time visualization of the sound field, usable for environmental analysis and for developing vectored thrust tactics to minimize acoustic detection.

(U) $1,143 Develop integrated human-centered information operations technologies to assess and predict human performance under information operations conditions to provide improved displays for quicker, more intuitive access to information, to enhance decision-making capabilities, to improve situational awareness, and to provide more effective training procedures and fatigue management techniques. This research will provide information operations warriors with human perception management tools and the means to evaluate the effectiveness of information operations strategies on the human target set. Human perception management tools will be refined for potential weaponization in offensive and defensive counter-information operations. Concepts of operation for effects-based planning, demonstrations of prototypes for next-generation planning, and decision aids and warfighter-tailored information visualizations that specifically focus on information operations will be developed.

(U) $5,771 Develop human injury criteria and protective system technologies for use against hazards encountered in crash and other hazardous environments. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including high gravitational forces, crashes, emergency escape, extended missions, and parachute opening shock. Revise injury criteria based

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**(U) A. Mission Description Continued**

(U) FY 2003 ($ in Thousands) Continued

on data from actual mishaps with ejection seat data recorder. Develop adaptable restraint system technologies, ensuring safety and expedient accommodation of diverse warfighters in Air Force transportation platforms. Thrust-vectored flight research results will improve aircrew performance in the operational environment. Research will provide cognitive performance and human information processing models that can be incorporated in war games and simulation-based acquisition models to accurately reflect the effects of physical stressors on human performance and mission effectiveness.

(U) $2,100 Develop technologies to counter spatial disorientation and improve pilot performance. Spatial disorientation countermeasures research will explore the feasibility of integrating emerging technologies such as 3-D audio, tactile situation awareness suit, pathway in the sky displays, and night vision devices to improve pilots' ability to maintain spatial orientation, thus preventing occurrence of spatial disorientation, and to aid recognition and recovery from spatial disorientation if it should occur.

(U) $30,323 Total

**(U) B. Project Change Summary**

Not Applicable.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602500F, Multi-disciplinary Space Technology.
(U) PE 0602702F, Command, Control, and Communications.
(U) PE 0603205F, Flight Vehicle Technology.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) PE 0603245F, Flight Vehicle Technology Integration.
(U) PE 0604703F, Aeromedical Systems Development.
(U) PE 0604706F, Life Support Systems.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

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**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 7757

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 7757 Bioeffects and Protection | 11,284 | 13,938 | 16,336 | 16,144 | 15,817 | 14,487 | 14,920 | Continuing | TBD |

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

**(U) A. Mission Description**

This project predicts and mitigates the effects of exposure to radio frequency energy, high power microwaves, ultra-wide band pulsed fields, lasers, warfighter fatigue, altitude and high onset rate G-forces. The project enables the safe operational use of Air Force aerospace systems through technology development to ameliorate/counter/exploit the biological effects of aerospace stressors including directed energy. It addresses areas such as safety, risk assessment, mission planning, countermeasures, and aircrew protection. The project also assesses the bioeffects of non-lethal directed energy technologies for force protection, special operations, military operations other than war, and peacekeeping applications. Note: In FY 2002, Congress added $1.7 million for Rapid Detection of Biological Weapons of Mass Destruction.

(U) FY 2001 ($ in Thousands)

(U) $4,024 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. Initiated 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. Completed the personnel biological effects model to assess combat vulnerability to emerging optical threats. Developed and demonstrated technology to produce a safe, active lasing experience into aircrew simulators, leading to development and refinement of engagement tactics, countermeasures, and training requirements. Expanded research in optical technology development for information warfare. Completed experiments with Federal Aviation Administration on safe active lasing.

(U) $5,780 Conducted radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy weapons and radar. Continued Air Expeditionary Force Agile Combat Support initiative for portable High Energy Microwave Active Denial Technology. Completed studies of millimeter effects on skin cancer and corneal eye damage for DoD exposure guidance. Continued wave propagation modeling for information warfare applications.

(U) $484 Evaluated Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collected and analyzed second year post-operative data.

(U) $996 Advanced rapid diagnostic and biological fingerprinting techniques along with molecular monitoring systems for the detection of nosocomial infections.

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**(U) A. Mission Description Continued**

(U) FY 2001 ($ in Thousands) Continued

(U) $11,284 Total

(U) FY 2002 ($ in Thousands)

(U) $5,581 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) $5,814 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of electromagnetic energy for directed energy weapons, non-lethal weapons, communications, and radar. Evaluate cellular 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) $298 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) $545 Develop safety design criteria for portable Active Denial Technology in support of the Air Expeditionary Force/Agile Combat Support initiative, enabling safe exploitation of directed energy weapons. 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) $1,700 Design and develop probe kits to rapidly detect and identify biological weapons of mass destruction.

(U) $13,938 Total

(U) FY 2003 ($ in Thousands)

(U) $5,108 Conduct laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while providing countermeasures for optical hazards/threats with and without laser eye protection. Begin evaluation of eye protection technologies to counter the agile laser threat. Investigate the safety and effectiveness of emerging compact ultrashort laser technologies for both anti-material and non-lethal weapons applications. Explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Expand research in optical technology development for information warfare and perception management applications.

(U) $7,203 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy. Expand laboratory assessment of biological effects of high power microwave and nanopulse emissions. Evaluate cellular effects of radio frequency energy. Complete updated

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**(U) A. Mission Description Continued**

(U) FY 2003 ($ in Thousands) Continued

laboratory and field radio frequency radiation (RFR) Dosimetry Tools for assessment of RFR exposure dose assessments by bioenvironmental engineering and occupational health personnel. Develop radio frequency and optical radiosensitive biotechnology tools to counter the proliferation of biological weapons of mass destruction.

(U) $500 Develop safety design criteria for portable active denial technology in support of the Air Expeditionary Force/Agile Combat Support initiative, enabling safe exploitation of directed energy weapons. Fabricate laboratory breadboard and complete laboratory demonstration of portable active denial technology. Begin assessments of cognitive and psychosocial effects of non-lethal applications while attending to needs of the intelligence community.

(U) $3,525 Develop aviation safety enhancing technologies to alleviate warfighter fatigue, counter physiological effects of high altitude flight, and improve pilot performance under high, rapid-onset gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions, and minimize adverse impacts of altitude and acceleration stresses on combat effectiveness. Sustained operations research will continue development and validation of quantitative models describing the effects of fatigue on human performance and mission effectiveness to increase the accuracy and realism of current human behavior representations used in war games, simulations, training exercises, and information warfare planning activities.

(U) $16,336 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 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**

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**(U) E. Schedule Profile Continued**

(U) Not Applicable.