DEPARTMENT OF THE AIR FORCE

FISCAL YEAR (FY) 2005 BUDGET ESTIMATES

RESEARCH, DEVELOPMENT, TEST AND EVALUATION (RDT&E)

DESCRIPTIVE SUMMARIES, VOLUME I

SCIENTIFIC AND TECHNOLOGY BUDGET ACTIVITIES 1 - 3

FEBRUARY 2004 (REVISED)

Fiscal Year 2005 Budget Estimates
RDT&E Descriptive Summaries, Volume I
Scientific and Technology Budget Activities 1 - 3
FEBRUARY 2004 (REVISED)

INTRODUCTION AND EXPLANATION OF CONTENTS

1. (U) GENERAL
   A. This document has been prepared to provide information on the United States Air Force (USAF) Research, Development, Test and Evaluation (RDT&E) program elements and projects in the FY 2005 President's Budget.
      1) All exhibits in this document have been assembled in accordance with DoD 7000.14R, Financial Management Regulation, Volume 2B, Chapter 5, Section 050402. Exception:
         a) Exhibit R-1, RDT&E Program, which was distributed under a separate cover due to classification.
      2) Other comments on exhibit contents in this document:
         a) Exhibits R-2/2a and R-3 provide narrative information for all RDT&E program elements and projects within the USAF FY 2005 RDT&E program with the exception of classified program elements. The formats and contents of this document are in accordance with the guidelines and requirements of the Congressional committees insofar as possible.
         b) The "Other Program Funding Summary" portion of the R-2 includes, in addition to RDT&E funds, Procurement funds and quantities, Military Construction appropriation funds on specific development programs, Operations and Maintenance appropriation funds where they are essential to the development effort described, and where appropriate, Department of Energy (DOE) costs.
         c) "Facilities Exhibits", Military Construction Project Data, (DD 1391), for improvements to and construction of government-owned facilities funded in RD&E, are included at the end of Volume III.

2. (U) CLASSIFICATION
   A. All exhibits contained in Volumes I, II, and III are unclassified. Classified exhibits are not included in the submission due to the level of security classification and necessity of special security clearances.

TABLE OF CONTENTS

TABLE OF CONTENTS Continued

TABLE OF CONTENTS Continued

#4 - Advanced Component Development and Prototypes (ACD&P) Continued

TABLE OF CONTENTS Continued

#5 - System Development and Demonstration (SDD)

TABLE OF CONTENTS Continued

#5 - System Development and Demonstration (SDD) Continued

#6 - RDT&E Management Support

TABLE OF CONTENTS Continued

#6 - RDT&E Management Support Continued

#7 - Operational System Development

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

TABLE OF CONTENTS Continued

#7 - Operational System Development Continued

ALPHABETICAL LISTING

PROGRAM ELEMENT COMPARISON SUMMARY

PROGRAM ELEMENT (By BUDGET ACTIVITY)		REMARKS
BUDGET ACTIVITY #1: BASIC RESEARCH (Volume I)		
0601102F	Defense Research Sciences	In FY 2005, Project 2311, Space Sciences changed its name to Space and Information Sciences.
0601102F		In FY 2005, Project 2304, Mathematical and Computer Services, efforts will be moved to the Project 2311, Space and Information Sciences.
		In FY 2005, Project 2311, Space and Information Sciences, efforts were transferred from Project 2304, Mathematical and Computer Services.
BUDGET ACTIVITY #2: APPLIED RESEARCH (Volume I)		
None		
BUDGET ACTIVITY #3: ADVANCED TECHNOLOGY DEVELOPMENT (Volume I)		
0603216F	Aerospace Propulsion and Power Technology	In FY 2005, Project 2480, Aerospace Fuels and Atmospheric Propulsion, efforts were transferred to Project 5098, Advanced Aerospace Propulsion.
		In FY 2005, Project 4921, Aircraft Propulsion Subsystems Integration, efforts was transferred to Project 5098, Advanced Aerospace Propulsion.
		In FY 2005, Project 5098, Advanced Aerospace Propulsion, efforts were transferred from Project 2480, Aerospace Fuels and Atmospheric Propulsion.
		In FY 2005, Project 5098, Advanced Aerospace Propulsion, efforts were transferred from Project 4921, Aircraft Aerospace Propulsion.
BUDGET ACTIVITY #4: ADVANCED COMPONENT DEVELOPMENT & PROTOTYPE (Volume 2)		
0603434F	National Polar-Orbiting Operations Environmental Satellite System (NPOESS)	In FY 2005, Project 4056, NPOESS, efforts were transferred to PE 0305178F, NPOESS, Project 4056, NPOESS, in order to accomplish program System Development & Demonstration.
0603791F	International Space Cooperative R&D	In FY 2005, Project 5035, International Space Cooperative R&D, includes new start efforts.
0603850F	Integrated Broadcast System (IBS)	In FY 2005, Project 4778, IBS, efforts were transferred to PE 0207443F, Family of Interoperable Operational Picture (FIOP), Project 5137, FIOP.
0604015F	Next Generation Bomber	In FY 2005, this is a new PE.
BUDGET ACTIVITY #5: SYSTEM DEVELOPMENT & DEMONSTRATION (SDD) (Volume 2)		

0207256F	**Joint-Unmanned Combat Air System (JUCAS)**	**In FY05, the PE was renamed Joint-Unmanned Combat Air System (JUCAS).**
		In FY 2005, Project 5118, J-UCAS, efforts were transferred to a new RDT&E Defense-wide Program Element.
0207434F	**Link 16 Support & Sustainment**	**In FY 2005, Project 5051, FIOP, efforts were transferred to PE 0207443F, FIOP, in order to consolidate FIOP funding.**

0207443F	Family of Interoperable Operational Picture (FIOP)	In FY 2005, this is a new PE.
		In FY 2005, efforts from PE 0604754F, Tactical Data Links Integration, Project 5051, FIOP, efforts were transferred to Project 5137, FIOP, in order to consolidate FIOP program funding.
		In FY 2005, efforts from PE 0207438F, Theater Battle Management C4I, Project 4790, Theater Battle Management Core System (TBMCS), were transferred to Project 5137, FIOP, in order to consolidate FIOP program funding.
		In FY 2005, efforts from PE 0603580F, Integrated Broadcast Service (IBS) (Dem/Val), Project 4781, IBS, efforts were transferred to Project 5137, FIOP, in order to consolidate FIOP program funding.
		In FY 2005, efforts from PE 0604754F, Tactical Data Links Integration, Project 654992, FIOP; were transferred to Project 5137, FIOP, in order to consolidate FIOP program funding.
		In FY 2005, efforts from PE 0207438F, Theater Battle Management C4I, Project 4790, TBMCS, were transferred to Project 5137, FIOP, in order to consolidate FIOP program funding.
		In FY 2005, efforts from PE 0603850F, IBS (Dem/Val), Project 4778, IBS, were transferred to Project 5137, FIOP, in order to consolidate FIOP program funding.
0207450F	Multi-Sensor Command and Control Aircraft (MC2A)	In FY 2005, this is a new PE.
		In FY 2005, PE 0207449F, C2C, Project 5064, Airframe, efforts were transferred to Project, 5131, M2CA Airframe.
		In FY 2005, PE 0207449F, C2C, Project 5065, Sensors, efforts were transferred to Project 5132, MC2A Sensors.
0305178F	NPOESS	In FY2005, this is a new PE.
		In FY2005, Project 4056, NPOESS, efforts were transferred from PE 0603434F, NPOESS, Project 4056, NPOESS, in order to accomplish System Development and Demonstration.
0604221F	Counterspace Systems	In FY 2005, Project A001, Counter Satellite Communications Systems, includes new start efforts.
0604226F	B-1B	In FY 2005, Project 4596, Conventional Mission Upgrade, includes new start efforts.
0604270F	Electronic Warfare (EW) Development	In FY 2005, Project 8462, Airborne Electronic Attack, includes new start efforts.
0604754F	Tactical Data Link Integration	In FY 2005, Project 4992, FIOP, efforts transferred to PE 0207443F, Family of Interoperable Operational Pictures (FIOP), Project 655137, FIOP in order to consolidate FIOP funding.

0604617F	Agile Combat Support	In FY 2005, Project 2895, Civil Engineering Readiness (CE), includes new start efforts.
0604731F	Joint-Unmanned Combat Air System (JUCAS)	In FY 2005, Project 5058, J-UCAS, efforts were transferred to a new RDT&E Defense-wide Program Element.
BUDGET ACTIVITY #6: RDT&E MANAGEMENT SUPPORT (Volume 2)		
0305116F	Aerial Targets	In FY 2005, this is a new PE.
		In FY 2005, Projects 5136, Target Systems Development, efforts were transferred from PE 0604735F, Combat Training Ranges, Project 2286, Combat Training Range Equipment.
0604759F	Major T&E Investment	In FY 2005, Project 4597, Air Force Test Investments, includes a new start effort
0702806F	Acquisition and Management Support	In FY05, this is a new PE.
BUDGET ACTIVITY #7: OPERATIONAL SYSTEM DEVELOPMENT (Volume 3)		
0101113F	B-52 Squadrons	In FY 2005, Project 5039, B-52 Modernization, includes new start efforts.
0207028F	Joint Expeditionary Force Experiment (JEFX)	In FY 2005, Project 4373, JEFX, efforts were transferred to PE 0207449F, C2C, Project 5140, JEFX.
		FY 2005, Project 4991, JDEP, efforts were transferred to PE 0207601F, USAF Modeling & Simulation, Project 5133, Joint Distribute Engineering Plant (JDEP).
0207141F	F-117A Squadrons	In FY 2005, Project 3956, F-117A Squadrons, includes new start efforts.
0207161F	Tactical AIM Missiles	In FY 2005, Project 4132, AIM-9 Product Improvement, includes new start efforts.
0207224F	Combat Rescue and Recovery	In FY 2005, this is a new PE.
0207438F	Theater Battle Management C4I	In FY 2005, Project 4790, TBMCS, efforts were transferred to PE 0207443F, FIOP, Project 5137, FIOP, in order to consolidate FIOP funding.
0207449F	Command and Control Constellation (C2C)	In FY 2005, this Program Element (PE) was renamed Command and Control Constellation (C2C).
		In FY 2005, Project 5078, Horizontal Integration, efforts were transferred from Project 5064, Airframe.
		In 2005, Project 5064, JEFX, efforts were transferred from PE 0207028F, Joint Expeditionary Force Experiment, Project 5140, JEFX.
		In FY 2005, Project 5064, Airframe, efforts were transferred to PE 0207450F, MC2A, Project 655131, MC2A Airframe.

		In FY 2005, Project 5065, Sensors, efforts were transferred to PE 0207450F, MC2A, Project 655132, MC2A Sensors.
		In FY 2005, Project 5078, Horizontal Integration, efforts were transferred from Project 675064, Airframe.
		In 2005, Projects 5140, JEFX, efforts were transferred from PE 0207028F, Joint Expeditionary Force Experiment, Project 674373, JEFX.
0207601F	**USAF Modeling & Simulation**	**In FY 2005, Project Number 5135, Distributed Mission Operations (DMO), includes new start efforts.**
		In FY05, Project 4567, was renamed to the Joint Synthetic Battlespace (JSB) Environment.
		In FY 2005, Project 4567, JSB, efforts were transferred from Project 5005, Executive Agent for Air Space Environment.
		In FY 2005, Projects 4991, JDEP, efforts were transferred from PE 0207028F, Joint Expeditionary Force Experiment, Project 674991, JDEP.
		In FY 2005, Project 5005, Executive Agent for Air Space Environment, efforts transferred to Project 4567, JSB Environment.

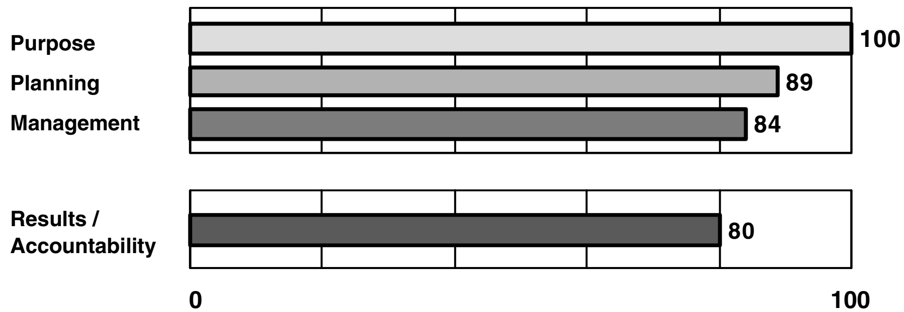
0303140F	Information Systems Security Program	In FY 2005, Project 4579, Information Warfare, was terminated.
		In FY 2005, Project 4871, Information Operations Technology, efforts were transferred to PE 0305193F, Intelligence Support to Information Operations, Project 4871, Information Operations Technology.
		In FY 2005, Projects 4871, Information Operations Technology, efforts were transferred to PE 0305887F, Intelligence Support to Information Warfare, Project IOT, Information Warfare Support.
0305193F	Intelligence Support to Information Operations	In FY 2005, this is a new PE.
		In FY 2005, Project 4871, Information Operations Technology, efforts were transferred from PE 0303140F, Information Systems Security Program, Project 4871, Information Operations Technology.
0305219F	Predator Development/Fielding	In FY2005, this is a new PE.
		In FY2005, Project 5143, Predator, efforts were transferred from PE 0305205F, Endurance Unmanned Aerial Vehicles, Project 4755, Predator..
0305220F	Global Hawk Development/Fielding	In FY 2005, this is a new PE.
		In FY 2005, Project 5144, Global Hawk, efforts were transferred from PE 305205F, Endurance Unmanned Aerial Vehicles, Project 4799, Global Hawk.
0305887F	Electronic Combat Intelligence Support	In FY 2005, this is a new PE.
		In FY 2005, Project IOT, Information Operations Technology, efforts were transferred from PE 0303140F, Information Systems Security Program, Project 4871, Information Operations Technology.
0401130F	C-17 Aircraft	In FY 2005, Project 4886, C-17 Aircraft, efforts were transferred to PE 41134F, Large Aircraft Infra-Red Countermeasures (LAIRCM), Project 4942, LAIRCM.
0401134F	Large Aircraft Infra-Red Countermeasures (LAIRCM)	In FY 2005, Project 4942, LAIRCM, efforts were transferred from PE 0401130F, C-17 Aircraft, Project 4886, C-17 Aircraft.
0408011F	Special Tactics/Combat Control	In FY 2005, this is a new PE.
0808716F	Other Personnel Activities	In FY 2005, this is a new PE.

The following are Program Elements not providing RDT&E exhibits due to classification:

0101815F	Advanced Strategic Programs
0207248F	Special Evaluation Program
0207424F	Evaluation and Analysis Program
0207591F	Advanced Program Evaluation
0208160F	Technical Evaluation System
0208161F	Special Evaluation System
0304311F	Selected Activities
0603801F	Special Programs

Program: *Basic Research*

Agency: *Department of Defense--Military*
Bureau: *Research, Development, Test, and Evaluation*



☑ Results Achieved
☐ Results Not Demonstrated
☑ Measures Adequate
☐ New Measures Needed

Key Performance Measures	*Year*	*Target*	*Actual*
Certification in biennial reviews by technically competent independent reviewers that the supported work, as a portfolio, is of high quality, serves to advance the national security and is efficiently managed and carried out.	2003 and later	100%	
Long-term Measure: Portion of funded research that is chosen on the basis of merit review Reduce non-merit-reviewed and -determined projects by one half in two years (from 6.0% to 3.0%)	2005	-50%	

***Rating:** *Effective*

Program Type *Research and Development*

Program Summary:

The Basic Research program includes scientific study and experimentation to increase fundamental knowledge in the physical, engineering, environmental and life sciences and consists of a wide portfolio of projects. The program is carried out primarily through grants to universities and non-profits. The results of this research are expected to improve the country's defense capabilities, although the actual results of any specific project are unpredictable. Notable successes in the past have led to advances in satellite communications and imagery, precision navigation, stealth, night vision and technologies allowing greatly expanded battlefield awareness. Due to the long-term nature of research results, the R&D PART emphasizes assessment of the process of choosing funded projects and independent assessments of how well the research portfolio is managed.

The assessment indicates that the basic research program has clear purposes of providing options for new weapons systems, helping prevent technological surprise by adversaries, and developing new scientists who will contribute to the DoD mission in the future. DoD can document--through its contracts and grants management regulations, public announcements of award competitions and results from independent review panels--the methodical management of its program. Additional findings include:
1. The grants/contract solicitation, review and award processes are competitive.
2. The program is reviewed regularly by technically capable outside reviewers, which recommend improvements they would like to be implemented. They indicate that the work is of overall high quality.
3. The program has competent planning and management.
4. Earmarking of projects in the program has increased in the past decade and contribute less than the typical research project to meeting the agency's mission.

In response to these findings, the Administration will:
1. Continue to emphasize the use of independent review panels in assessing the performance of the program.
2. Work with the research community and Congress to explain the need to limit claims on research grant funds to proposals that independently can meet the standards of a strict merit-review process.

Program Funding Level (in millions of dollars)

* This assessments has not changed since publication in the FY 2004 Budget. For updated program funding levels, see Data File - Funding, Scores, and Ratings.

PE NUMBER: 0601102F
PE TITLE: Defense Research Sciences

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601102F Defense Research Sciences

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	211.559	212.897	217.304	230.536	256.246	245.626	248.537	0.000	0.000
2301	Physics	23.487	25.749	23.690	23.904	27.774	24.828	25.199	0.000	0.000
2302	Solid Mechanics and Structures	11.236	11.641	13.276	14.873	16.594	17.314	18.535	0.000	0.000
2303	Chemistry	27.987	27.939	29.292	28.531	31.485	28.218	28.698	0.000	0.000
2304	Mathematical and Computer Sciences	31.286	29.293	25.663	34.397	39.314	35.952	32.022	0.000	0.000
2305	Electronics	23.234	25.041	25.174	26.833	29.722	29.674	30.117	0.000	0.000
2306	Materials	14.170	15.035	15.917	15.971	17.704	17.538	17.871	0.000	0.000
2307	Fluid Mechanics	10.025	12.875	10.902	10.997	11.715	11.426	11.630	0.000	0.000
2308	Propulsion	22.554	15.660	15.864	16.918	17.791	17.675	18.053	0.000	0.000
2311	Space and Information Sciences	14.681	20.379	24.661	23.286	22.523	22.868	23.660	0.000	0.000
2312	Biological Sciences	13.605	9.272	9.631	9.756	13.443	10.279	10.526	0.000	0.000
2313	Human Performance	12.332	12.667	13.596	13.655	14.412	14.105	14.319	0.000	0.000
4113	External Research Programs Interface	6.962	7.346	9.638	11.415	13.769	15.749	17.907	0.000	0.000

Note: In FY 2005, Project 2311, "Space Sciences," changed its name to "Space and Information Sciences."

(U) **A. Mission Description and Budget Item Justification**

This program consists of extramural research activities in academia and industry along with in-house investigations performed in the Air Force Research Laboratory. This program funds fundamental broad-based scientific and engineering research in areas critical to Air Force weapon systems. Projects are coordinated through the Defense Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds across the Department of Defense. All research areas are subject to long-range planning and technical review by both Air Force and tri-Service scientific planning groups. Note: In FY 2004, Congress added $1.0 million for Advanced Adaptive Optics, $1.7 million for National Fotonics Research, $0.5 million for Non-lethal Stunning/Immobilizing Weapons Research, $1.0 million for Corrosion Protection of Aluminum Alloys Used in Aircraft, $1.4 million for Thin Film Magnetic Materials, $2.0 million for the National Hypersonic Research Center, $2.55 million for Coal-Based Jet Fuel, $2.0 million for the Chabot Space and Science Center, $1.1 million for Quantum Information Technology, and $1.8 million for Information Security and Cyber Counter Terrorism.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	217.863	204.754	218.188
(U)	Current PBR/President's Budget	211.559	212.897	217.304
(U)	Total Adjustments	-6.304	8.143	
(U)	Congressional Program Reductions		-5.080	
	Congressional Rescissions		-1.827	
	Congressional Increases		15.050	
	Reprogrammings	-0.076		
	SBIR/STTR Transfer	-6.228		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are a result of higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2301 Physics**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2301 Physics	23.487	25.749	23.690	23.904	27.774	24.828	25.199	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Physics basic research aims to revolutionize advances in and expand the fundamental knowledge supporting laser technologies, sensors and imaging, miniature satellites, optics, electro-energetics, and communications to allow superior strategic awareness. The goals are to enable and enhance technologies critical to Air Force lasers, optics, avionics, and microwaves and to improve technologies associated with non-intrusive/non-destructive testing and analysis. Research topics focus on revolutionary improvements in electromagnetic countermeasures, communications, small satellites, and novel sensors. The primary areas of research investigated by this project are laser and optical physics; electro-energetics (includes plasma) physics; atomic, molecular, and particle physics; and space sensors and imaging (includes environment interactions) physics.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate regulated, broad-spectrum, variable-energy lasers, laser arrays, and multi-aperture adaptive optics.	8.785	9.987	8.223

(U) In FY 2003: Studied combining high power solid state lasers with integrated nonlinear and pulse forming optics. Investigated concepts to achieve laser high output powers at wavelengths required for space applications. Explored large, lightweight adaptive optics and large aperture telescopes for very high-resolution space surveillance and imaging applications. Studied laser micro-machining techniques for producing specialized space micro-systems for multi-functional micro- and nano-satellites.

(U) In FY 2004: Expand studies of high power fiber lasers, in particular those using novel material combinations, which support large-core, single-mode fibers. Investigate direct and nonlinear optical methods for combining beams of fiber lasers to achieve power levels needed for multiple directed energy applications. Continue research to convert wavelengths of high-power laser arrays to values needed for space applications and aircraft protection. Expand studies of large, lightweight adaptive optics and large aperture telescopes for very high-resolution space surveillance and imaging applications. Extend studies of large aperture adaptive telescopes for very high-resolution deep space imaging. Study new optical techniques to achieve very large aperture, very wide-band phased array radars in space. Study laser micro-machining techniques for producing specialized micro- and nano-components for multi-functional micro- and nano-satellites.

(U) In FY 2005: Continue investigating physical properties of lasers to enable, monitor, and regulate tunable, wide wavelength band lasers (e.g., solid state, free electron, fiber). Investigate novel tomographic and optical techniques tied to large, multi-aperture, adaptive telescopes and radars. Expand studies of novel laser micro-and nano-machining techniques and their applications to new materials with desirable space and electronic properties. Explore laser

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2301 Physics**

	applications for infrared countermeasures.			
(U)				
(U)	MAJOR THRUST: Explore high-energy electro-energetic devices, communication systems, surveillance and countermeasure platforms, and aerodynamic systems to facilitate creation of better propellants and more capable directed energy weapons. Note: In FY 2005, these activities will be moved to the "atoms, molecules, and particles" efforts in this Project.	8.133	8.012	0.000
(U)	In FY 2003: Researched plasma physics to investigate fundamental interactions between charged particles and electromagnetic fields for future directed energy weapons, affordable low-observables, and space communications and surveillance. Explored physics governing dynamic molecular interactions in combustion and high energy density propellants. Examined the detailed physics of material, surface, and air breakdown in the presence of strong electric fields.			
(U)	In FY 2004: Enhance research studies in plasma physics to investigate fundamental interactions between charged particles and electromagnetic fields for all-electric military platforms, high-bandwidth communications, advanced long-distance covert surveillance, and space communications and surveillance. Expand research into the physics of molecular interactions in combustion and high energy density propellants. Continue examining the detailed physics of material, surface, and air breakdown in the presence of strong electric fields to facilitate creation of more compact, lighter weight, portable pulsed power systems in order to power future directed energy weapons. Expand the understanding of short-pulse intense electric fields' effects on cells and organelles.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "atoms, molecules, and particles" efforts in this Project.			
(U)				
(U)	MAJOR THRUST: Manipulate atomic and molecular properties, atomic collision processes, and atomic, molecular, ionic, and radiation interactions to improve explosives and fuels, advance directed energy systems, enhance surveillance, provide superior communications, and improve precision navigation.	4.646	1.295	11.422
(U)	In FY 2003: Investigated fundamental interplay between atoms and strong electromagnetic fields to identify potentially new classes of lasers. Completed isomeric, high energy density storage for flash radiation devices to diminish or eliminate refueling requirements on long endurance flights. Furthered research of holographic films for correction of distortion and aberration in space surveillance telescopes. Commenced measuring ultraviolet emission cross sections from electron impact to provide fundamental data needed in satellite surveillance.			
(U)	In FY 2004: Expand investigations into the fundamental interplay between atoms and strong electromagnetic fields to identify potentially new classes of lasers. Continue measuring ultraviolet emission cross sections from electron impact. Explore uses for laser-cooled and trapped atoms. Note: In FY 2004, flash radiation efforts were transferred to another DoD agency.			
(U)	In FY 2005: Continue to characterize interactions of atoms and molecules in strong electromagnetic fields for laser			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2301 Physics**

applications. Examine techniques for precision measurement of atomic and molecular properties, atomic collision processes, and fundamental interactions between atoms, molecules, ions, and radiation. Explore advances in high-resolution spectroscopy via the trapping and cooling of atoms and ions. Continue exploring dynamic molecular interactions in combustion and high energy density propellants. Continue examining materials, surfaces, and air breakdown in the presence of strong electric and sub-meter wave fields. Continue plasma physics studies in the areas of all-electric military platforms, high-bandwidth communications, and advanced long-distance covert surveillance. Continue probing the effects of short-pulse intense electric fields on cells and organelles. Note: In FY 2005, the "high-energy electro-energetics" efforts described earlier in this Project were moved to this activity.

(U)

		FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Advance technologies for space sensors, imaging, identification, and tracking methods, and effective space situational awareness.	0.000	3.281	4.045

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Conduct research on the interaction of systems and sensors with atmospheric and space environments. Develop models to predict the atmospheric effects on laser propagation. Investigate means to expand models of sensor performance to incorporate measurements of terrestrial and space backgrounds and radiation. Examine methods of using holographic techniques for dynamic correction of distortion and aberration in space surveillance telescopes. Study methods to enhance hyperspectral imagery using polarization and hypertemporal information. Note: Highlighted focus area beginning in FY 2004.

(U) In FY 2005: Probe effects of atmospheric and space environments on sensors and energy (i.e., information) propagation. Identify, characterize, and model parameters enabling remote sensing, locating, and precision tracking of objects in and from space. Evaluate tools and enhance system interactions for enabling effective space situational awareness.

(U)

		FY 2003	FY 2004	FY 2005
(U)	CONGRESSIONAL ADD: Center for Astronomical Active Optics.	1.923	0.992	0.000

(U) In FY 2003: Expanded research studies on adaptive optics to further enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers.

(U) In FY 2004: Study optional methods and techniques that may be used to produce larger telescope based on ongoing adaptive optic accomplishments.

(U) In FY 2005: Not Applicable.

(U)

		FY 2003	FY 2004	FY 2005
(U)	CONGRESSIONAL ADD: National Fotonics Research Center.	0.000	1.686	0.000

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Support fundamental research at the National Fotonics Research Center.

(U) In FY 2005: Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2301 Physics**

(U)				
(U)	CONGRESSIONAL ADD: Non-lethal Stunning/Immobilizing Weapons Research.	0.000	0.496	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct fundamental scientific investigations in non-lethal stunning and immobilizing weapons research.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	23.487	25.749	23.690

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602601F, Space Technology.									
(U)	PE 0602605F, Directed Energy Technology.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	0601102F Defense Research Sciences	2302 Solid Mechanics and Structures

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2302 Solid Mechanics and Structures	11.236	11.641	13.276	14.873	16.594	17.314	18.535	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

Solid mechanics and structures basic research aims to improve load-bearing performance of air and space structures through the prediction and control of multi-scale phenomena ranging from micro-level deformation and fracture of materials to the structural dynamics of large platforms. The goals are cost-effective development and safe, reliable operation of superior Air Force weapon and defensive systems. Fundamental knowledge of "multi-functional" structures with smart materials, sensors, actuators, and control systems integrated to accomplish damage control, thermal management, vibration reduction, and reconfigurable shapes. Research topics include: the modeling of non-linear static/dynamic behavior of structures; mechanical reliability of micro-devices; design of multi-functional materials; mechanical behavior of nano-materials; and composite materials for structures.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Explore advanced, nano-scale materials, mechanics, and devices for direct application in advanced turbine engines, air vehicles, space systems, and other weapon systems.	2.540	2.478	6.357
(U) In FY 2003: Conducted research in mechanics of advanced materials and devices to accelerate their use as composites, high-temperature alloys, and ceramic matrix composites. Applied multi-functional mechanics with nonlinear behavior to begin designing multi-functional materials and structures. Developed methods to combine multi-scale modeling and information technology to design new materials and structures.			
(U) In FY 2004: Enhance research in the mechanics of advanced materials and devices to accelerate their use as composites, high-temperature alloys, and ceramic matrix composites. Continue to apply multi-functional mechanics with nonlinear behavior to enhance design of multi-functional materials and structures. Continue development of methods to combine multi-scale modeling and information technology to design new materials and structures. Examine the foundations of nano-mechanics in transitioning between continuum mechanics and atomistic modeling.			
(U) In FY 2005: Advance research in the mechanics of materials and devices, with continued focus in the areas of multi-functional design, diagnostics, prognostics, self-healing, micro-/nano-mechanics, autonomics, thermal management, and energy harvest. Search for methods to combine information technology and multi-scale modeling in the design of new materials and structures. Continue nano-mechanics research to promote the transition from continuum mechanics to atomistic modeling. Note: In FY 2005, activities described later in this Project were moved to this activity.			
(U)			
(U) MAJOR THRUST: Analyze and model structural fatigue and loss of integrity to mitigate their detrimental impact to Air Force weapon systems.	4.506	4.965	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2302 Solid Mechanics and Structures**

(U)	In FY 2003: Researched the structural and material aspects of high-cycle metal fatigue and other aging mechanisms of aircraft. Explored metal fatigue-generation caused by the vibration of compressor and turbine blades and blade motion/fluid flow coupling. Improved fundamental computer simulations to predict structural response to assorted stimuli. Investigated material science to identify and mitigate material degeneration and degradation. Advanced development of novel system techniques to analyze vehicle integrity.			
(U)	In FY 2004: Continue to investigate the structural and material aspects of high-cycle metal fatigue and other aging mechanisms. Continue to explore metal fatigue-generation caused by the vibration of compressor and turbine blades. Expand and enhance fundamental computer simulations to predict structural response to assorted stimuli. Explore material science research to identify and mitigate material degeneration and degradation. Continue to develop novel system techniques to analyze vehicle integrity.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these efforts will be moved to the "structural fatigue and mechanics" activity in this Project.			
(U)				
(U)	MAJOR THRUST: Conduct structural mechanics research to examine innovative adaptive structure concepts to improve the design and performance of air and space systems to include multi-mission unmanned aerial vehicles (UAVs).	4.190	4.198	0.000
(U)	In FY 2003: Developed models to predict the interaction between structural motion and high-speed aerodynamics characteristic of UAVs. Further investigated the behavior of distributed sensor and actuator systems. Explored the mechanical and dynamic behavior of micro- and nano-scale structures to achieve exceptional capabilities in micro-electro-mechanical systems and nano-electro-mechanical systems.			
(U)	In FY 2004: Expand models to predict the interaction between structural motion and high-speed aerodynamics characteristic of UAVs. Further probe the behavior of distributed sensor and actuator systems of aircraft. Continue exploring the mechanical and dynamic behavior of micro- and nano-scale structures to achieve exceptional capabilities in micro-electro-mechanical systems and nano-electro-mechanical systems.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these efforts will be moved to the "structural fatigue and mechanics" activity in this Project.			
(U)				
(U)	MAJOR THRUST: Analyze structural fatigue and mechanics, adaptive structures, and material properties to improve the design, robustness, and performance of air and space systems to include multi-mission unmanned aerial vehicles (UAVs).	0.000	0.000	6.919
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue to examine and analyze structural mechanics to include fatigue, integrity, high cycle metal fatigue, and other material aging phenomena. Investigate metal fatigue-generation caused by the vibration of			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2302 Solid Mechanics and Structures**

compressors and turbine blades. Continue assessing means and models to identify, evaluate, and mitigate material degeneration and degradation. Continue developing novel system techniques to analyze vehicle integrity. Advance models of interaction between UAV structural motion and high-speed aerodynamics. Characterize distributed sensor and actuator systems. Explore the mechanical and dynamic behavior of micro/nano-scale structures. Note: Prior to FY 2005, these efforts were covered under other activities in this Project.

(U)	Total Cost	11.236	11.641	13.276

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0602201F, Aerospace Flight Dynamics.									
(U)	PE 0602202F, Human Effectiveness Applied Research.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0603211F, Aerospace Structures.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2303 Chemistry**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2303 Chemistry	27.987	27.939	29.292	28.531	31.485	28.218	28.698	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

Chemistry basic research seeks bold innovations in understanding, modeling, and controlling chemical reactions for developing new materials, improving synthesis of existing materials, controlling energy flow and storage, and regulating interactions between materials and their environments. Studies expand fundamental understanding of properties regulating the chemical dynamics and energy transfer processes that foster advances in laser weaponry and allow predictions of the infrared, optical, and radar signatures of reaction products and intermediates that advance reliable target assessment and tracking. Critical research topics include: novel synthesis and characterization of lower cost, higher performance functional and structural materials, electronics, and photonic materials; nano-structures; electromagnetics; and conventional weaponry. Focused investigations include the effects of chemical and morphological structures on functional and mechanical properties of polymeric materials and the exploration of atomic and molecular surface interactions that limit performance of electronic devices, compact power sources, and lubricant materials. Primary areas of research include molecular reaction dynamics; theoretical chemistry; polymer chemistry; and surface and interfacial science.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Research and characterize molecular dynamics, reaction mechanics/interactions, and theoretical chemistry to model, predict, control, and exploit atomic and molecular energetics and reactivities for advanced fuels, munitions, and countermeasure techniques, as well as drag reduction.	10.776	11.654	13.523
(U) In FY 2003: Modeled interactions between aerospace systems and the space environment. Explored uses of ion and plasma chemistry for flow control applications. Investigated concepts of reactive energetic nano-structures for applications to propulsion and munitions. Developed and began to validate theoretical methods to predict and design behavior and properties of nano-structures. Modeled chemically reacting flows associated with hypersonic vehicles. Researched new chemical sources of electronic excited states needed to fuel chemical laser systems.			
(U) In FY 2004: Complete modeling efforts of the chemical interactions between air and space systems and the space environment. Explore uses of ion and plasma chemistry for combustion control applications. Investigate concepts of reactive energetic nano-structures for safer penetrating munitions and enhanced spacecraft payload fractions. Develop and validate theoretical methods to predict and design the behavior and properties of nano-structures. Probe novel chemical theories, syntheses, detection techniques, and modeling and simulation focused on fuels and rocket propellants that are more energetic, environmentally benign, and emit reduced signatures and are less sensitive to accidental detonations. Study the fundamental behavior of new fuels in hydrocarbon-fueled scramjets and combined-cycle engines. Enhance models of chemically reacting flows associated with hypersonic vehicles. Research new chemical sources of electronic excited states needed to fuel chemical laser systems. Optimize properties of potential fuels to increase the mass of space payloads and satellite lifetimes.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2303 Chemistry**

(U)	In FY 2005: Explore ion and plasma chemistry for combustion control applications. Investigate nano-structure concepts and models for propulsion and munition reactive energetics. Continue modeling chemically reacting flows associated with hypersonic vehicles, hydrocarbon-fueled scramjets, and combined-cycle engines. Continue to optimize chemical properties enriching high-energy lasers, advancing high-energy high-density fuels and materials, enhancing space lift, and extending time-on-orbit/station.			
(U)				
(U)	MAJOR THRUST: Research super energetic propellants through chemical theory, synthesis, and detection techniques, as well as modeling and simulation focused on fuels and rocket propellants.	2.036	0.000	0.000
(U)	In FY 2003: Studied the application of potential fuels for hydrocarbon-fueled scramjets and combined-cycle engines. Identified and investigated potential fuels increasing the mass of payloads put into space and increasing the lifetime of satellites on orbit.			
(U)	In FY 2004: Not Applicable. Note: In FY 2004, these efforts were moved to the "molecular dynamics, reaction mechanics/interactions, and theoretical chemistry" activity in this Project.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Enhance fundamental understanding of polymer chemical structures, reactivity, molecular engineering, processing controls, and materials technologies to develop advanced organic and matrix composites aimed at improving Air Force systems performance and life-spans to allow effective air and space persistence.	9.273	9.286	8.737
(U)	In FY 2003: Explored magnetic, conductive, and optical properties of coating materials to achieve smart skin concepts with on-demand tunable properties. Investigated bio-inspired polymer concepts to achieve enhanced photonic properties and photonic bandgap structures. Explored molecular conformational changes to achieve controllable mechanical actuation in polymeric materials. Exploited transportable large optics technology.			
(U)	In FY 2004: Develop organic molecules with high optical nonlinearities for protection against laser threats. Explore flexible structures that can provide functions such as sensing, power generation and storage, electronics, and electronic memory for integration into multi-functional structures. Enhance electro-optic polymers for improved performance for photonic radar development. Research organic-based electronics for multi-functional integration.			
(U)	In FY 2005: Design and characterize conductive polymers, photonic polymers, nano-structures, and bio-inspired polymers. Evaluate nano-composite structures and mechanical properties for potential applications under harsh space environments.			
(U)				
(U)	MAJOR THRUST: Expand the fundamental chemistry and physics of surfaces and interfacial processes pertaining to corrosion protection, wear reduction, micro- and nano-assemblies, and power storage for air and space systems.	5.902	6.007	7.032
(U)	In FY 2003: Developed theoretical and predictive methods for surface and interfacial chemical processes. Explored physical properties of novel lubricants to create new low-friction, long-life coatings and surface structures for			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 01 Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT NUMBER AND TITLE 2303 Chemistry

terrestrial and space environments. Probed nano-scale surface structures with enhanced energy densities for better weapon system energy storage and delivery. Researched novel three-dimensional surface nano-structures for sensor, optical, and power applications.

(U) In FY 2004: Improve theoretical and predictive methods for surface and interfacial chemical processes. Explore the chemical and physical properties of novel lubricants. Assemble novel multi-functional coatings for the corrosion protection of aging aircraft. Develop low-friction, long-life multi-functional surface structures and coatings. Continue probing nano-scale surface structures with enhanced energy densities for better weapon system energy storage and delivery. Study chemically directed self-assembly to produce novel three-dimensional surface nano-structures for sensor, optical, and power applications.

(U) In FY 2005: Enhance theoretical and predictive methods for surface and interfacial chemical processes. Create and characterize novel multi-functional surface structures, coatings, covers, and lubricants. Continue investigating nano-scale surface structures for enhanced energy-density storage/delivery and chemically-directed self-assembled surfaces for sensor, optical, and power applications. Probe electro-chemical behaviors at surfaces and interfacial regions.

(U)

(U)	CONGRESSIONAL ADD: Corrosion Protection of Aluminum Alloys Used in Aircraft.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Advance fundamental scientific research to enable, enhance, and exploit corrosion protection of aluminum alloys used in air and space vehicles.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	27.987	27.939	29.292

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602601F, Space Technology.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2303 Chemistry**

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

(U) PE 0602602F, Conventional Munitions.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematical and Computer Sciences**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2304 Mathematical and Computer Sciences	31.286	29.293	25.663	34.397	39.314	35.952	32.022	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2005, some activities in this project will be moved to the Project 2311 in this Program Element.

(U) A. Mission Description and Budget Item Justification

Mathematics and computing sciences basic research develops novel techniques for mathematical modeling and simulation, algorithm development, complex systems control, and innovative analytical and high performance computing methods for air and space systems. Basic research provides fundamental knowledge enabling improved performance and control of systems and subsystems through accurate models and computational tools, artificial intelligence, and improved programming techniques and theories. The primary areas of research investigated by this project are dynamics and control; physical mathematics and applied analysis; optimization and discreet mathematics; computational mathematics; and electromagnetics.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Perform dynamics and control research to develop new techniques for design and analysis of control systems in order to enhance capabilities and performance of air and space vehicles.	6.172	6.488	7.735

(U) In FY 2003: Performed research on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned aerial vehicles (UAVs), and constellations of small satellites. Explored means to improve control of nonequilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion, and materials processing. Fostered advances in image processing and sensor technology that can be utilized in UAV controllers, smart munitions, and nondestructive vehicle testing. Commenced designing computational models to analyze natural processes for adaptation to air and space systems.

(U) In FY 2004: Continue research on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, UAVs, and constellations of small satellites. Develop control methodology to improve non-equilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion, materials processing, and agile autonomous flight. Explore advances in image processing and sensors applicable to advanced UAV controllers, smart munitions, and non-destructive vehicle testing. Enhance designs of computational models to analyze natural processes for adaptation to air and space systems. Adapt explorations in bio-inspired sensing systems to assess feasibility for and applicability in use in controlling autonomous systems.

(U) In FY 2005: Advance research on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, UAVs, and constellations of small satellites. Further develop control methodologies to improve non-equilibrium behavior of complex, unsteady fluid systems with applications for combustion, materials processing, and agile autonomous flight. Continue to probe advances in image processing and

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematical and Computer Sciences**

	sensor technologies for use in UAV controllers, smart munitions, and nondestructive vehicle testing. Investigate the adaptation of bio-inspired sensing systems, controls, and computational methods.			
(U)				
(U)	MAJOR THRUST: Investigate signal communications, surveillance, and targeting for increased awareness and improved command and control for the battlefield commander. Efforts include research in linear operator theory, generalized functions and probability, harmonic methods, and asymptotic expansions.	2.872	2.504	0.000
(U)	In FY 2003: Conducted investigations to expand the capability of critical mobile, networked communications, and surveillance/reconnaissance and targeting systems through examination of fundamental principles governing signal analysis. Explored source-channel encoding methods for robust wireless communication using optical transmission phenomenology. Developed a rigorous basis for and commenced delineating the domain of applicability of self-learning, trial and error (heuristic) methods such as super-resolution imaging. Researched technologies with higher information rates and higher reliability of communications.			
(U)	In FY 2004: Continue investigations to expand the capability of critical mobile, networked communications through mathematical innovations in signal processing. Explore hybrid radio frequency and optical phenomenology to achieve robust wireless communication. Further delineate the domain of applicability of self-learning and heuristic methods such as super-resolution imaging. Examine the fundamental principles of stochastic and probabilistic analysis to actuate proof-of-concept surveillance/reconnaissance and targeting systems. Examine revolutionary technologies that attain ultra-fast, reliable information exchange. Employ linear operator theory, generalized functions, differential equations, and quantum theory to facilitate flexible, high bandwidth reliable transmission of multi-source data.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to Project 2311 in this Program Element.			
(U)				
(U)	MAJOR THRUST: Conduct research in complex systems and algorithms for highly flexible, reliable, and rich information systems supporting battlefield commanders; using artificial intelligence, information warfare, intelligent agents, knowledge bases, distributed systems, machine learning, uncertainty reasoning, and intelligence/ information assurance, and information fusion.	6.172	6.261	0.000
(U)	In FY 2003: Explored methods to enhance research in information operations, including support for language-based security, mobile code security, protected execution, and dynamic, adaptive intrusion detection for protection of future battlespace/infosphere systems and networks. Developed new computational techniques/software in extremely large (10,000,000+ axioms) knowledge bases to provide decision support.			
(U)	In FY 2004: Continue research in information assurance, including support for language-based security, mobile code security, protected execution, steganography/steganalysis, dynamic, and adaptive intrusion detection for protection of future battlespace/infosphere systems and networks. Further develop computational techniques/software for			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematical and Computer Sciences**

information fusion at the situation refinement and impact assessment levels to provide decision support. Construct quantum computer devices that enable atomic level computing a million times faster than a state-of-the-art silicon chip to allow enhanced target tracking, command and control, and decisive awareness. Design, implement, and test quantum computing algorithms and architectures enabling fast, accurate solutions of complex fluid dynamics problems eliminating the need for multiple design iterations and prototype testing. Develop scalable quantum computers for automatic target recognition and target characterization.

(U) In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to Project 2311 in this Program Element.

(U)

		FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Research physical mathematics, applied analysis, and electromagnetics.	6.613	6.216	8.257

(U) In FY 2003: Researched developing accurate models of physical phenomena to enhance the fidelity of simulations and predictability of devices. Investigated the properties of coherently propagating ultrashort laser pulses through the air and their exploitation in areas such as electronic warfare and laser-guided munitions. Developed algorithms to simulate nonlinear optical effects within semiconductor lasers and nonlinear optical media. Improved the formulation of optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluated methods to penetrate tree cover with wide band radar to recognize and track targets. Studied the feasibility of designing reconfigurable warheads by suitable placement/timing of micro-detonators. Pursued the dynamics of internal stores released from transonic/supersonic platforms.

(U) In FY 2004: Continue research to develop accurate models of physical phenomena that enhance the fidelity of simulations and predictability of devices. Further investigate the properties of coherently propagating ultrashort laser pulses through the air and their exploitation in areas such as electronic warfare, laser-guided munitions, and irradiation of chemical/biological clouds. Develop algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media. Complete formulating optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Continue evaluating novel methods to penetrate tree cover with wide band radar to recognize and track targets. Continue studying the feasibility of designing reconfigurable warheads by suitable placement/timing of microdetonators. Enhance description of the dynamics of internal stores released from transonic/supersonic platforms.

(U) In FY 2005: Continue research to develop models of physical phenomena to improve simulations and device predictability. Investigate methods to advance target location, recognition and identification, and tracking. Probe the properties of coherently propagating ultra-short laser pulses through the atmosphere. Evaluate algorithms of nonlinear optical effects within fiber lasers and nonlinear optical media. Study the dynamics of transonic/supersonic/hypersonic platforms and warhead reconfiguration through micro-detonation.

(U)

		FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Investigate optimization and discrete mathematics to validate and further advance mathematical	4.897	4.382	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematical and Computer Sciences**

	methods, algorithms, and models.			
(U)	In FY 2003: Conducted research for solving complex problems in logistics, engineering design, and strategic/tactical planning for battlespace information management. Evaluated anytime algorithms -- those that produce a feasible, but not necessarily optimal, solution. Examined new modeling techniques and algorithms for various Air Force problems such as target tracking, mobilization planning, and manufacturing.			
(U)	In FY 2004: Enhance research for solving complex problems in system diagnostics/prognostics, air mobility contingencies, and strategic/tactical planning for battlespace information management. Further evaluate anytime algorithms -- those that produce a feasible, but not necessarily optimal, solution. Continue examining new modeling techniques and algorithms for various Air Force current and long-term challenges, such as target allocation for unmanned air vehicles, special operations planning, and system health and maintenance.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "computational and discrete mathematics research" efforts in this Project.			
(U)				
(U)	MAJOR THRUST: Perform computational mathematics research to develop unique modeling and simulation capabilities to improve designs of advanced Air Force systems.	4.560	3.442	0.000
(U)	In FY 2003: Devised means to integrate new multi-disciplinary design optimization strategies with high-order, time-accurate solvers in order to design superior jet engines, aircraft wings, munitions, and other aerospace components. Developed new algorithms for unsteady reactive flow, munitions penetration and fragmentation, and plasma dynamics for directed energy weapons. Developed quantum computing algorithms, architectures, and implementations to enable exponential improvements in speed, accuracy, and fidelity of fluid dynamics simulations, signal processing, and data mining.			
(U)	In FY 2004: Initiate the integration of new multi-disciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, munitions, as well as other air and space components. Continue developing algorithms for unsteady reactive flow, munitions penetration and fragmentation, and plasma dynamics for directed energy weapons. Compute the simulation uncertainty in nonlinear models of aerodynamic flows and structural failure predictions.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "computational and discrete mathematics research" efforts in this Project.			
(U)				
(U)	MAJOR THRUST: Conduct research in optimization, as well as computational and discrete mathematics to validate and further advance mathematical methods, algorithms, and modeling and simulation to solve problems and improve designs of advanced Air Force systems.	0.000	0.000	9.671
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematical and Computer Sciences**

(U) In FY 2005: Solve complex problems in system diagnostics/prognostics, air mobility contingencies, and strategic/tactical planning for battlespace information management. Design modeling techniques and algorithms for various present day and longer term challenges. Integrate new multi-disciplinary design optimization strategies with high-order, time-accurate solutions for superior design of jet engines, directed energy devices, munitions and penetrators, air and space components, and system health and maintenance systems. Continue computing the simulation uncertainty in non-linear models of aerodynamic flows and structural failure predictions. Note: Prior to FY 2005, these activities were covered under other efforts earlier in this Project.

(U)	Total Cost	31.286	29.293	25.663

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602201F, Aerospace Flight Dynamics.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602602F, Conventional Munitions.									
(U)	PE 0602702F, Command, Control, and Communications.									
(U)	PE 0603789F, C3I Advanced Development.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2305 Electronics**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2305 Electronics	23.234	25.041	25.174	26.833	29.722	29.674	30.117	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Electronics basic research enhances the fundamental understanding of electronic materials, devices, and systems to advance Air Force operational capabilities in directed energy weapons, stealth technologies, electronic countermeasures, information and signal processing, and communications. This research enables the development of electronic processes to model and predict the performance of electronic materials, devices, and systems for power generation, optical signal processing, radiation effects, and high-speed signal processing. The goals are to firmly control the complexity and reliability of electronic systems, increase data transmission and information processing speeds, and to improve the security and reliability of electronic information. The primary areas of research investigated by this project are space electronics: semiconductor materials; optoelectronic information processing and memory; and quantum electronic solids.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Assess military space platform unique electronic circuits to increase their reliability, survivability, and functionality while simultaneously reducing component cost, size, and weight in order to improve spacelift, battlefield awareness and control, mission flexibility, and ease of augmentation and upgrade.	8.143	8.428	6.573

(U) In FY 2003: Expanded studies of intense radio frequency (RF) pulse effects on electronic circuits and systems. Commenced designing, fabricating, and evaluating wide bandgap semiconductor materials to achieve a unique combination of high RF power output, high efficiency, low noise, robustness, and radiation hardness. Examined reconfigurable electronics. Conducted research on the interaction of systems and sensors with the space environment. Developed models to predict the effect of terrestrial and space backgrounds and radiation on sensor performance in order to promote secure, wide-bandwidth communication through the atmosphere and ionosphere as well as between satellites. Initiated joint Air Force-NASA program in university nano-satellites, seeking novel space innovations and their demonstrations.

(U) In FY 2004: Probe intense RF pulse effects on electronic circuits and systems. Design, fabricate, and evaluate wide bandgap semiconductor materials to achieve a unique combination of high RF power output, high efficiency, low noise, robustness, and radiation hardness. Evaluate efforts to identify electronic approaches to increasing spacecraft survivability. Enhance research on the interaction of systems and sensors with the space environment. Continue development of models to predict the effect of terrestrial and space backgrounds and radiation on sensor performance in order to promote secure, wide-bandwidth communication through the atmosphere and ionosphere as well as between satellites. Explore design and potential applications of small satellites (1kg to 100 kg) for rapid access to space and flexible mission capabilities. Research scientific barriers to component miniaturization, nano-propulsion and power, smart skins, radiation hardening, and quantum effect electronics. Continue joint Air Force-NASA

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2305 Electronics**

	university nano-satellite projects with emphasis on space industry partnerships.			
(U)	In FY 2005: Further investigate effects of intense RF pulses on electronic circuits and systems. Continue designing, fabricating, and evaluating wide bandgap semiconductor materials towards achieve an unique combination of high RF power output, high efficiency, low noise, robustness, and radiation hardness. Research scientific barriers to electronic component miniaturization, nano-propulsion and power, smart skins, radiation hardening, and quantum effect electronics. Complete specific Air Force-NASA nano-satellite projects.			
(U)				
(U)	MAJOR THRUST: Conduct semiconductor materials research for detection and emission of optical radiation from the far infrared to ultraviolet range to achieve spectral dominance of the battlespace including surveillance, target tracking, and target signature identification.	7.127	7.580	0.000
(U)	In FY 2003: Investigated unique nonlinear optical materials to protect critical optical systems from laser radiation. Synthesized laser materials to degrade or disable an adversary's detection and tracking capabilities. Initiated development of nano-fabrication technology for unique optoelectronic material properties. Assessed basic electronic mechanisms to improve the efficiency and reduce the cooling requirements of lasers and detectors. Explored fast multi-band detectors for battlespace characterization.			
(U)	In FY 2004: Continue pursuit of nonlinear optical materials to protect critical optical systems from laser radiation. Synthesize laser materials to degrade or disable an adversary's detection and tracking capabilities. Enhance nano-fabrication technology for unique optoelectronic materials. Continue assessing basic electronic mechanisms to improve the efficiency and reduce the cooling requirements of lasers and detectors. Evaluate fast multi-band detectors for battlespace characterization. Identify new materials for high efficiency photovoltaic devices room temperature ferromagnets, and compact, high-power semiconductor lasers.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "quantum and optoelectronic materials" efforts in this Project.			
(U)				
(U)	MAJOR THRUST: Conduct research in optoelectronic information processing and nano-science to explore the design, development, and application of novel optoelectronic materials and devices to enhance critical communication system accuracy and speed.	2.376	2.281	0.000
(U)	In FY 2003: Examined complex semiconductor structures and developed optical materials for use in high bandwidth, multi-wavelength modulators and detectors for satellite imaging and data transfer. Explored optoelectronic nanotechnologies including nano-photonics, nano-electronics, and nano-sensors and opportunities in terahertz technologies.			
(U)	In FY 2004: Continue exploration of ultracompact, micro-photonic, and nano-photonic structures and chip scale optical networks. Expand investigation of robust monolithic and miniature tetrahertz frequency devices for security, remote sensing, optical communications, and optical signal processing. Initiate terahertz quantum cascade laser			

	research.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "quantum and optoelectronic materials" efforts in this Project.			
(U)				
(U)	MAJOR THRUST: Examine optoelectronic memory and persistent spectral hole-burning approaches for enhanced data storage and processing to enable superior strategic awareness.	1.587	1.522	0.000
(U)	In FY 2003: Investigated page-oriented or holographic memory configurations in two- or three-dimensions. Explored capabilities to buffer, store, and retrieve data at rates and quantities anticipated for multi-spectral devices. Developed new technologies to increase capabilities in high-speed image capture, data storage, and information processing for surveillance, target discrimination, and autonomous navigation. Advanced research on the interaction of systems and sensors with the space environment.			
(U)	In FY 2004: Continue investigating methods for constructing page-oriented or holographic memory configurations in two- or three-dimensions. Explore methods of buffering, storing, and retrieving data at rates and quantities anticipated for multi-spectral devices. Investigate techniques for enhancing capabilities in high-speed image capture, data storage, and information processing for surveillance, target discrimination, and autonomous navigation.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "quantum and optoelectronic materials" efforts in this Project.			
(U)				
(U)	MAJOR THRUST: Investigate quantum and optoelectronic materials, memory, and information processing, as well as nano-science for wide-field spectral sensors and critical, high-speed communication systems in order to achieve spectral dominance of the battlespace to include surveillance, target tracking, and target signature identification.	0.000	0.000	13.545
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue exploring unique nonlinear optical and laser materials and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Improve efficiency and reduce cooling requirements of lasers and detector electronics. Explore ultracompact micro- and nano-photonic structures, chip-scale optical networks, and enhanced data storage (e.g., optoelectronic memory). Probe robust monolithic and miniature terahertz frequency spectrum devices and quantum cascade lasers. Investigate communication network technologies, room temperature ferromagnetic materials, and the interaction of system electronics and sensors with atmospheric and space environments. Note: Prior to FY 2005, these activities were covered under other efforts prior in this Project.			
(U)				
(U)	MAJOR THRUST: Investigate quantum electronic solids phenomena to explore superconducting, magnetic, and nanoscopic materials for advanced sensing, communications, and signal processing.	4.001	3.842	5.056
(U)	In FY 2003: Examined superconducting quantum systems for adaptation to quantum computing and encryption.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2305 Electronics**

Further investigated high-current, high-temperature superconducting cables and tapes for enhanced power generation and storage on Air Force directed energy weapons and space platforms. Developed new high-temperature magnetic materials with sufficient mechanical strength for use in aircraft with higher electric workloads.

(U) In FY 2004: Examine superconducting quantum systems for adaptation to quantum computing and encryption. Conduct research on improving high-current, high-temperature superconducting cables and tapes for enhanced power generation and storage on directed energy weapons and space platforms. Further the development of new high-temperature magnetic materials with sufficient mechanical strength for use in aircraft with higher electric workloads.

(U) In FY 2005: Continue examining superconducting quantum computing systems and encryption techniques. Examine methodologies to fabricate high current, high-temperature superconducting cables for enhanced power generation and storage devices. Continue the development of high-temperature magnetic materials with sufficient mechanical strength for use in aircraft electrical systems.

(U)

(U)	CONGRESSIONAL ADD: Thin Film Magnetic Materials.	0.000	1.388	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Study the fundamental scientific phenomena associated with thin film magnetic materials.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	23.234	25.041	25.174

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0602702F, Command, Control, and Communications.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603789F, C3I Advanced Development.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2306 Materials**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2306 Materials	14.170	15.035	15.917	15.971	17.704	17.538	17.871	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) <u>A. Mission Description and Budget Item Justification</u>

Materials basic research enhances the performance, cost, and reliability of structural materials to eliminate reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. This research expands fundamental knowledge of material properties that leads to the development of novel materials for airframe, turbine engine, and spacecraft structures. The goals of this project are to develop improved materials for air and space vehicles that provide increased structural efficiency and reliability, increase the operating temperature of engine materials, and further increase thrust-to-weight ratio of engines. Basic research emphasis is on refractory alloys, intermetallics, polymer composites, metal and ceramic matrix composites, advanced ceramics, and new material processing methods. The primary areas investigated by this project are ceramics, non-metallic hybrid composites, and metallic materials.

(U) <u>B. Accomplishments/Planned Program ($ in Millions)</u>	<u>FY 2003</u>	<u>FY 2004</u>	<u>FY 2005</u>
(U) MAJOR THRUST: Identify ceramic and non-metallic materials for use in developing new materials and composites for very-high (>1400F) and ultra-high (>2500F) temperature applications.	4.823	4.992	0.000
(U) In FY 2003: Investigated the optimization of thermal and mechanical stability of oxide composites for aircraft and jet engine blade applications. Created ultra-high temperature materials systems based on non-oxide materials for space applications. Worked toward designing and optimizing multi-functional materials to enable the combination of structural and functional ceramics to enable enhanced fuel cells, sensors, and actuators.			
(U) In FY 2004: Optimize the thermal and mechanical stability of oxide composites for aircraft and jet engine blade applications. Extend research on ultra-high temperature ceramic materials for space propulsion and structural systems. Maintain research focus on the design and optimization of multi-functional ceramic materials to enable structurally enhanced smart systems.			
(U) In FY 2005: Not Applicable. Note: In FY 2005, all non-metallic efforts will be combined into a single effort later in this Project.			
(U)			
(U) MAJOR THRUST: Investigate organic matrix composites and hybrid materials (including adhesives/epoxies) that can be used to increase the strength and life span of air and space structural materials.	2.291	2.270	0.000
(U) In FY 2003: Analyzed the effects of cyclic thermal loads on polymer matrix composites down to cryogenic temperatures to increase durability in liquid fuel tank materials. Developed new fiber sizing techniques in glass fiber reinforced structures to minimize degradation of mechanical and electromagnetic properties due to moisture.			
(U) In FY 2004: Further probe the effects of cyclic thermal loads down to cryogenic temperatures on polymer matrix composites in order to increase durability in liquid fuel tank materials. Continue research into fiber sizing techniques			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2306 Materials**

	in glass fiber reinforced structures to minimize the degradation of mechanical and electromagnetic properties due to moisture.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, all non-metallic efforts will be combined into a single effort later in this Project.			
(U)				
(U)	MAJOR THRUST: Perform non-metallic, ceramic, and hybrid materials research to identify and to design new materials and composites with s very-high (>1400F) and ultra-high (>2500F) temperature applications. Create organic matrix composites and hybrid materials (including adhesives/epoxies) used to increase the strength, application, and life span of air and space structural materials.	0.000	0.000	6.439
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Optimize the thermal and mechanical stability of oxide composites for aircraft and engine applications. Identify and design multi-functional ceramic materials to enable structurally enhanced smart systems. Continue research on very-high and ultra-high temperature ceramic materials. Analyze cyclic thermal (cryogenic to high temperature) effects on organic and polymer matrix composites. Continue evaluating fiber-sizing techniques for glass/carbon fiber reinforced structures. Note: Prior to FY 2005, these activities were covered under other efforts earlier in this Project.			
(U)				
(U)	MAJOR THRUST: Research metallic materials and identify relationships between structure (including microstructure), processing, properties and performance so as to develop affordable and durable metallic systems for advanced engines and aerospace structural applications.	7.056	7.773	9.478
(U)	In FY 2003: Integrated computational modeling into the design of engineering components, the evaluation of the mechanical and thermal stability of metal matrix composites, and the characterization of refractory metal alloys and intermetallics in very-high temperature aircraft applications. Developed functionally graded structures for superior thermal barrier coatings. Created advanced metals for multi-functional space systems.			
(U)	In FY 2004: Expand experimental and modeling studies of mechanical strength, thermal stability, performance prediction, and lifetime assessment of composites, refractory metal alloys, and intermetallics for applications at moderate and very high temperatures. Continue developing advanced alloys for multi-functional space systems. Explore scientific bases for computational design to reduce new material experimentation development costs. Develop new models to reduce new material maturity time and to minimize associated costs. Seek to develop high performance materials more affordably by integrating material development and engineering system design.			
(U)	In FY 2005: Continue exploring and modeling metal matrix composites, refractory metal alloys, and intermetallics for applications at moderate and very high temperatures. Create advanced alloys for multi-functional space systems. Enhance and broaden computational models by implementing strategies that reduce new structural material maturity			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2306 Materials**

time, assess/validate materials design codes, seek integration with design processes, and minimize costs.

(U)	Total Cost	14.170	15.035	15.917

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0602201F, Aerospace Flight Dynamics.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602601F, Space Technology.									
(U)	PE 0603211F, Aerospace Structures.									
(U)	PE 0708011F, Industrial Preparedness.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2307 Fluid Mechanics**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2307 Fluid Mechanics	10.025	12.875	10.902	10.997	11.715	11.426	11.630	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Fluid mechanics basic research advances fundamental knowledge, tools, data, concepts, and methods for improving the efficiency, effectiveness, and reliability of air and space vehicles. The goals are to improve theoretical models for aerodynamic prediction and design, as well as to originate flow control concepts and predictive methods used to expand current flight performance boundaries through enhanced understanding of key fluid flow (primarily high-speed air) phenomena. Basic research emphasis is on turbulence prediction and control, unsteady and separated flows, subsonic/supersonic/hypersonic flows, and internal fluid dynamics. The primary approach is to formulate advanced computational methods to: simulate and study complex flows; predict real gas effects in high-speed flight; and control and predict turbulence in flight vehicles and propulsion systems. Primary areas of research investigated by this project are unsteady aerodynamics, supersonic and hypersonic aerodynamics, turbulence, as well as rotating and internal flow characteristics and controls.

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Characterize the critical phenomena in unsteady aerodynamic flows and expand fundamental knowledge of high-speed airflows to optimize current air vehicle designs that will revolutionize future weapon systems.	2.521	2.760	0.000
(U) In FY 2003: Investigated unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned aerial vehicles (UAVs). Investigated rapid maneuver UAV aerodynamics. Investigated highly separated flow situations occurring in complex air vehicle and weapon systems.			
(U) In FY 2004: Develop numerical tools and validate the experimental database to determine the effect of unsteady, vortex-dominated flows on the control and flight performance of UAVs. Investigate aero/structure interactions associated with rapid maneuver UAVs. Evaluate tools for the accurate prediction of highly separated flow over complex air vehicle and weapon systems.			
(U) In FY 2005: Not Applicable. Note: In FY 2005, these activities will become part of the "supersonic, hypersonic, unsteady aerodynamics" efforts later in this Project.			
(U)			
(U) MAJOR THRUST: Investigate complex phenomena in supersonic and hypersonic flows to enable the design of future Air Force trans-atmospheric vehicles and flight control systems.	2.999	3.163	0.000
(U) In FY 2003: Developed supersonic flow control concepts, including plasma and magneto-hydrodynamic techniques. Developed high-speed flow prediction codes to quantify thermal stresses and designed mitigation techniques for hypersonic flight vehicles.			
(U) In FY 2004: Examine advanced flow control concepts for shock-dominated flows. Pursue aerothermal numerical			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2307 Fluid Mechanics**

	simulation capabilities to quantify heat transfer and unsteadiness for flight vehicles.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will become part of the "supersonic, hypersonic, unsteady aerodynamics" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Investigate and characterize complex phenomena in supersonic, hypersonic, and unsteady flows to enable and optimize the design of air and space vehicles and flight control systems.	0.000	0.000	4.912
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Explore methods to optimize unsteady, vortex-dominated flows and rapid maneuver control on unmanned aerial vehicles (UAVs). Model unsteady aerodynamics of complex, configuration-induced flows and characterize hypersonic flows to include boundary layer effects, engine integration, and plasma aerodynamics. Model aerothermal and local shock phenomena in hypersonic flows, control concepts, and performance optimization. Explore control strategies for the mitigation of excessive heat transfer and unsteadiness in hypersonic flows and for abating the effects of highly separated flows. Note: Prior to FY 2005, these activities were covered under other efforts earlier in this Project.			
(U)				
(U)	MAJOR THRUST: Explore fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts to enhance the performance, controllability, and stability in air vehicles.	2.521	2.760	0.000
(U)	In FY 2003: Investigated new areas and methods of flow control on aircraft wings and jet engines. Developed reduced order models for turbulent flow control applications and affordable engineering predictive models for the air vehicle design process. Assessed quality of promising flow control actuation concepts on realistic geometries. Investigated flow control coupling mechanisms in turbulent flows to enable agile flight vehicles.			
(U)	In FY 2004: Develop approaches for modeling unsteady flow control inputs on aircraft wings and jet engines. Utilize reduced order models for turbulent flow control applications and affordable engineering predictive models for the air vehicle design process. Evaluate promising flow control actuation concepts on realistic geometries in wind tunnel tests. Further investigations into flow control-coupling mechanisms in turbulent flows to enable agile flight vehicles.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will become part of the "turbulence and rotating flows" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Study complex rotating and internal flow characteristics related to turbomachinery and jet engine applications.	1.984	2.209	0.000
(U)	In FY 2003: Evaluated unsteady flow phenomena and enhanced the understanding of forcing modes in turbomachinery to predict and avoid high cycle and thermal failures in jet engines. Investigated application of large eddy simulation techniques to explore complex gas turbine engine flow fields and heat transfer effects. Evaluated			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2307 Fluid Mechanics**

		FY 2003	FY 2004	FY 2005
	flow control measurement and actuation devices for use in harsh environments.			
(U)	In FY 2004: Explore coupling mechanisms in multiple blade row interactions in order to develop understanding of forcing modes in turbomachinery and to predict high cycle fatigue failures in jet engines. Use large eddy simulation techniques to explore heat transfer and fluid flow coupling in turbine engine flow fields. Investigate detailed flow interactions using flow control measurement and actuation devices for use in harsh environments.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will become part of the "turbulence and rotating flows" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Expand fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts. Study complex rotating and internal flow phenomena related to turbomachinery and jet engine applications.	0.000	0.000	5.990
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Evaluate validation studies of advanced flow control coupling mechanisms in turbulent flows. Use large eddy simulation techniques to probe heat transfer and fluid flow coupling. Model unsteady flow control inputs on wings and jet engines to include reduced order, closed-loop flow control demonstrations. Explore aerodynamic mistuning mechanisms in multiple blade row interactions tied to high cycle fatigue failures. Investigate detailed flow interactions using flow control measurements and actuation devices for harsh environments and wind tunnel tests. Note: Prior to FY 2005, these activities were covered under other efforts earlier in this Project.			
(U)				
(U)	CONGRESSIONAL ADD: National Hypersonic Research Center.	0.000	1.983	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct fundamental scientific and engineering research studies at the National Hypersonics Research Center.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	10.025	12.875	10.902

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602201F, Aerospace Flight Dynamics.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2307 Fluid Mechanics**

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

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0603211F, Aerospace Structures.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2308 Propulsion**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2308 Propulsion	22.554	15.660	15.864	16.918	17.791	17.675	18.053	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) <u>A. Mission Description and Budget Item Justification</u>

Propulsion basic research expounds fundamental knowledge to enable and enhance efficient utilization of energy in airbreathing engines, chemical and non-chemical rockets, and combined cycle propulsion systems for future rapid global reach and on-demand space access. Basic research thrusts include airbreathing propulsion, space power and propulsion, high altitude signature characterization and contamination, propulsion diagnostics, thermal management of space-based power and propulsion, and the synthesis of new chemical propellants. These thrusts can be grouped into reacting flows and non-chemical energetics. Study of reacting flows involves the complex coupling between energy release through chemical reaction and the flow processes that transport chemical reactants, products, and energy. Non-chemical energetics research includes both plasma and beamed-energy propulsion for orbit raising space missions and ultra-high energy techniques for space-based energy utilization. Primary areas of research investigated by this project are space power, propulsion, combustion, and diagnostics.

(U) <u>B. Accomplishments/Planned Program ($ in Millions)</u>	<u>FY 2003</u>	<u>FY 2004</u>	<u>FY 2005</u>
(U) MAJOR THRUST: Study methods for enabling and improving aerodynamics and propulsion for next generation air and space vehicles.	2.022	0.000	0.000
(U) In FY 2003: Expanded research studies to develop a sound scientific basis for plasma utilization to improve aerodynamic characteristics and propulsive efficiencies so as to enhance hypersonic vehicle range by more than 10%. Investigated plasma control effects and evaluated means to engineer them into operational systems. Investigated plasma effects on lowering fuel consumption, improving propulsion system performance, providing on-board power generation, and alleviating sonic boom and engine noise.			
(U) In FY 2004: Not Applicable. Note: In FY 2004, these activities will be consolidated with the "space propulsion and power" efforts in this Project.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Research and model space propulsion and power in the areas of chemistry, electronics, miniaturization, and contamination/signature.	6.915	6.700	7.923
(U) In FY 2003: Studied means to improve thrust and control of propulsion systems to develop high-precision constellations of cooperating micro-satellites. Expanded the understanding of mechanical-electric energy conversion to increase payload and thrust. Studied the feasibility of excess silicon as a space propellant in developing concepts for self-consuming satellites. Researched new engine concepts such as pulsed detonation engines, hybrid rockets, and combined cycle engines. Created advanced supercritical combustion models and leverage computational capability to enhance the design of new engines. Researched plasma turbulence and its effect on the transport coefficients to			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2308 Propulsion**

	develop a new class of more versatile plasma thrusters.			
(U)	In FY 2004: Study micro-chemical, plasma-based, and beamed-energy based thrusters to improve thrust, specific impulse, and control of propulsion systems for high-precision constellations of cooperating micro-satellites in order to enhance decisive awareness of threats and opportunities. Further research into new engine concepts such as pulsed detonation engines, hybrid rockets, and combined cycle engines. Advance supercritical combustion models and leverage computational capabilities that will enhance the design of new hydrocarbon, cryogenic, and monopropellant-fueled engines. Complete research of plasma turbulence and its effects on the transport coefficients in order to develop a new class of more versatile plasma thrusters. Research high altitude signature characterization and spacecraft cross-contamination, especially in the presence of multiple thrusters and satellites. Examine magnetohydrodynamic (MHD) flow control to optimize propulsion system flow path performance in scramjets. Investigate lightweight super conducting magnet capability for onboard flight-rated systems needed to achieve MHD flow control of advanced engines. Investigate plasma ignition approaches to improve combustion efficiency and stability in scramjets and high altitude subsonic airbreathing propulsion systems.			
(U)	In FY 2005: Expand studies in plasma-based, charged droplet-based (collide), and beamed-energy thrusters. Explore new engine concepts such as pulsed detonation rocket engines. Evaluate unsteady flow coupling and plasma ignition combustion efficiencies and stability. Investigate high altitude signature characterization and spacecraft cross-contamination. Examine MHD flow control to optimize scramjet flow path performance. Investigate lightweight superconducting magnet capability for MHD flow control of advanced engines. Note: In FY 2005, the plasma activities in this effort will be moved to the "combustion, propulsion, and diagnostics" effort in this Project.			
(U)				
(U)	MAJOR THRUST: Study diagnostics and data reduction analyses.	4.491	0.000	0.000
(U)	In FY 2003: Completed studies of advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Completed study of laser-induced fluorescence and absorption spectroscopic measurements in relation to infrared and ultraviolet excitation wavelength regimes.			
(U)	In FY 2004: Not Applicable. Note: In FY 2004, these activities will be consolidated with "combustion and diagnostics" efforts in this Project.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Explore combustion, propulsion, and diagnostics in subsonics, supersonics, and hypersonics. Investigate multi-phase, turbulent reacting flows to improve the performance of propulsion systems, including gas turbines, ramjets, scramjets, pulsed detonation engines, and rockets.	6.626	6.432	7.941
(U)	In FY 2003: Developed enhanced computer models that predict unsteady behavior, such as combustion instability. Advanced the state of large eddy simulation methods for turbulent hydrocarbon combustion by incorporating upgraded subgrid-scale models for chemistry and fuel droplets.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2308 Propulsion**

(U) In FY 2004: Improve laser diagnostic measurement capabilities with expanded agility over limited wavelength ranges for time-resolved characterization of reacting flows. Develop detailed mechanisms for hydrocarbon fuel combustion at elevated pressures. Explore scientific basis for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies.

(U) In FY 2005: Improve laser diagnostic measurement capabilities in the characterization of reacting flows. Probe molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions. Incorporate prediction methodologies, which are both quantitatively accurate and computationally tractable, into turbulent combustion models. Enhance scientific bases for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies. Identify and evaluate fuels and propellants that are more energetic, environmentally benign, and less sensitive to accidental detonations.

(U)

(U)	CONGRESSIONAL ADD: Coal-derived Jet Fuels.	2.500	2.528	0.000

(U) In FY 2003: Produced limited quantities (50 gallons) of coal-derived fuel for large-scale combustion, fuel system fouling, and ignition experiments. Furthered investigations for coal-derived fuel production scale-up.

(U) In FY 2004: Produce coal-based jet fuels in increasingly larger quantities through refinery trials. Evaluate refinery produced fuels for large-scale combustion and thermal stability.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	22.554	15.660	15.864

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602601F, Space Technology.									
(U)	PE 0603211F, Aerospace Structures.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2308 Propulsion**

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2311 Space and Information Sciences	14.681	20.379	24.661	23.286	22.523	22.868	23.660	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2005, the Project name, "Space Sciences," changed to "Space and Information Sciences." Additionally, in FY 2005, some activities in Project 2304 of this Program Element will be moved to this Project.

(U) A. Mission Description and Budget Item Justification

Space and information sciences basic research provides fundamental understanding of the space environment for optimum design of Air Force systems operating in near-Earth orbit, geosynchronous orbit, and deep space. The goal is to enable greater, more cost-affordable, protection of space assets from space debris, solar wind, solar flares, cosmic rays, and geomagnetic storms. Focus is on specifying the flow of mass, momentum, and energy through space to develop a global model that connects solar activity with the deposition of energy at the Earth. Methods are developed to forecast the turbulent plasma phenomena that mediate the flow of energy through space in order to enhance the effectiveness of Air Force global dominance through space operations. The primary areas of research investigated by the space environment portion of this program are solar phenomena and weather; magnetospheric and ionospheric effects; space debris studies; and innovative space-based communications. The primary research areas in the information sciences portion of this program are complex systems and algorithms, communications and signal processing, information operations, and information fusion.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Analyze solar physics and weather to develop techniques for improved space observations and protection of Air Force space assets and operations.	3.714	3.628	0.000
(U) In FY 2003: Observed and analyzed solar phenomena to characterize and model the physics of solar magnetic fields for enhanced prediction of large-scale, high-energy plasma ejections to develop protective spacecraft structures and more robust designs. Explored technology requirements to enable development of a new ground-based Advanced Technology Solar Telescope to exploit adaptive optics techniques. Expanded the investigation of solar dynamo physics, solar oscillation modes, solar flares, coronal mass ejections, magnetic reconnection in space plasmas, and solar magnetic field complexity to enable forecasting of solar eruptions and predict environmental risks to critical Air Force space operations.			
(U) In FY 2004: Exploit solar physics models to develop techniques for protecting assets against high-energy plasma ejections. Support cutting-edge instrumentation development for the ground-based Advanced Technology Solar Telescope. Continue investigating solar flares, coronal mass ejections, magnetic reconnection in space plasmas, and solar magnetic field complexity through support of ground-based optical and radio solar observatories, as well as university and government teams managing space-based instruments. Define best practices and commonalities of algorithms used to model and simulate the space environment, focused on plug-and-play capability within next-generation computational architectures.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**

(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be consolidated into "Space Environment Research" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Research magnetosphere and ionosphere effects to enhance global surveillance, geolocation, and communication.	3.714	3.628	0.000
(U)	In FY 2003: Developed mitigation techniques for ionospheric scintillation and plasma turbulence radio disruptions to enhance global surveillance, geolocation, and communication. Supported scientific analysis of space-based and ground-based data assimilation techniques to modernize ionospheric and space weather forecasting. Observed atmospheric gravity wave interactions from high and low geomagnetic latitudes, as well as tropical observation sites, using radars, advanced electro-optical instrumentation, and light detection and ranging techniques in order to develop seasonal and climatic models of ionospheric phenomena.			
(U)	In FY 2004: Expand deployment of research sensors to observe ionospheric scintillation and worldwide plasma turbulence radio disruptions. Support scientific analyses of space-based and ground-based data assimilation techniques to modernize ionospheric and space weather forecasting. Design and examine observational equipment globally to improve capability to observe atmospheric gravity wave interactions with radars, advance electro-optical instrumentation, and light detection and ranging techniques. Exploit cutting-edge developments in all-sky imaging optics to obtain sensitive infrared observations of ionospheric plasma physics, gravity waves, dynamics, and optical clutter.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be consolidated into "Space Environment Research" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Research, characterize, and model space debris to protect Air Force space assets.	4.215	4.310	0.000
(U)	In FY 2003: Improved the cataloging and tracking the populations of Near Earth Objects (NEOs) and space debris particles derived from comets and asteroids. Explored laser guide-star development for observations of NEOs, as well as ballistic and orbital targets. Developed advanced astronomical instrumentation and observational methods to include laser ranging and adaptive optics for deep space surveillance. Began studies into the developments in astronomical detection and tracking algorithms for enhancement of DoD surveillance capabilities, and support observational campaigns to characterize the aerodynamic drag, turbulence, and optical clutter in the lower ionosphere that degrade DoD targeting.			
(U)	In FY 2004: Continue efforts to catalog and track the populations of Near Space/Earth Objects and space debris particles derived from comets and asteroids. Advance multi-conjugate adaptive optics for unparalleled resolution of small, dim, deep space targets. Further developments in astronomical detection and tracking algorithms to enhance space awareness and control capabilities. Expand development of future space radar surveillance systems using nanotechnology and advanced signal processing algorithms.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**

(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be consolidated into "Space Environment Research" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Expand theories for the development of physics-based modeling, improved space observations through advancements in multi-conjugate adaptive optics, and the quantifying of risks to Air Force systems.	3.038	2.954	0.000
(U)	In FY 2003: Provided support to the Air Force's Communications/Navigation Outage Forecast System and Solar Mass Ejection Imager satellite missions. Investigated the theoretical underpinnings of robust antenna designs for the space environment and charged particle remediation techniques. Investigated the variable energy deposited in near-Earth space by energetic charged particles from deep space and by cosmic rays to quantify risks to Air Force systems.			
(U)	In FY 2004: Create new space environment models and enhance current theories using data from the Air Force's Communications/Navigation Outage Forecasting System and Solar Mass Ejection Imager satellite missions. Continue investigating the theoretical underpinnings of active and passive space environment remediation techniques. Stimulate novel efforts to advance design, study, and development new sensor technologies to observe cosmic rays and energetic charged particles from deep space in order to better quantify risks to Air Force systems. Research simulation and visualization techniques to simplify complex data analysis and ensure future strategic awareness.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be consolidated into "Space Environment Research" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Research space environment to improve solar theories and modeling in the areas of solar phenomena and weather, magneto/ionosphere effects, space debris, adaptive optics for improved space observation, better space-based communications, and the quantifying of risks to space systems.	0.000	0.000	8.463
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Exploit astronomical detection, tracking, and cataloging algorithms for enhanced protection of DoD surveillance capability in conjunction with data from the Communications/Navigation Outage Forecasting System and Solar Mass Ejection Imager satellites. Support development of ground-based advanced technology solar telescope adaptive optics systems, light detection and ranging radars, nanotechnology, and advanced signal-processing algorithms. Refine forecasting of ionosphere and space environment effects. Exploit developments in all-sky imaging and multiconjugate adaptive optics to obtain infrared observations of ionospheric plasma physics, gravity waves, dynamics, optical clutter and small, dim, deep space targets. Continue investigating solar flares, coronal mass ejections, magnetic reconnection in space plasmas, and solar magnetic field complexity. Note: Prior to FY 2005, these activities were part of other efforts earlier in this Project.			
(U)				
(U)	MAJOR THRUST: Investigate innovative technologies for space-based communication capabilities to ensure	0.000	1.000	1.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**

	continued Air Force space dominance.			
(U)	In FY 2003: Not Applicable. Note: This is a new thrust area for FY 2004.			
(U)	In FY 2004: Research innovative methods for optical communications. Begin probing novel techniques for potential bandwidth efficient modulation to enhance satellite communications. Start exploring the basic mechanisms of dual polarization antennas for space applications.			
(U)	In FY 2005: Examine innovative methods for optical communications. Probe novel techniques for potential bandwidth efficient modulation to enhance satellite communications. Explore the basic mechanisms of dual polarization antennas for space applications.			
(U)				
(U)	MAJOR THRUST: Investigate signal communications, surveillance, and targeting for increased awareness and improved command and control for the battlefield commander. Efforts include research in linear operator theory, generalized functions and probability, harmonic methods, and asymptotic expansions. Note: Prior to FY 2005, these activities were covered under Project 2304 in this Program Element.	0.000	0.000	4.211
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Improve data fusion science to permit rapid data conversion across multiple bands into graphical and conceptualized information. Promote methodologies to evaluate the performance of new wireless mobile, networked communications systems. Assess technical alternatives on the overall feasibility of super-resolution millimeter and search and rescue imagery. Solidify the hybrid radio-frequency/free-space optical paradigm and refine the parameters of other innovative technologies to attain ultra-fast, reliable information exchange. Enable ultra-wide band transmission of hyperspectral and other diverse data.			
(U)				
(U)	MAJOR THRUST: Conduct research in complex systems and algorithms for highly flexible, reliable, and rich information systems supporting battlefield commanders using artificial intelligence, information warfare, intelligent agents, knowledge bases, distributed systems, machine learning, uncertainty reasoning, and artificial intelligence, information assurance, and information fusion. Note: Prior to FY 2005, these activities were covered under Project 2304 in this Program Element.	0.000	0.000	10.987
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue research in information assurance for protection of future battlespace/infosphere systems and networks. Develop information fusion to provide deep, adaptive, expert decision support. Construct quantum computer devices and algorithms to allow enhanced tracking, recognition, and characterization to improve awareness, command and control. Design, implement, and evaluate quantum-computing architectures for fast, accurate solutions of complex fluid dynamics.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**

(U)				
(U)	CONGRESSIONAL ADD: Chabot Space and Science Center.	0.000	1.983	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Support the development of astronomical and scientific research and education capabilities at the Chabot Space and Science Center.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Quantum Information Technology.	0.000	1.091	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct fundamental scientific research associated with quantum information technologies.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Information Security and Cyber Counter Terrorism.	0.000	1.785	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct fundamental scientific studies related to information security and cyber counter terrorism.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	14.681	20.379	24.661

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602601F, Space Technology.									
(U)	PE 0602702F, Command, Control, and Communications.									
(U)	PE 0603410F, Space System Environmental Interactions Technology.									
(U)	PE 0603500F, Multi-Disciplinary Advanced									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**

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

Development Space
Technology.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2312 Biological Sciences**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2312 Biological Sciences	13.605	9.272	9.631	9.756	13.443	10.279	10.526	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Biological basic science research provides the fundamental knowledge necessary to understand and enable technologies associated with chemical and physical agent toxicity, electromagnetic sensors based on biomimicry, biomolecular materials, biochromatics, and luminescence. The goal is to exploit biological properties to control and manipulate operational environments. Research topics in toxicology explore the interaction of Air Force chemicals and physical agents (lasers and microwaves) with human tissues and associated effects to enable safety assessment strategies to ensure the hazard-free development and use of future air and space materials and directed energy systems. Research in biomimetic sensors strives to mimic the biological detection systems of organisms at the molecular level in developing novel man-made sensors. Basic research in biocatalysis characterizes cellular enzymes that will catalyze the synthesis of chemical feedstocks used in the safe production of space and air materials. Research in biomaterials focuses on the mimicking of natural materials, using organisms as biomaterial factories of new materials, genetically altering existing organisms for new materials capabilities, or taking existing biomaterials/organisms and using them as novel materials like viral gradients or processing them further to make a useful material as in biominerialization. Research in biointerfacial science is focused on new biosensors and bionanotechnology, and specifically addresses the fundamental science at either the biotic-biotic or the biotic-abiotic interface. The primary areas of research investigated by this project are bio-informatics, profiling, and response; biocatalysis and bioenzymatic properties; and biomimetic, biomaterials, and biointerfacial sciences.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate natural response profiling and assessment from exposure to fuels, chemicals, and directed energy systems. Probe biocatalysis and bioenzymatic properties to characterize and modify enzymes as affordable and efficient catalysts in the manufacture of air and space materials.	6.136	6.912	5.568

(U) In FY 2003: Identified organ-specific molecular pathways altered by JP-8 jet fuel exposures and evaluated various biomolecular indicators and mediators of the toxic response for use as potential biomarkers of human exposure and to enable the development of protective strategies. Explored mechanisms and commenced developing novel molecular descriptors that will help integrate in vitro toxicity data into a mathematical format for use in the rapid computational prediction of toxicity of air and space chemicals and new forms of directed energies. Investigated the biological effects of chronic low-level exposures to directed energy by profiling and modeling intracellular molecular responses and commenced identifying potentially harmful extra-cellular mediators.

(U) In FY 2004: Continue a biokinetics study of the uptake, biodistribution, metabolism, and elimination of JP-8 fuel in animals exposed through the inhalation and skin routes as a first step in assessing the risks of jet fuels. Extend research on molecular descriptors and mathematical expression of in vitro toxicity data to include data from genomics and proteomics profiles to rapidly predict computationally the toxicity of air and space chemicals. Extend sensitive genomics and proteomics profiling techniques to studies investigating the cellular and extra cellular effects of chronic

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2312 Biological Sciences**

	and acute low-level exposures of animals to laser and microwave systems. Note: In FY 2004, the "biocatalysis and bioenzymatic" activities were moved from another effort later in this Project to this effort.			
(U)	In FY 2005: Model risks associated with exposure to fuels and complex mixtures. Analyze the biokinetics and biodistribution of JP-8 jet fuel components. Continue exploring, profiling, and modeling bio-informatics methodologies. Characterize, parameterize, and codify enzymes, proteins, biocatalysts, and bio-energetic agents to enable and enhance efficiencies in the synthesis and processing of future air and space materials.			
(U)				
(U)	MAJOR THRUST: Evaluate biocatalysis and bioenzymatic properties to characterize, modify, and utilize enzymes as catalysts in the processing and manufacturing of air and space materials.	3.661	0.000	0.000
(U)	In FY 2003: Furthered the essential and fundamental process of enzyme discovery and characterization. Genetically modified the natural biocatalytic potential of enzymes to meet various synthetic manufacturing requirements by extending substrate ranges and specificities or altering reaction rates. Explored alternative metabolic engineering techniques for maintaining or enhancing reaction rates during large-scale production.			
(U)	In FY 2004: Not Applicable. Note: In FY 2004, these activities were consolidated into the "bio-response profiling and assessment" efforts earlier in this Project.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Model chronobiology (biophysical and neural) mechanisms to determine a warfighter's cognitive performance under conditions of sleep loss, sustained operations, and non-standard sleep/wake duty cycles.	2.051	0.000	0.000
(U)	In FY 2003: Investigated the biophysical mechanisms responsible for crew fatigue in sustained operations or in non-standard duty cycles and in adapting to jet lag. Explored mathematical models of sleep/wake dynamics, including the effects of wake-promoting countermeasures on the homeostatic and circadian systems, and extended these models to predict specific deficits in human performance under conditions of sleep loss. Conducted new research to identify the phenotypic differences that enable some individuals to maintain highly accurate cognitive and psychomotor performance under sleep deprivation. Note: In FY 2003, the vast majority of these efforts were in this activity were completed, so this separate focus was closed.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Explore biomimetics, biomaterials, and biointerfacial sciences to enable development of novel sensors, engineering processes and mechanisms, and the synthesis of novel materials.	1.757	2.360	4.063
(U)	In FY 2003: Enhanced modeling of the fundamental principles, processes, and designs of infrared sensitive biosystems at the sub-cellular, molecular and genomic levels to enable the further development of infrared materials, devices, and systems with enhanced structural and functional capabilities. Identified, modeled, and constructed			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2312 Biological Sciences**

alternative biomimetic, near ambient infrared sensing devices. Probed and manipulated the functionality of alternative sensors for time-response characteristics. Commenced adapting biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems.

(U) In FY 2004: Model the fundamental principles, processes, and designs of non-cryogenic infrared sensitive biosystems at the sub-cellular and molecular levels to enable future infrared materials, devices, and systems with enhanced structural and functional capabilities to identify, model, and construct near ambient infrared sensing devices. Continue adapting characteristics of microbial and protein-based biosystems for applications to military sensor systems. Explore mimicking natural materials, using organisms as factories of new materials, or taking existing biomaterials and processing them into Air Force useful materials. Study the fundamental science and nano surface structure of biomaterials for application to military sensor systems that will ensure reliable assessment and monitoring.

(U) In FY 2005: Investigate, evaluate, and model natural occurrences, processes, and designs for future applications in infrared devices. Explore biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems. Exploit biomaterial and biointerfacial sciences to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications.

(U) Total Cost	13.605	9.272	9.631

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702F, Command, Control, and Communication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2313 Human Performance**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2313 Human Performance	12.332	12.667	13.596	13.655	14.412	14.105	14.319	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

Human performance basic research provides the fundamental knowledge necessary to examine and exploit all aspects of human information processing critical to Air Force operations. The goal is to develop useful quantitative models of the way warfighters perceive, appraise, and manipulate their environment; make decisions in complex tasks under stress or uncertainty; and adapt to extreme sensory, biophysical, or cognitive workloads. Sensory research emphasizes visual, auditory, equilibrium, and kinesthetic systems and their optimal integration. Basic research topics focus investigations on the scientific foundation for several developing Air Force technologies including specialized interactive displays, simulators, intelligent control systems, sensors and fused-image displays, and adaptive systems for operator and team training. Novel strategies to maintain decisive awareness by preventing impaired operating performance due to jet lag, shift work, night operations, and the loss of life and/or aircraft due to stress, inattention, or lack of vigilance are being evaluated. The primary areas of research investigated by this project are sensory systems; cognition, perception, and chronobiology; and behavioral and physiological measures of fatigue.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Probe human sensory systems and perceptions critical for warfighter performance (auditory and visual processes, multi-sensory integration, and sensory biomimetics) to enhance human-machine interaction in Air Force weapon systems. Research biophysical and neural mechanisms to determine human cognitive performance under conditions of sleep loss, sustained operations, and non-standard sleep/wake duty cycles.	3.363	3.468	7.856
(U) In FY 2003: Tested theories of sensory and perceptual systems. Evaluated theories and models of perception and cognition for accurate simulation and fused sensor processing. Investigated novel methods for evaluating design options for visual displays used in scene analysis and command and control in several task domains. Used performance metrics to critically test theories of sensory integration for image understanding.			
(U) In FY 2004: Critically investigate and model theories of sensory and perceptual systems. Continue evaluating theories and models of perception and cognition for more accurate simulation and improved fusion of sensor data. Examine visual information processing techniques to improve methods for evaluating display designs, enhancing the capability for collaboration, and improving the movement and sharing of information. Use performance metrics to critically test theories of sensory integration to understand complex images. Probe intrinsic differences in humans that make some individuals highly resistant to, and other highly susceptible to, sleep loss.			
(U) In FY 2005: Conduct empirical research with mathematical and/or computational modeling in spatial audition, speech perception, and hearing protection. Assess multi-sensory integration methods and novel biological sensing mechanisms. Probe biophysical mechanisms responsible for fatigue. Evaluate models of sleep/wake dynamics to predict specific deficits in warfighter performance.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2313 Human Performance**

		FY 2003	FY 2004	FY 2005
(U)				
(U)	MAJOR THRUST: Evaluate cognition and perception research to measure and analyze dimensions of human performance in complex, multi-interaction command and control tasks. Investigate behavioral and physiological theories of cognitive workload, alertness, and vulnerability to sleep loss.	4.648	4.704	5.740
(U)	In FY 2003: Extended models of cognitive dimensions of human performance in complex command and control tasks to inform studies of automated decision-making. Tested models of enhanced human performance aided or augmented by intelligent systems. Commenced determining mechanisms affecting training effectiveness for operator and team performance under stress and sustained operations.			
(U)	In FY 2004: Extend models of the cognitive dimensions of human performance in complex command and control tasks to enable studies of automated decision-making and enhanced risk assessment and measured response. Continue testing models for enhanced human performance aided or augmented by intelligent systems. Explore mechanisms affecting training effectiveness of operator and team performance under stress and sustained operations.			
(U)	In FY 2005: Analyze models of enhanced human performance aided or augmented by intelligent systems. Assess mechanisms affecting training effectiveness for operator and team performance. Continue modeling relationships between individual skill differences and interactions with envisioned training. Explore measures to avert/mitigate human error in conditions of information overload and fatigue.			
(U)				
(U)	MAJOR THRUST: Study and critically test behavioral and physiological theories of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance.	4.321	4.495	0.000
(U)	In FY 2003: Improved modeling relationships between individual skill differences and interactions with envisioned training pedagogies. Further determined behavioral and physiological measures to avert human error in conditions of information overload and fatigue.			
(U)	In FY 2004: Model relationships between individual skill differences and interactions with envisioned training techniques. Study behavioral and physiological measures to avert human error in conditions of information overload and fatigue and maintain full spectrum air and space vigilance.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be consolidated into the "cognition and perception" efforts earlier in this Project.			
(U)	Total Cost	12.332	12.667	13.596

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602202F, Human									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2313 Human Performance**

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

Effectiveness Applied Research.

(U) PE 0602702F, Command, Control, and Communication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **4113 External Research Programs Interface**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4113 External Research Programs Interface	6.962	7.346	9.638	11.415	13.769	15.749	17.907	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

External basic research programs interface facilitates interactions between the international and domestic research communities and U.S. Air Force researchers. These professional interchanges and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities, and attract talented scientists and engineers to address Air Force needs. International interactions ensure future interoperability of coalition systems and foster relationships with future coalition partners. Projects also seek to enhance educational interactions with historically black colleges and universities, Hispanic serving institutions, and minority institutions. The primary elements of this effort are international strategy, international technology liaison, and scientist and engineer research interchange.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Support the Air Force Research Laboratory international strategy mission.	2.303	2.458	0.000
(U) In FY 2003: Provided centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provided the primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and the Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.			
(U) In FY 2004: Continue provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provide the primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and the Air Force Materiel Command to coordinate international participation among appropriate Department of Defense organizations.			
(U) In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "international science and technology" efforts later in this Project.			
(U)			
(U) MAJOR THRUST: Support the international technology liaison missions, through the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development, to identify unique international research capabilities and make them available to the Air Force.	2.732	2.803	0.000
(U) In FY 2003: Supported on-site coordination with international research organizations and support international visits of high-level DoD delegations. Sustained and funded Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.			
(U) In FY 2004: Continue on-site coordination with international research organizations and support international visits of high-level DoD delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **4113 External Research Programs Interface**

		FY 2003	FY 2004	FY 2005
	as the Von Karman Institute.			
(U)	In FY 2005: Not Applicable. Note: In FY 2005, these activities will be moved to the "international science and technology" efforts later in this Project.			
(U)				
(U)	MAJOR THRUST: Foster international science and technology cooperation by supporting the Air Force's international strategy mission. Identify and obtain unique foreign research capabilities through the international technology liaison missions of the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development. Note: Prior to FY 2005, these activities were part of other efforts earlier in this Project.	0.000	0.000	6.061
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Provide centralized cooperation expertise, support international technology liaison missions, and identify unique research capabilities of high interest to the US Air Force. Support international visits of high-level DoD delegations and provide primary interface to coordinate international participation among DoD organizations. Aid in Air Force fiscal commitments to foreign NATO-affiliated research institutes.			
(U)				
(U)	MAJOR THRUST: Support scientist and engineer development assuring the Air Force of continuing availability of superior technical talent and forging Air Force Research Laboratory relationships with premiere scientists.	1.927	2.085	3.577
(U)	In FY 2003: Supported scientist and engineer research program at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Improved awareness of Air Force research needs throughout the civilian scientific community, while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.			
(U)	In FY 2004: Support scientist and engineering research programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Improve awareness of Air Force research needs throughout the civilian scientific community, while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.			
(U)	In FY 2005: Continue to support scientist and engineering research programs at U.S. colleges and universities, including historically black colleges and universities, Hispanic serving institutions, and other minority institutions. Enhance awareness of Air Force research needs throughout civilian scientific community, while simultaneously identifying/ recruiting the best scientific talent to participate in critical Air Force research.			
(U)	Total Cost	6.962	7.346	9.638

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **4113 External Research Programs Interface**

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601103D, University Research Initiative.									
(U) PE 0602102F, Materials.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602204F, Aerospace Avionics.									
(U) PE 0602269F, Hypersonic Technology Program.									
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0602601F, Space Technology.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702F, Command, Control and Communication.									

(U) D. Acquisition Strategy

Not Applicable.

PE NUMBER: 0601103F
PE TITLE: University Research Initiatives

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601103F University Research Initiatives

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	106.313	115.865	110.092	110.273	110.924	113.020	0.000	0.000
5094 University Research Initiatives	0.000	106.313	115.865	110.092	110.273	110.924	113.020	0.000	0.000

Note: In FY 2004, the Office of the Secretary of Defense devolved a portion of the Department of Defense University Research Initiative program to this program in the Air Force.

(U) A. Mission Description and Budget Item Justification

This program supports defense-related basic research in a wide range of scientific and engineering disciplines pertinent to maintaining U.S. military technology superiority; enhances and promotes the education of U.S. scientists and engineers in disciplines critical to maintaining, advancing, and enabling future U.S. defense technologies; and assists universities in establishing superior instrumentation capabilities needed to improve the quality of defense-related research and education. A fundamental component of this program is the recognition that future technologies and technology exploitations require highly coordinated and concerted multi- and interdisciplinary efforts.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	105.224	116.169
(U)	Current PBR/President's Budget	0.000	106.313	115.865
(U)	Total Adjustments	0.000	1.089	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.911	
	Congressional Increases		2.000	
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601103F University Research Initiatives**	**5094 University Research Initiatives**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5094 University Research Initiatives	0.000	106.313	115.865	110.092	110.273	110.924	113.020	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2004, the Office of the Secretary of Defense devolved a portion of the Department of Defense University Research Initiative program to this program in the Air Force.

(U) **A. Mission Description and Budget Item Justification**

This program supports defense-related basic research in a wide range of scientific and engineering disciplines pertinent to maintaining U.S. military technology superiority; enhances and promotes the education of U.S. scientists and engineers in disciplines critical to maintaining, advancing, and enabling future U.S. defense technologies; and assists universities in establishing superior instrumentation capabilities needed to improve the quality of defense-related research and education. A fundamental component of this program is the recognition that future technologies and technology exploitations require highly coordinated and concerted multi- and interdisciplinary efforts.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Promote fundamental, inter- and multi-disciplinary science and engineering research projects.	0.000	52.548	62.198
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Issue competitive research awards to universities focused on enabling Air Force-related technologies usually not achievable through single investigator awards. Topics will be selected in scientific research areas related to transformational and high priority technologies, such as nanotechnology, biomimetic sensor networks, intelligence information fusion, smart materials and structures, efficient energy and power conversion, high energy materials for propulsion and control, enhancing human performance, and improving research related to student training in instrumentation development. Continue funding of multi-disciplinary programs begun in prior years.			
(U) In FY 2005: Fund competitive research awards at U.S. universities to focus on underpinning Air Force-related technologies usually not achievable through typical single investigator awards. Topics will be selected in scientific research areas related to transformational capabilities and high priority technologies, such as nanotechnology, informatics, biotechnologies (e.g., biomimetic sensory networks, intelligent information fusion, smart materials, etc.), energy and power conversion, high energy propellants and materials, and enhanced human performance. Continue funding of multi-disciplinary programs begun in prior years.			
(U)			
(U) MAJOR THRUST: Support post-graduate, graduate, and undergraduate education in science and engineering disciplines at U.S. universities.	0.000	34.520	39.670
(U) In FY 2003: Not Applicable			
(U) In FY 2004: Award approximately 170 highly competitive graduate fellowships as part of the FY 2004 National Defense Science and Engineering Graduate Fellowship Program. These fellowships are awarded under a joint			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601103F University Research Initiatives**	PROJECT NUMBER AND TITLE **5094 University Research Initiatives**

		FY 2003	FY 2004	FY 2005
	tri-Service and Office of the Director of Defense Research and Engineering competition. Support competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Promote and advance recognition of superior academic research under Federal programs such as the Presidential Early Career Award for Scientists and Engineers. Continue funding for awards made under prior year Department of Defense programs.			
(U)	In FY 2005: Award approximately 180 highly competitive graduate fellowships as part of the FY 2005 National Defense Science and Engineering Graduate Fellowship Program. Fellowships are awarded under a joint tri-Service and Office of the Director of Defense Research and Engineering competition. Support competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Stimulate and recognize superior academic research under Federal programs such as the Presidential Early Career Award for Scientists and Engineers. Continue funding for awards made under prior year Department of Defense programs.			
(U)				
(U)	MAJOR THRUST: Enhance the scientific and engineering research and education infrastructure and instrumentation at U.S. universities.	0.000	17.261	13.997
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct the competition for U.S. universities to establish unique capability, high technology instrumentation and infrastructure under the Defense University Research Instrumentation Program.			
(U)	In FY 2005: Conduct the competition for U.S. universities to acquire state-of-the-art, high technology instrumentation and infrastructure to enhance research and educational capabilities under the Defense University Research Instrumentation Program.			
(U)				
(U)	CONGRESSIONAL ADD: Network and Information Space Security Center.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct fundamental multidisciplinary scientific research associated with network and information efforts.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Kelly Material Science and Engineering Laboratory.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct fundamental multidisciplinary scientific research at Kelly Material Science and Engineering Laboratory.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	0.000	106.313	115.865

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601103F University Research Initiatives**	PROJECT NUMBER AND TITLE **5094 University Research Initiatives**

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

(U) **D. Acquisition Strategy**

Not Applicable.

PE NUMBER: 0601108F
PE TITLE: High Energy Laser Research Initiatives

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601108F High Energy Laser Research Initiatives

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	11.961	12.331	12.467	12.716	12.872	13.096	0.000	0.000
5097 High Energy Laser Research Initiatves	0.000	11.961	12.331	12.467	12.716	12.872	13.096	0.000	0.000

Note: In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the High Energy Laser (HEL) Joint Technology Office (JTO).

(U) A. Mission Description and Budget Item Justification

This program funds basic research aimed at developing fundamental scientific knowledge to support future DOD HEL systems. HEL systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DOD effort in HEL science and technology conducted by the HEL JTO. In general, efforts funded under this program are chosen for their potential to have a broad impact on multiple HEL systems and Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, beam control, optics, propagation, and free electron lasers. The program funds theoretical, computational, and experimental investigations.

This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the Air Force invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	12.063	12.363
(U)	Current PBR/President's Budget	0.000	11.961	12.331
(U)	Total Adjustments	0.000	-0.102	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.102	
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the HEL JTO.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601108F High Energy Laser Research Initiatives**	**5097 High Energy Laser Research Initiatves**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5097 High Energy Laser Research Initiatves	0.000	11.961	12.331	12.467	12.716	12.872	13.096	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds basic research aimed at developing fundamental scientific knowledge to support future DOD HEL systems. HEL systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DOD effort in HEL science and technology conducted by the HEL JTO. In general, efforts funded under this program are chosen for their potential to have a broad impact on multiple HEL systems and Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, beam control, optics, propagation, and free electron lasers. The program funds theoretical, computational, and experimental investigations.

This program is in Budget Activity 1, Basic Research, because it funds scientific study and experimentation. Through this program, the Air Force invests in research directed toward increasing knowledge and understanding in those fields of science and engineering related to long-term national security needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) For FY 2003, this activity was performed under PE 0601108D8Z, High Energy Laser Initiative, and the funding for FY 2003 was approximately $12.1 million.			
(U)			
(U) MAJOR THRUST: Conduct fundamental research in solid state lasers focused on breaching the cost, power, and efficiency barriers to achieving the promise of simplified logistics and platform integration.	0.000	2.320	2.420
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section and the ability to operate at high temperatures, athermal laser gain media, modular and scalable architectures for laser power scaling, means of increasing efficiency in excess of 20%, operation in harsh environments, and corrections for thermally induced distortions in gain media. Research focuses on ceramic gain material fabrication methods, low absorption laser gain media, laser-diode pump sources, fiber lasers, and vertical external cavity laser brightness and power extraction through advancements in cooling and fabrication techniques. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 continue to receive funding.			
(U) In FY 2005: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section and the ability to operate at high temperatures, athermal laser gain media, modular and scalable			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601108F High Energy Laser Research Initiatives**	PROJECT NUMBER AND TITLE **5097 High Energy Laser Research Initiatves**

architectures for laser power scaling, means of increasing efficiency in excess of 20%, operation in harsh environments, and corrections for thermally induced distortions in gain media. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to receive funding.

(U)

(U)	MAJOR THRUST: Conduct fundamental research in high-power, lightweight optics.	0.000	1.910	1.960

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Conduct research in areas of interest including basic materials and fabrication techniques, large optics lightweight structure and deployment concepts, HEL optical coatings, multipurpose materials (e.g., wavefront correction combined with aperture adjustment), and control mechanisms. Develop negative thermal expansion optical coating materials to match zero expansion substrates and measure thermal and strain responses of these coatings. Begin investigation of heat transfer in micromachined adaptive mirrors. Develop methods to fabricate, measure, align, and coat large off-axis aspherical optics. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to receive funding.

(U) In FY 2005: Conduct research in areas of interest including basic materials and fabrication techniques, large optics lightweight structure and deployment concepts, HEL optical coatings, multipurpose materials (e.g., wavefront correction combined with aperture adjustment), and control mechanisms. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas begun during FY 2002 will continue to receive funding.

(U)

(U)	MAJOR THRUST: Conduct research focused on the scientific concerns associated with atmospheric beam control including atmospheric characterization in aerial, battlefield, and maritime-like environments. These efforts could lead to substantial increases in the lethality of HEL systems without the need for significantly increased power levels.	0.000	3.313	3.351

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wavefront sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wavefront correction. Research focuses on new methods for wavefront control, imaging and tracking through turbulence, and modeling and simulation of beam propagation. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas that were begun during FY 2002 continue to receive funding.

(U) In FY 2005: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wavefront sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wavefront correction. Pursuant to the nature of the

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601108F High Energy Laser Research Initiatives**	PROJECT NUMBER AND TITLE **5097 High Energy Laser Research Initiatves**

	university-led multidisciplinary research initiative program, all of the efforts to address the above research areas that were begun during FY 2002 will continue to receive funding.			
(U)				
(U)	MAJOR THRUST: Conduct fundamental research in chemical lasers to improve the understanding of the processes necessary for the realization of truly closed cycle, lightweight, high-power, continuously operating chemical lasers.	0.000	1.208	1.200
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and electrically driven oxygen iodine laser architectures. Measure chemical kinetics for an all gas phase chemical laser and study plasma physics of an electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas that were begun during FY 2002 continue to receive funding.			
(U)	In FY 2005: Conduct research in areas of interest including studies of chemical processes and reactions for a closed-cycle chemical laser system, new sources of the high-energy chemical species needed to produce the lasing event, and novel recovery systems for regeneration of the laser fuels. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas that were begun during FY 2002 will continue to receive funding.			
(U)				
(U)	MAJOR THRUST: Conduct fundamental research in high-average-power ultra-short-pulse free electron lasers to significantly increase the average power obtainable by ultra-short-pulse free electron lasers, while decreasing relative size and cost.	0.000	1.710	1.900
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct research in areas of interest including high-current devices and control methods, higher damage threshold resonator optics, advanced optical cavity designs for high power and compact spaces, and design methods for scaling free electron lasers to reach multi-megawatt class average power levels. Research focuses on dispenser photocathodes, free electron laser beam dynamics, methods to measure high average current beams, and methods to improve free electron laser energy recovery process. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas that were begun during FY 2002 continue to receive funding.			
(U)	In FY 2005: Conduct research in areas of interest including high-current devices and control methods, higher damage threshold resonator optics, advanced optical cavity designs for high power and compact spaces, and design methods for scaling free electron lasers to reach multi-megawatt class average power levels. Pursuant to the nature of the university-led multidisciplinary research initiative program, all of the efforts to address the above research areas that were begun during FY 2002 will continue to receive funding.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601108F High Energy Laser Research Initiatives**	PROJECT NUMBER AND TITLE **5097 High Energy Laser Research Initiatves**

(U)				
(U)	MAJOR THRUST: Conduct fundamental research in modeling and simulation for HELs.	0.000	1.500	1.500
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue development of models and simulation techniques to achieve a balance between high-fidelity technical analyses, engineering trade studies that allow analyses of a wide range of systems, and analyses of HEL systems' military utility in a broad range of missions.			
(U)	In FY 2005: Continue development of models and simulation techniques to achieve a balance between high-fidelity technical analyses, engineering trade studies that allow analyses of a wide range of systems, and analyses of HEL systems' military utility in a broad range of missions.			
(U)	Total Cost	0.000	11.961	12.331

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602890F, High Energy Laser Research.									
(U)	PE 0603444F, Maui Space Surveillance System.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	PE 0603605F, Advanced Weapons Technology.									
(U)	PE 0603924F, High Energy Laser Advanced Technology Program.									
(U)	PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U)	PE 0602605F, Directed Energy Technology.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601108F High Energy Laser Research Initiatives**	PROJECT NUMBER AND TITLE **5097 High Energy Laser Research Initiatves**

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

(U) PE 0602307A, Advanced Weapons Technology.

(U) PE 0602114N, Power Projection Applied Research.

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

(U) D. Acquisition Strategy

Not Applicable.

PE NUMBER: 0602102F
PE TITLE: Materials

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602102F Materials

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	105.237	109.222	73.660	71.548	77.516	80.112	77.598	0.000	0.000
4347	Materials for Structures, Propulsion, and Subsystems	65.429	64.131	41.057	40.876	45.924	47.644	44.371	0.000	0.000
4348	Materials for Electronics, Optics, and Survivability	18.253	19.252	12.437	11.716	12.080	12.444	12.728	0.000	0.000
4349	Materials Technology for Sustainment	16.933	16.204	17.825	16.562	17.054	17.503	17.916	0.000	0.000
4915	Deployed Air Base Technology	3.367	9.635	2.341	2.394	2.458	2.521	2.583	0.000	0.000
5015	Rocket Materials Technology	1.255	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: In FY 2003, space unique tasks in Projects 4347 and 4348 were transferred to PE 0602500F, Project 5025, Space Materials Development, as a result of the Space Commission recommendation to consolidate all space unique activities. In FY 2004, space unique tasks in Project 5015 will be transferred to PE 0602500F, Project 5025, as a result of the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program develops advanced materials, processing, and inspection technologies to reduce life cycle costs and improve performance, affordability, supportability, reliability, and survivability of current and future Air Force systems and operations. The program has four projects that develop: (1) structural, propulsion, and sub-systems materials and processes technologies; (2) electronic, optical, and survivability materials and processes technologies; (3) sustainment materials, processes technologies, and advanced non-destructive inspection methodologies; and (4) air base operations technologies including deployable base infrastructure, force protection, and and fire fighting capabilities. Note: In FY 2004, Congress added $1.5 million for Composite Fire Safety Consortium, $2.6 million for Advanced Wide Bandgap Materials, $1.0 million for Computational Tools for Material Development, $1.7 million for Gallium Nitride Microelectronics and Material Development, $2.4 million for Tyndall Air Force Research Laboratory Research and Development, $1.0 million for Discontinuous Titanium Matrix Composites for Aerospace Applications, $4.0 million for Wright Brothers Institute - Nanostructured Materials for Advanced Air Force Concepts, $2.9 million for Titanium Matrix Composites Program, $1.4 million for Closed Cell Foam Material, $2.8 million for Ultraviolet Free Electron Laser (UV FEL) Capabilities for Aerospace Microfabrication, $10.0 million for Strategic Partnership for Research in Nanotechnology (SPRING), $1.2 million for Durable Hybrid Coatings for Aircraft Systems, $2.3 million for Thermal Sprays for Structural Protection, $1.0 million for Nanotechnology Research, $4.2 million for Microfabrication, and $1.5 million for Composite Materials for Unmanned Air Vehicles (UAV) Initiative.
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.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	106.955	68.657	68.283
(U)	Current PBR/President's Budget	105.237	109.222	73.660
(U)	Total Adjustments	-1.718	40.565	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.935	
	Congressional Increases		41.500	
	Reprogrammings			
	SBIR/STTR Transfer	-1.718		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602102F Materials**	**4347 Materials for Structures, Propulsion, and Subsystems**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4347	Materials for Structures, Propulsion, and Subsystems	65.429	64.131	41.057	40.876	45.924	47.644	44.371	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in Project 4347 were transferred to PE 0602500F, Project 5025, as a result of the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

This project develops the materials and processing technology base for aircraft and missiles to improve affordability, maintainability, and performance of current and future Air Force systems. A family of affordable lightweight materials is being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites to provide upgraded capabilities for existing aircraft, missile, and propulsion systems to meet the future system requirements. Develops high-temperature turbine engine materials that will enable engine designs to double the turbine engine thrust to weight ratio. Advanced high temperature protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet aerospace and missile requirements. Alternative or replacement materials are being developed to maintain the performance of aging operational systems. Friction and wear-resistant materials, paints, coatings, and other pervasive nonstructural materials technologies are being developed for propulsion and subsystems on aircraft, spacecraft, and missiles. Concurrently develops advanced processing methods to enable adaptive processing of aerospace materials.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop ceramics and ceramic matrix composite technologies for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures.	3.208	4.721	4.733
(U) In FY 2003: Tested advanced ceramic composites for exhaust and hot section components under real and simulated service life conditions, using the data for durability assessment and life prediction development. Developed highly durable thermal protection materials for aerospace vehicles with aircraft-like operability through hot acoustic and other specialized testing. Developed laboratory-scale radar absorbing material coating repair for superalloy and/or titanium alloy substrates. Evaluated more durable ceramic composites based on emerging fibers and advanced interface coatings.			
(U) In FY 2004: Design new advanced ceramics and ceramic composites with improved durability and fracture resistance for aircraft applications. Develop advanced analytical techniques to predict the life of advanced ceramic composites containing stress concentration sites. Develop advanced analytical models to design integrally woven, actively cooled ceramic composite structures for advanced combustor applications. Design advanced ceramic composites for severe environments using the best available fiber-matrix interface technology.			
(U) In FY 2005: Develop damage resistant advanced ceramic composites for high friction and fracture-prone environments. Test tip rub tolerant concepts for ceramic blades. Update the advanced ceramic composites life			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

prediction model to permit prediction of its durability under stress gradients, temperature gradients, and long-term thermal exposure. Fabricate and test integrally cooled ceramic composite sub-elements and small components. Develop laboratory-scale advanced fiber-matrix interface concepts, optimizing on the robustness of these state-of-the-art ceramic composites in severe environments.

(U)

(U)	MAJOR THRUST: Develop materials processing technologies involving process models, advanced control methods, and advanced non-invasive sensors.	2.000	2.470	2.731

(U) In FY 2003: Investigated the feasibility of using evanescent microwave or inelastic photon (Raman) imaging of the surface and near-surface region as a process sensor. Evaluated new techniques for generating large-scale dynamic and phase behavior simulations for nanomaterial process design. Transitioned an interactive design-manufacturing environment, which allows rapid design interaction between multiple sites over the Internet. Tested a high-power, tunable laser processing tool for micro-engineered aerospace components and subsystems.

(U) In FY 2004: Evaluate the use of evanescent microwave sensors for evaluating laser damage and subsurface corrosion. Establish baseline parameters for selected techniques for generating large-scale dynamic and phase behavior simulations for nanomaterial process design. Investigate process control of optical deposition for scale-up and stress control of optical and multi-functional coatings for transfer to industry. Initiate studies of processing relationships to produce variation in composites. Investigate nucleation and growth mechanism for single wall carbon nanotubes in order to optimize manufacturing ability.

(U) In FY 2005: Evaluate Raman imaging as an in situ process sensor for processing of nanoscale structural materials. Initiate validation process for large-scale dynamic and phase behavior simulations for nanoparticle processing. Continue investigation and evaluation of process control of optical deposition for scale-up and stress control of optical and multi-functional coatings. Continue investigation of variability in composites for enhanced control and commercial transition. Continue exploration of carbon nanotube growth for commercial scalability.

(U)

(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop enabling polymeric materials for diverse aerospace structural applications including enhanced aircraft canopies, micromechanical devices, advanced wiring concepts, and improved low-observable platforms. Note: In FY 2003, this effort includes Congressional Adds of $6.0 million for Strategic Partnership for Nanotechnology Research and $1.0 million for Closed Cell Foam Material. In FY 2004, this effort includes Congressional Adds of $4.2 million for Microfabrication, $1.0 million for Nanotechnology Research, and $10.0 million for Strategic Partnership for Research in Nanotechnology (SPRING).	9.407	18.025	3.276

(U) In FY 2003: Confirmed feasibility of nanostructured materials for temperature-resistant applications and evaluated applicability for gas and fluid containment components for pervasive Air Force aerospace subcomponent applications. Tested new methods for rapid fabrication of micron-scale three-dimensional structures for Air Force micromechanical devices. Evaluated the use of hybrid thin wires for Air Force aerospace component applications. Demonstrated

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

light-absorbing polymeric materials for incorporation into sensor protection and other applications. Investigated new methods for room temperature cure of resins for advanced Air Force composite applications. Evaluated the use of conductive materials for low-observable gap sealants in Air Force aircraft applications.

(U) In FY 2004: Test clay infiltrated nanostructured polymeric materials for impermeability of gas and fluids. Develop rapid fabrication of nanoscale three-dimensional structures for Air Force conducting, structural, and electromechanical applications. Test hybrid thin wires under rigorous environmental conditions and extreme mechanical stresses. Scale up and complete advanced evaluation of two photon absorbing (TPA) polymer materials for night vision goggle protection. Develop the curing process for and initiate testing of composites containing advanced resins. Develop nanostructured polymer materials for low-observable and electromagnetic interference applications.

(U) In FY 2005: Establish the enhanced performance of nanostructured polymeric materials for gas and fluid containment. Continue to develop techniques and materials for nanoscale architectures to address advanced Air Force conducting, structural, and electromechanical applications. Complete development of a hybrid thin wire making process. Complete development of TPA polymer materials for night vision goggle and sensor protection applications. Test the durability of water borne conductive nanocomposites. Enhance conductive polymeric nanocomposites for use in elimination of secondary conductive coatings for aircraft lighting strike protection. Show the feasibility of lightweight radio frequency polymer substrates for reduced aperture size, conformal radar, and antenna systems.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable, advanced organic matrix composite structural materials and technologies for Air Force systems applications including lightweight structures for aerospace subcomponents and other structures requiring thermal and/or structural management for environmental control. Note: In FY 2003, this effort includes Congressional Adds of $3.25 million for Nanostructured Materials, $1.3 million for Thermal Management for Military Aircraft and Space Structures, $1.25 million for Cost-effective Materials for Unmanned Aerial Vehicles, and $0.5 million for Composite Materials Training Program. In FY 2004, this effort includes Congressional Adds of $1.5 million for Composite Materials for Unmanned Aerial Vehicles (UAV) Initiative and $4.0 million for Wright Brothers Institute - Nanostructured Materials for Advanced Air Force Concepts.	13.690	13.170	9.006

(U) In FY 2003: Developed composite material degradation mechanisms to improve life prediction for aircraft environmental control systems, hot exhaust-washed structures, and engine components. Developed next generation high temperature organic matrix composites for aerospace platforms. Improved the processing and fabrication of novel product foams such as nanomaterials, nanotubes, and carbon foams for lightweight, tough, and affordable structural materials.

(U) In FY 2004: Continue to develop an understanding of degradation mechanisms and life prediction capabilities for aircraft turbine engine and exhaust-washed structures as a function of their environments. Validate materials, processing, and fabrication scale-up of high-temperature organic matrix composites for turbine engines, aircraft and

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

high-Mach vehicle applications. Evaluate nanomaterials technologies for multifunctional properties required by military aircraft and satellites. Evaluate innovative carbon materials, such as carbon foams, and processing techniques for aircraft thermal management applications.

(U) In FY 2005: Test life prediction capabilities for high temperature turbine engines and airframe hot structures. Optimize materials and processing scale-up of high temperature organic matrix composites for affordable turbine, aircraft structures, and high-Mach vehicles. Develop materials and processes for nanomaterials as matrix additives and/or high performance composites with tailored and multi-functional capabilities. Test materials and processes at the subcomponent level for improved reliability and performance of thermal management application.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop nonstructural materials for fluids, lubricants, aircraft topcoat and corrosion resistant coatings, and specialty treatments to improve system performance and reduce life cycle costs. Note: In FY 2003, this effort includes Congressional Adds of $1.0 million for Nanostructures Protective Coatings, $2.8 million for Durable Coatings for Aircraft Systems, and $1.0 million for Environmentally Sound Aircraft Coatings. In FY 2004, this effort includes a Congressional Add of $1.2 million for Durable Hybrid Coatings for Aircraft Systems. — 11.054 — 8.095 — 7.621

(U) In FY 2003: Developed electrically conductive elastomers for use in electrostatic discharge control gap treatments. Developed advanced analytical techniques to predict the optical properties of specialty coatings. Established criteria for permanent corrosion-resistant primer resins and environmentally safe corrosion protection with a 30-year life. Established baseline for nanostructured multi-functional coatings to control friction and wear in extreme environments. Developed surface treatments for friction, stiction, and wear control in micro-devices.

(U) In FY 2004: Formulate the most promising electrically conductive elastomers for specific electrostatic discharge control gap treatments. Continue to develop advanced analytical techniques to predict the optical properties of specialty coatings. Investigate non-chromate surface treatments with advanced performance coatings for aircraft corrosion protection systems. Develop environmentally friendly corrosion protection systems with a 30-year life expectancy. Evaluate nanostructured multi-functional coatings to control friction and wear in extreme environments. Refine candidate surface treatments for friction, stiction, and wear control in micro-devices. Investigate potential status monitoring techniques for hydraulic fluids and related subsystems to extend aircraft life and establish condition-based maintenance procedures. Identify materials technologies suitable for use in secure and/or tamper resistant electronics.

(U) In FY 2005: Fabricate candidate materials for use in electrostatic discharge control gap treatments. Refine the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Evaluate the non-chromate surface treatments with advanced performance coatings for aircraft corrosion protection systems. Continue to develop environmentally friendly corrosion protection systems with a 30-year life expectancy. Design and develop nanostructured multi-functional coatings to control friction and wear in extreme

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

environments. Fabricate and test surface treatments for friction, stiction, and wear control in micro-devices. Evaluate candidate in situ status monitoring techniques for hydraulic systems to extend aircraft life and establish condition-based criteria for repair or replacement. Evaluate material and/or design-based concepts to provide secure and/or tamper resistant electronics.

(U)

(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable lightweight metallic materials, behavior and life prediction technologies, higher temperature intermetallic alloys, and metals processing technology to enable enhanced performance, lower acquisition costs, increased durability, and improved reliability for Air Force weapon systems. Note: In FY 2003, this effort includes Congressional Adds of $4.4 million for Titanium Matrix Composites and $5.3 million for Metals Affordability Initiative. In FY 2004, this effort includes Congressional Adds of $1.0 million for Discontinuous Titanium Matrix Composites for Aerospace Applications and $2.9 million for Titanium Matrix Composites Program.	26.070	17.650	13.690
(U)	In FY 2003: Transitioned life prediction methodology and surface treatments needed to prevent high cycle fatigue damage in integrally bladed rotors. Developed processing methods for second-generation alloys with the potential of achieving a 300°F temperature capability increase over current turbine blade materials. Developed computational methods for modeling the mechanical properties of specific metallic alloys. Optimized and transitioned advanced affordable process technologies to enable more affordable production of complex structural metal components for Air Force aerospace vehicles.			
(U)	In FY 2004: Initiate development of new life prediction technologies for improving aircraft turbine engine rotor durability in thermal-mechanical fatigue design systems. Continue to develop and analyze second-generation high-temperature structural materials that are nickel- and molybdenum-based for turbine engine applications. Develop computational methods for modeling mechanical properties of metals and alloys and validate these tools so that they can be used to reduce the amount of proof testing required to release metals for final component production. Identify processes and protocols for unitized manufacturing of aerospace components.			
(U)	In FY 2005: Develop reliable life extension capabilities for turbine engine rotors. Evaluate performance of high-temperature structural materials through preliminary certification testing and/or ground based engine rig testing. Develop and mature computational methods of modeling mechanical properties to metal suppliers and vendors to enable cost and schedule savings due to reduced amount of proof and release testing. Evaluate processes and protocols for unitized manufacturing of aerospace components.			
(U)	Total Cost	65.429	64.131	41.057

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602102F Materials**	**4347 Materials for Structures, Propulsion, and Subsystems**

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602102F Materials**	**4348 Materials for Electronics, Optics, and Survivability**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4348	Materials for Electronics, Optics, and Survivability	18.253	19.252	12.437	11.716	12.080	12.444	12.728	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in Project 4348 were transferred to PE 0602500F, Project 5025, as a result of the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

This project develops materials technologies for surveillance and situational awareness systems and subsystems for aircraft and missile applications, including sensor, microwave, and infrared detection and countermeasures devices used for targeting, electronic warfare, and active aircraft protection. Materials for protection of aircrews, sensors, and aircraft from laser and high-power microwave directed energy threats are also developed. Electronic and optical materials are being developed to enable surveillance and situational awareness with faster operating speeds, greater tunability, higher power output, improved thermal management (including higher operating temperatures), greater sensitivity, and extended dynamic range. New materials are being developed to counter the most prominent laser threats and to respond to emerging and agile threat wavelengths without impairing mission effectiveness.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop, evaluate, and mature infrared (IR) detector materials and materials processing technologies to enable improved performance, affordability, and operational capability of Air Force surveillance, tracking, targeting, and situational awareness systems.	2.885	0.472	0.500
(U) In FY 2003: Developed the process control required for growth of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Transitioned new processing techniques to improve IR detector materials yield and affordability in small lots. Investigated IR detector materials that provide enhanced real-time tracking capability.			
(U) In FY 2004: Validate the military utility of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Exploit validated processing techniques to develop enhanced IR detector materials performance and improve military utility. Show the process control required for growth of complex IR detector materials that require control on an atomic level to structure their detection properties. Investigate potential nano-scale materials solutions for detectors for a broad range of Air Force sensing needs including the detection of chemical threats.			
(U) In FY 2005: Continue development of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Validate the materials properties of complex IR detector materials that require control on an atomic level to structure their detection properties. Develop promising innovative nano-scale materials as potential IR materials for a broad range of Air Force sensing needs including the detection of chemical threats.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4348 Materials for Electronics, Optics, and Survivability**

(U)				
(U)	MAJOR THRUST: Develop, evaluate, and mature materials technologies to enhance the safety and survivability of aircrews and related assets against heat seeking infrared (IR) missiles and laser threats.	5.240	4.925	5.840
(U)	In FY 2003: Developed growth and processing techniques for large nonlinear crystals for generating higher power mid-IR laser radiation for future IR countermeasures (IRCM). Incorporated promising nonlinear absorbing materials into candidate host materials and tested their performance in the Air Force Optical Limiting Testbed for the protection of personnel eyes, viewing systems, and night vision goggles.			
(U)	In FY 2004: Investigate growth and processing techniques for nonlinear optical crystals including surface coatings and nanostructuring for generating laser radiation with significantly higher energy per pulse for future IRCM. Optimize the performance of promising nonlinear absorbing materials in candidate host materials and test their improved performance in the Air Force Optical Limiting Testbed for the protection of personnel eyes, viewing systems, and night vision goggles.			
(U)	In FY 2005: Develop growth and processing techniques for nonlinear optical crystals including surface processing for generating laser radiation with significantly higher energy per pulse for future IRCM. Characterize the performance of the optimized nonlinear absorbing materials in candidate host materials and document the test results obtained for the protection of personnel eyes, viewing systems, and night vision goggles.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and evaluate materials and process technologies for power generation, power control, and microwave components to provide improved performance, affordability, and operational capability for Air Force surveillance, tracking, targeting, situational awareness, and lethal and non-lethal weapon systems. Note: In FY 2003, this effort includes Congressional Adds of $1.1 million for Advanced Materials Deposition for Semiconductor Nanotechnology, $2.1 million for Free Electron Laser Materials Processing, and $3.4 million for Advanced Wide Bandgap Material Technology. In FY 2004, this effort includes Congressional Adds of $2.6 million for Advanced Wide Bandgap Materials and $1.7 million for Gallium Nitride Microelectronics and Material Development.	9.195	8.300	4.225
(U)	In FY 2003: Evaluated materials and materials processing technologies to enable increased Air Force systems reliability and temperature capability, while reducing power consumption, weight, cost, cooling, complexity, and size. Furthered the development and maturation of materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Began scale-up and assessment of materials and materials process technologies for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft.			
(U)	In FY 2004: Continue evaluation of materials and materials processing technologies to enable increased Air Force systems reliability and temperature capability, while reducing power consumption, weight, cost, cooling, complexity, and size. Continue development and testing of materials and processes to provide presently unattainable performance			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4348 Materials for Electronics, Optics, and Survivability**

for power control systems, advanced radar, and electronic countermeasures. Complete scale-up and maturation of baseline materials and materials process technologies for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Explore materials and materials process technologies for Terahertz components to provide the bandwidth required for the next order of magnitude leap in speed of Air Force sensor and communication systems.

(U) In FY 2005: Enhance specific baseline materials and materials processing technologies to enable increased Air Force systems reliability and temperature capability, while reducing power consumption, weight, cost, cooling, complexity, and size. Investigate advanced materials and materials processing technologies to provide capabilities beyond those achievable with baseline materials. Optimize and scale-up materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Complete assessment of baseline materials and materials process technologies for ultra-lightweight, ultra-high power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Develop advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes. Develop and analyze materials and materials process technologies for Terahertz components to provide the bandwidth required for the next order of magnitude leap in speed of Air Force sensor and communication systems.

(U)

(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and mature enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensors, viewing systems, and night vision goggles against laser threats. In FY 2004, this effort includes Congressional Adds of $1.0 million for Computational Tools for Material Development and $2.8 million for Ultraviolet Free Electron Laser (UV FEL) Capabilities for Aerospace Microfabrication.	0.933	5.555	1.872
(U)	In FY 2003: Developed liquid crystal materials employed in autonomous tunable filters to block near-infrared (IR) wavelengths. Developed high optical density, multiple wavelength switchable filter stacks.			
(U)	In FY 2004: Validate the performance of liquid crystal materials employed in autonomous tunable filters to block near-IR wavelengths. Fabricate laboratory samples of high optical density, multiple wavelength switchable filter stacks.			
(U)	In FY 2005: Design a representative brassboard protection system in the near-IR wavelengths using liquid crystal-based autonomous tunable filters. Characterize the optical performance of high optical density, multiple wavelength switchable filter stacks.			
(U)	Total Cost	18.253	19.252	12.437

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4348 Materials for Electronics, Optics, and Survivability**

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603112F, Advanced Materials for Weapon Systems.									
(U)	PE 0602202F, Human Effectiveness Applied Research.									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U)	PE 0603211F, Aerospace Technology Dev/Demo.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4349 Materials Technology for Sustainment**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4349 Materials Technology for Sustainment	16.933	16.204	17.825	16.562	17.054	17.503	17.916	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops materials and materials processing technologies to support operational Air Force mission areas by providing the ability to inspect the quality of delivered systems, transitioning more reliable and maintainable materials, establishing a capability to detect and characterize performance threatening defects, characterizing materials processes and properties necessary for materials transition, and providing quick reaction support and failure analysis to the operational commands and repair centers. Repair techniques and nondestructive inspection/evaluation (NDI/E) methods are developed that are needed for metallic and non-metallic structures, coatings, corrosion control processes, and to support integration of composite structures for aerospace systems. Various NDI/E methods are essential to ensure optimum quality in the design and production of aircraft, propulsion, and missile systems. These NDI/E methods are also essential to monitor and detect the onset of any service-initiated damage and/or deterioration due to aging of operational systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop NDI/E technologies to identify and characterize damage in aging aerospace structures, propulsion systems, and complex, low-observable (LO) materials and structures.	4.769	3.386	3.788
(U) In FY 2003: Developed inspection methods for aging aerospace structures and propulsion systems. Evaluated methods to rapidly detect and characterize multi-site damage and cracks in large area, aging structures. Evaluated computer simulations and models of NDI/E technique response, which will enable the development of improved inspections in a virtual environment to permit the depots to rapidly assess the potential of new corrosion and crack detection NDI/E methods. Evaluated NDI/E methods to characterize the LO properties of paints and coatings during and after application. Researched residual stress gradient measurement approaches to identify a new capability for subsurface measurement on shot peened surfaces.			
(U) In FY 2004: Improve methods to inspect and maintain the integrity of aging aerospace structures and propulsion systems. Develop electromagnetic methods to rapidly detect and characterize multi-site damage and cracks in large-area, aging structures. Develop computer simulations and models of NDI/E technique response, which will enable the development of improved inspections in a virtual environment to permit the depots to rapidly assess the potential of new corrosion and crack detection NDI/E methods. Evaluate technology concepts for measuring complex electromagnetic material properties beneath dielectric tiles in LO applications. Identify methods to detect and characterize damage in repaired (linear friction welded) advanced engine components. Develop residual stress gradient measurement capability for selected turbine engine materials to increase measurement depth capabilities on shot peened surfaces.			
(U) In FY 2005: Evaluate electromagnetic methods to rapidly detect and characterize multi-site damage and cracks in			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4349 Materials Technology for Sustainment**

	large area, aging structures. Evaluate computer simulations and models of NDI/E technique response, which will enable the development of improved inspections in a virtual environment to permit the depots to rapidly assess the potential of new corrosion and crack detection non-destructive inspection/evaluation (NDI/E) methods. Develop sensor technologies for measuring complex electromagnetic material properties beneath dielectric tiles. Continue development of a residual stress gradient measurement capability for selected turbine engine materials for shot peened surfaces.			
(U)				
(U)	MAJOR THRUST: Develop enabling low-observable (LO) requirements technologies to reduce the Air Force maintenance burden.	2.426	3.765	4.047
(U)	In FY 2003: Validated capability for NDI/E point inspection devices and verified repair quality. Developed an integrated LO repair kit that includes conductive gap fillers, radar absorbing material (RAM) repair materials, RAM removal equipment, radar absorbing structure (RAS) repair materials, and NDI/E equipment and software.			
(U)	In FY 2004: Complete development of NDI/E point inspection device capability. Develop a standardized LO repair kit for use on multiple aircraft systems, which will result in standardization of aircraft repair processes that includes conductive gap fillers, RAM repair materials, RAM removal equipment, RAS repair materials, and NDI/E equipment and software.			
(U)	In FY 2005: Optimize technologies for an integrated, standardized LO repair kit that includes conductive gap fillers, RAM repair materials, RAM removal equipment, RAS repair materials, and NDI/E equipment and software.			
(U)				
(U)	MAJOR THRUST: Develop support capabilities, information, and processes to resolve problems in the use of materials and provide electronic and structural failure analysis of components.	3.833	3.681	4.040
(U)	In FY 2003: Performed failure analysis and materials investigations for field, acquisition, and depot organizations. Certified and transitioned emerging electrostatic discharge protection materials technologies and techniques for LO applications. Evaluated testing techniques needed for analyzing structural failures of replacement materials for aging Air Force systems.			
(U)	In FY 2004: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Develop electrostatic discharge protection technologies for emerging avionics subsystems. Develop new test methodologies for analyzing structural failures of replacement materials for aging Air Force systems. Investigate materials technologies effort to replace aging wiring in Air Force aircraft subsystems.			
(U)	In FY 2005: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Validate electrostatic discharge protection technologies for emerging avionics sub-systems. Validate new test methodologies for analyzing structural failures of replacement materials for aging Air Force systems. Develop materials technologies effort to replace aging wiring in Air Force aircraft subsystems.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4349 Materials Technology for Sustainment**

(U)	MAJOR THRUST: Develop support capabilities, information, and processes to resolve problems in the use of materials in the repair of aircraft structures and to reduce aircraft corrosion.	5.905	5.372	5.950
(U)	In FY 2003: Published residual stresses baseline criteria of high cycle fatigue foreign object damage in turbine engine blade materials. Transitioned advanced composite materials compatibility with laser effluents as an alternative to metallic materials for high-energy chemical oxygen-iodine laser devices. Established capabilities to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Published baseline for improved corrosion management procedures.			
(U)	In FY 2004: Develop and evaluate methodologies to determine corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Identify failure mechanisms in Micro-Electro-Mechanical Systems (MEMS) used in hybrid, multifunctional, or status monitoring structures and subsystems.			
(U)	In FY 2005: Mature methodologies to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Evaluate methodologies to test failure limits for MEMS Structures and subsystems.			
(U)	Total Cost	16.933	16.204	17.825

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603112F, Advanced Materials for Weapons Systems.									
(U)	PE 0603211F, Aerospace Technology Dev/Demo.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	0602102F Materials	4915 Deployed Air Base Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4915 Deployed Air Base Technology	3.367	9.635	2.341	2.394	2.458	2.521	2.583	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project supports the Aerospace Expeditionary Forces (AEF) through development of new technologies for deployable airbase systems to reduce airlift and manpower requirements, setup times, and sustainment costs, and to improve protection and survivability of deployed AEF warfighters. Efficient and cost-effective technologies are developed for base infrastructure, fire fighting, and force protection to improve deployed operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Developed affordable, deployable technologies to ensure military readiness, maintain aerospace missions, support weapon systems sustainment, and ensure deployablity. Enhanced development of safe, cost-effective disposal of problem AEF wastes for low-observable material waste treatment. Note: In FY 2004, remaining activities in this thrust will be integrated into the other major thrusts in this project.	0.101	0.000	0.000
(U) In FY 2003: Developed affordable, deployable technologies to ensure military readiness, maintain aerospace missions, support weapon systems sustainment, and ensure deployablity. Developed safe, cost-effective disposal of problem AEF wastes for low-observable material waste treatment.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop new deployable airbase technologies to reduce airlift and manpower requirements, setup times, and sustainment costs in support of AEF operations. Note: In FY 2003, this effort includes a Congressional Add of $1.2 million for Tyndall Air Force Research Laboratory. In FY 2004, this effort includes half of a Congressional Add of $2.4 million for Tyndall Air Force Research Laboratory Research and Development.	1.794	2.240	1.173
(U) In FY 2003: Developed deployable fuel cell, solar power, and heat pump technologies that increase performance, decrease maintenance, increase mean time between failure, increase operating efficiency, and reduce sustainment costs.			
(U) In FY 2004: Mature deployable fuel cell power system to advanced technology development. Continue development of high-efficiency solid state solar cell technology. Initiate development of an advanced, compact integrated shelter/utility system that will integrate fuel cell and solar power with heat pump technologies to provide highly efficient, individual systems for deployable shelters. Initiate research on polymer-clay stabilization technology for rapid airfield expansion that will reduce the time required to prepare aircraft operating surfaces at contingency bases. Initiate research on catalysis and degradation of Air Force materials that will provide cleaner and lower cost advanced			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4915 Deployed Air Base Technology**

materials.

(U) In FY 2005: Develop high-efficiency solid state solar cell technology. Develop advanced integrated shelter power/Heating, Ventilation, and Air Conditioning concepts that will integrate fuel cell, solar and heat pump technologies into a highly efficient compact system that can provide total energy and air conditioning requirements for individual deployable shelters. Develop polymer-clay stabilization agents for rapid airfield expansion that will reduce time to prepare aircraft operating surfaces at unimproved contingency bases. Evaluate catalysis and degradation technologies of Air Force materials that will provide cleaner, lower cost advanced materials.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop cost-effective technologies to provide force protection and survivability to Aerospace Expeditionary Forces (AEF) deployed warfighters and infrastructure. Note: In FY 2004, this effort includes Congressional Adds of $1.4 million for Closed Cell Foam Materials, $1.5 million for Composite Fire Safety Consortium, $2.3 million for Thermal Sprays for Structural Protection, and half of $2.4 million for Tyndall Air Force Research Laboratory Research and Development.	1.472	7.395	1.168

(U) In FY 2003: Developed atmospheric threat prediction models and deployable sensors systems to protect AEF personnel from toxic industrial materials. Developed effective advanced fire fighting agents and equipment and advanced blast protection materials to protect deployed warfighters.

(U) In FY 2004: Continue development of fire fighting foam agents in conjunction with combined fire suppressant equipment and advanced blast protection materials to protect deployed warfighters. Develop and evaluate polymer-based retrofit technologies for expeditionary and permanent structures to protect the warfighter.

(U) In FY 2005: Develop effective advanced fire fighting agents and equipment and advanced blast protection materials to protect deployed warfighters. Initiate research on chemical laser fire suppression agents for effective protection of laser weapons systems. Initiate research on resilient infrastructure technologies for more effective protection of structures and inhabitants.

(U) Total Cost	3.367	9.635	2.341

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 0603112F, Advanced Materials for Weapon Systems.

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

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4915 Deployed Air Base Technology**

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

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **5015 Rocket Materials Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5015 Rocket Materials Technology	1.255	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, civilian salaries associated with space unique tasks in PE 0602102 were transferred to Project 5015. In FY 2004, these salaries in Project 5015 will be transferred to PE 0602500F, Project 5025, as a result of the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops advanced pervasive materials and processing technologies for aerospace propulsion technologies to dramatically improve affordability, performance, and reliability of current and future aerospace engine applications. The components of liquid-fuel engines that advanced materials can significantly impact include lightweight ducts, turbo pumps, injectors, and nozzles sub-systems. The material advancements in these aerospace systems will provide lighter weight, performance, and cost-reduction enhancements for overall aerospace engine applications. This project will develop material property databases and initiate the demonstration of suitability for new materials application using representative geometry and processing conditions for the intended aerospace engine components.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and evaluate pervasive materials and processing technologies for aerospace engine components and sub-components to dramatically improve affordability, performance, and reliability of current and future Air Force aerospace systems.	1.255	0.000	0.000
(U) In FY 2003: Evaluated chemistry/heat treatment combination for new compatible alloys for aerospace propulsion housing components. Identified and developed pervasive zero erosion materials for multiple aerospace engine and missile applications. Identified and evaluated pervasive high temperature catalyst materials that will enable the use of high performance monopropellants for aerospace propulsion systems.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U) Total Cost	1.255	0.000	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0602203F, Aerospace Propulsion.									
(U) PE 0603112F, Advanced Materials for Weapon Systems. PE 0602500F,									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **5015 Rocket Materials Technology**

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

Multi-Disciplinary Space Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

PE NUMBER: 0602201F
PE TITLE: Aerospace Vehicle Technologies

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2004**

BUDGET ACTIVITY: **02 Applied Research**

PE NUMBER AND TITLE: **0602201F Aerospace Vehicle Technologies**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	75.067	64.311	74.679	103.895	111.893	105.771	108.164	Continuing	TBD
2401	Structures	26.267	28.679	32.831	43.196	46.599	41.726	42.646	Continuing	TBD
2403	Flight Controls and Pilot-Vehicle Interface	16.777	15.486	16.643	30.324	33.315	28.784	29.589	Continuing	TBD
2404	Aeromechanics and Integration	32.023	20.146	25.205	30.375	31.979	35.261	35.929	Continuing	TBD
4397	Air Base Technology	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2003, only the space unique efforts in Project 2403 transferred to PE 0602500F, Project 5030, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program investigates, develops, and analyzes aerospace vehicle technologies in the three primary areas of structures, controls, and aeromechanics. First, advanced structures concepts are explored and developed to exploit new materials, fabrication processes, and design techniques. Second, flight control technologies are developed and simulated for both manned and unmanned aerospace vehicles. Third, the aeromechanics of advanced aerodynamic vehicle configurations are developed and analyzed through simulations, experiments, and multidisciplinary analysis. Resulting technologies reduce life cycle costs and improve the performance of existing and future manned and unmanned aerospace vehicles. Note: In FY 2004, Congress added $1.1 million for intelligent flight control simulation research laboratory.

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

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	76.347	65.662	77.571
(U)	Current PBR/President's Budget	75.067	64.311	74.679
(U)	Total Adjustments	-1.280	-1.351	
(U)	Congressional Program Reductions		-2.000	
	Congressional Rescissions		-0.551	
	Congressional Increases		1.200	
	Reprogrammings			
	SBIR/STTR Transfer	-1.280		

(U) Significant Program Changes:

None

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602201F Aerospace Vehicle Technologies**	**2401 Structures**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2401 Structures	26.267	28.679	32.831	43.196	46.599	41.726	42.646	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops advanced structures concepts to exploit new materials and fabrication processes and investigates new structural concepts and design techniques. Resulting technologies strengthen and extend the life of current and future manned and unmanned aerospace vehicle structures. Payoffs to the warfighter include reduced weight and cost, as well as improved operability and maintainability of aerospace vehicles.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop an economic service life analysis capability comprised of analysis tools, methodologies, and monitoring schemes.	7.880	7.170	6.332
(U) In FY 2003: Developed economic service life analysis for current and future aircraft, enhancing capability, component replacement, and technology direction. Continued development of unitized structural concepts and multidisciplinary optimization methodologies that enhance affordability and decrease vulnerability for current and future aerospace vehicles. Incorporated newly developed analysis tools into life prediction and failure analysis software.			
(U) In FY 2004: Develop economic service life analysis and structural design tools for current and future aircraft, enhancing capabilities, component replacement, and technology direction. Continue the development of unitized structural concepts and multidisciplinary methodologies that enhance affordability and decrease vulnerability for current and future aerospace vehicles. Incorporate newly developed analysis tools into life prediction and failure analysis. Complete reliability based design tools for advanced aircraft components and concepts.			
(U) In FY 2005: Develop alternative methodologies and concepts for structural repair. Develop structural health monitoring schemes for structures susceptible to damage. Pursue additional aspects of the development of economic service life analysis and structural design tools for current and future aircraft enhancing capabilities, component replacement, and technology direction. Incorporate newly developed analysis tools for life prediction and failure analysis. Continue to develop failure criteria tools for advanced high temperature aircraft components and concepts. Complete the development of unitized structural concepts and multidisciplinary methodologies that enhance affordability and decrease vulnerability for current and future aerospace vehicles.			
(U)			
(U) MAJOR THRUST: Develop methodologies to allow for analytical air-worthiness certification that will reduce the cost and time involved in actual full-scale testing of components and aircraft prior to obtaining air-worthiness certification.	4.203	7.743	6.550

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2401 Structures**

(U)	In FY 2003: Developed analytical certification methodologies for the incorporation of advanced methods, concepts, and manufacturing technologies into legacy aircraft components and future vehicle designs. Improved the air-worthiness certification process for aircraft subjected to dynamic aeroelastic loads with high fidelity models.			
(U)	In FY 2004: Develop analytical certification methodologies for the incorporation of advanced methods, concepts, diagnostic techniques, and manufacturing technologies into legacy aircraft components and airframe design. Improve the air-worthiness certification process for aircraft subject to dynamics laods and with high fidelity.			
(U)	In FY 2005: Continue to develop analytical certification methodologies for the incorporation of advanced methods, concepts, diagnostic techniques, and manufacturing technologies into legacy aircraft components and airframe design. Improve air-worthiness certification process for aircraft subject to dynamic loads and with high fidelity.			
(U)				
(U)	MAJOR THRUST: Develop design methods to capitalize on new materials and integration of various subsystem hardware items (e.g., antennas and sensors) into the actual aircraft structures and/or skin of the aircraft.	2.101	5.736	5.424
(U)	In FY 2003: Continued development of structural concepts, design, analysis methods that enable the integration of structure with other airframe functions to reduce cost and increase the survivability of future systems. Concepts included adaptive structures for varying moldline, subsystems hardware, and antennae contained within the load bearing structure.			
(U)	In FY 2004: Develop concepts, design, and analysis methods and components that enable the integration of structures with other air vehicle functions to reduce cost and weight, as well as increase the survivability of future systems. Continue the development of concepts that include adaptive structures, subsystem hardware, and antenna integration into a load-bearing structure to create multifunction or ultra lightweight concepts.			
(U)	In FY 2005: Refine concepts, design and analysis methods, and components that enable the integration of structures with other air vehicle functions to reduce cost and weight, as well as increase the survivability of future systems. Continue the development of concepts that include adaptive structures, subsystem hardware, and antenna integration into a load-bearing structure to create multifunction or ultra lightweight concepts.			
(U)				
(U)	MAJOR THRUST: Develop technologies that will permit the structural development of aircraft that can operate at an extreme altitude while at sustained speeds greater than Mach 2.	12.083	8.030	14.525
(U)	In FY 2003: Developed technologies that incorporated advanced materials as well as passive and active cooling to withstand extreme flight environments. Concepts included advanced, durable, all-weather thermal protection systems, attachment techniques, vehicle health monitoring and health management, integrated thermal protection systems, hot primary structures, hybrid structures, unitized structures, joining concepts, and cryogenic/non-cryogenic tank structures.			
(U)	In FY 2004: Develop technologies that incorporate advanced materials, as well as passive and active cooling to withstand extreme flight environments. Complete the development of assessment methodologies for air vehicle			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2401 Structures**

assessment.

(U) In FY 2005: Continue to develop technologies that incorporate advanced materials, and design concepts for the creation of an integrated air vehicle structure that can withstand extreme flight environments. Continue the development of concepts germane to advanced, all-weather, durable, thermal protection systems; attachment techniques; vehicle health monitoring; hot primary structures; hybrid structures; joining concepts; and tanks.

(U)	Total Cost	26.267	28.679	32.831

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0603112F, Advanced Materials for Weapon Systems.									
(U)	PE 0603211F, Aerospace Technology Dev/Demo.									
(U)	PE 0603333F, Unmanned Air Vehicle Dev/Demo.									
(U)	PE 0604105F, Next Generation Bomber.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2403	Flight Controls and Pilot-Vehicle Interface	16.777	15.486	16.643	30.324	33.315	28.784	29.589	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, the space unique tasks in Project 2403 will be transferred to PE 0602500F, Project 5030, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops technologies that enable maximum affordable capability from manned and unmanned aerospace vehicles. Advanced flight control technologies are developed for maximum vehicle performance throughout the flight envelope and simulated in virtual environments. Resulting technologies contribute significantly towards the development of reliable autonomous unmanned air vehicles, space access systems with aircraft-like operations, and extended-life legacy aircraft. Payoffs to the warfighter include enhanced mission effectiveness, optimized flight safety, increased survivability, improved maintenance, and decreased size, weight, and cost. Leverages a network of synthetic environments for evaluation of advanced concepts.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop advanced flight control systems, components, and integrated vehicle health monitoring systems for both manned and unmanned aircraft. In addition to increased reliability, efforts will also focus on reducing the size, weight, and cost of control and prognostic systems.	2.852	5.718	7.177

(U) In FY 2003: Developed and assessed advanced control mechanization technologies to provide highly reliable operation for manned and unmanned systems at reduced size, weight, and cost. Demonstrated validation and verification techniques for complex, adaptive, and autonomous control software. Assessed micro-effector technologies for lightweight, long-endurance air vehicle applications. Developed real-time fault compensation using an integrated prognostic health management system.

(U) In FY 2004: Develop and assess advanced control mechanization to provide highly reliable operations for manned and unmanned systems at reduced size, weight, and cost. Continue to develop demonstrations of validation and verification techniques for complex, adaptive, and autonomous control software. Define sensing requirements for unmanned systems situational awareness in airspace operations.

(U) In FY 2005: Continue to develop and assess advanced control mechanization to provide highly reliable operations for manned and unmanned systems at reduced size, weight, and cost. Develop and assess tools and processes for the affordable validation and verification of complex, adaptive, and autonomous control software. Develop design analyses and technologies that enable analytical safety of flight certification of advanced complex control systems for applications in legacy and future air vehicles. Continue the evaluation of sensing and associated interpretation techniques for unmanned system situational awareness in airspace operations. Continue to enhance real-time fault

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**

	compensation for aerospace vehicles using an integrated prognostic health management system. Initiate the development and evaluation of novel flight control effectors for distributed actuation and morphing aerospace vehicles.			
(U)				
(U)	MAJOR THRUST: Develop flight control systems that will permit safe interoperability between manned aircraft and unmanned aircraft. Concepts will also provide mission responsiveness and adaptability for improved operational effectiveness of manned and unmanned systems.	7.550	4.575	3.679
(U)	In FY 2003: Developed and assessed novel control automation techniques and algorithms to enable the safe and interoperable application of unmanned vehicle systems. Conducted feasibility assessments of automated aerial refueling system concept. Developed reliability and performance analyses of self-organizing, distributed control of multi-unmanned vehicle packages.			
(U)	In FY 2004: Continue to develop and assess novel control automation techniques and algorithms to enable safe and interoperable application of unmanned vehicle systems. Investigate feasibility of biology inspired control techniques to simplify unmanned systems autonomy implementations. Continue to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle packages. Develop intelligent situational awareness algorithms to implement autonomous airspace operations control for unmanned vehicle systems.			
(U)	In FY 2005: Continue efforts to develop and assess novel control automation techniques and algorithms to enable safe and interoperable applications of unmanned vehicle systems. Continue to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle flight formations. Continue development of intelligent situational awareness algorithms to implement autonomous airspace operations control for unmanned vehicle systems.			
(U)				
(U)	MAJOR THRUST: Develop tools and methods for capitalizing on simulation-based research and development of future aircraft.	5.208	4.003	5.787
(U)	In FY 2003: Assessed the value of air vehicle technologies to future aerospace systems through the development and utilization of in-house tools, systems, and processes for simulation-based research and development. Continued development of virtual simulations for unmanned air vehicles used in validating autonomous control algorithms for mixed manned and unmanned air vehicle operations. Continued to enhance simulation and analysis capabilities though incorporation of cost models to determine the affordability of new technologies. Continued development of the capability to virtually simulate future strike aircraft. Develop capability to virtually simulate space access operability.			
(U)	In FY 2004: Assess the value of air vehicle technologies to future aerospace systems through the development and utilization of in-house tools, systems and processes for simulation-based research and development. Conduct simulation assessments of advanced unmanned aerospace vehicles concepts. Continue to enhance simulation and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**

analysis capabilities through incorporation of cost models to determine the affordability of new technologies. Continue development capability to virtually simulate future strike aircraft. Formulate and simulate concepts for future intelligence, surveillance, and reconnaissance platforms, future high-speed vehicles, advanced transports and future tankers.

(U) In FY 2005: Refine efforts to assess the value of air vehicle technologies to future aerospace systems through the development and utilization of in-house tools, systems, and processes for simulation-based research and development. Conduct simulation assessments of advanced manned and unmanned aerospace vehicles concepts. Complete the enhancement of simulation and analysis capabilities through incorporation of cost models to determine the affordability of new technologies. Complete the development of the virtual simulation environment for future strike aircraft. Continue to formulate and simulate concepts for future intelligence, surveillance, and reconnaissance platforms, future high-speed vehicles, advanced transports, and future tankers.

(U)

(U)	CONGRESSIONAL ADD: Intelligent Flight Control Simulation Research.	1.167	1.190	0.000
(U)	In FY 2003: Establish a distributed Intelligent Flight Control Simulation Research Laboratory capability between Wright-Patterson Air Force Base and other geographical locations.			
(U)	In FY 2004: Continue Congressionally-directed effort for intelligent flight control simulation research laboratory.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	16.777	15.486	16.643

(U) <u>C. Other Program Funding Summary ($ in Millions)</u>

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602202F, Human Effectiveness Applied Research.									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0603211F, Aerospace Technology Dev/Demo.									
(U)	PE 0604105F, Next Generation Bomber.									
(U)	This project has been coordinated through the Reliance process to harmonize									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**

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

efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602201F Aerospace Vehicle Technologies**	**2404 Aeromechanics and Integration**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2404 Aeromechanics and Integration	32.023	20.146	25.205	30.375	31.979	35.261	35.929	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops aerodynamic configurations of a broad range of revolutionary, affordable air vehicles. It matures and applies modeling and numerical simulation methods for fast and affordable aerodynamics prediction, and integrates and demonstrates multidisciplinary advances in airframe-propulsion, airframe-weapon, and air vehicle control integration. Technologies developed will greatly enhance warfighter capability in aircraft, missiles, and high-speed aerospace vehicles. The payoffs from these technology programs include lower vehicle costs (both production, and operations and support costs), increased payload and range capability, and improved supportability, safety, and survivability of aerospace vehicles.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop aerodynamic prediction efforts centered on expanding the design capabilities of unmanned air vehicles.	6.725	3.828	2.588
(U) In FY 2003: Developed and assessed aeronautical technologies that enable broad use of unmanned air vehicles in future missions to reduce life cycle cost and decrease human risk. Continued preliminary development of conformal inlet designs that improve airflow to engines while providing low signature for increased survivability and improved propulsion system performance. Continued development of signature compatible, high lift wings for long-duration surveillance missions.			
(U) In FY 2004: Develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions to reduce life cycle costs and decrease human risk. Complete development of signature compatible, high lift wings for long-duration surveillance missions. Complete development of technology to improve engine nozzle design for increased survivability. Continue to perform mission assessment and develop low-cost unmanned air vehicle concept to perform tactical surveillance. Apply flow control techniques to complex air vehicle designs to achieve reduced drag and improve propulsion performance.			
(U) In FY 2005: Continue efforts to develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions, including offensive missions, to reduce life cycle costs and decrease human risk. Continue to perform mission assessment and develop low-cost unmanned air vehicle concept to perform tactical surveillance and weapon delivery. Continue to apply flow control techniques to complex air vehicle designs to achieve reduced drag and improved propulsion system performance. Initiate research into rapid prototyping and analysis techniques to support virtual and physical models. Continue to develop technologies for improved weapon delivery and propulsion system performance in unmanned air vehicles.			
(U)			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2404 Aeromechanics and Integration**

(U)	MAJOR THRUST: Develop aerodynamic prediction efforts centered on expanding the design capabilities of manned air vehicles.	7.045	2.216	0.000
(U)	In FY 2003: Developed design tools that permit quicker and more affordable certification of aerodynamic enhancements to extend the operational life of the current fleet. Continued development of analysis tools to accelerate the aerodynamic integration of new and existing weapons with current aircraft to enhance their warfighting ability. Continued to enhance computer design and analysis code that reduces the need for expensive flight-testing.			
(U)	In FY 2004: Develop design tools that permit quicker and more affordable certification of aerodynamic enhancements to extend the operational life of the current fleet. Continue enhancement of computer design and analysis code that reduces the need for expensive flight-testing, including completion of a robust unstructured mesh generation and adoption framework.			
(U)	In FY 2005: Not Applicable. Changes to this program since the previous President's Budget are due to higher Air Force priorities.			
(U)				
(U)	MAJOR THRUST: Develop new and improved concepts, designs, and analysis of technologies to enable revolutionary capabilities for sustained high-speed flight and access to space. Note: In FY 2005, access to space efforts separated into the following related thrust area to allow for increased visibility between the high-speed and access to space efforts.)	16.332	0.000	8.903
(U)	In FY 2003: Developed and assessed aerospace technologies that enable high-speed flight and low-cost access to orbit to permit global reach. Continued development of analytic methods for modeling the plasma flow field over high-speed vehicles to reduce drag. Developed experimental capability to generate and control plasma flows. Continued development of complex configurations that mitigate the extreme thermal environment under which high-speed aerospace vehicles operate. Continued development of techniques to carry and deploy weapons from aerospace vehicles flying at high speeds and high temperatures.			
(U)	In FY 2004: Not Applicable. Note: In FY 2004, the funding for this effort was decreased to support increased emphasis being placed on the National Aerospace Initiative.			
(U)	In FY 2005: Develop and assess aerospace technologies that enable sustained high-speed (greater than Mach 2) flight to permit global reach. Continue development of integrated airframe-propulsion design concepts for high-speed aerospace vehicles. Develop analytic methods for modeling the plasma flow field over high-speed vehicles to reduce drag. Complete development of techniques to carry and deploy weapons from aerospace vehicles operating at high speeds (greater than Mach 2) and high temperatures.			
(U)				
(U)	MAJOR THRUST: Develop new and improved concepts, designs, and analysis of technologies to enable revolutionary capabilities for access to space. Note: In FY 2005, the access to space efforts were previously described in the above related thrust area were broken out to allow for increased visibility between the high-speed and	0.000	0.000	7.296

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2404 Aeromechanics and Integration**

	access to space efforts.			
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Develop and assess aerospace technologies that enable high-speed flight to permit aircraft-like access to space. Continue development of computational, multidisciplinary, experimental and analytical tools to simulate and control the flow fields around advanced concepts for ultra-high speed aerospace vehicles in extreme flight environments, including staging. Develop techniques to evaluate transatmospheric vehicle aerodynamic configurations to validate aero thermodynamic predictions and analysis techniques.			
(U)				
(U)	MAJOR THRUST: Develop enabling technologies to allow integration of directed energy weapons into current and future air vehicle platforms.	1.921	9.066	4.141
(U)	In FY 2003: Developed and evaluated critical aeronautical technologies to enable directed energy weapons to be carried on future air vehicles to improve combat effectiveness. Continued development of aircraft techniques to enhance energy beam transmission through the complex, turbulent aerodynamic environment surrounding aircraft enabling the use of directed energy weapons from high-speed, maneuvering aircraft.			
(U)	In FY 2004: Continue to develop and evaluate critical aeronautical technologies to enable directed energy weapons to be carried on future air vehicles to improve combat effectiveness. Complete development of aircraft techniques to enhance energy beam transmission through the complex, turbulent aerodynamic environment surrounding aircraft enabling the use of directed energy weapons from high-speed, maneuvering aircraft. Continue analysis of tactical utility of high-energy laser on fighter aircraft. Perform flight test measurements of the actual aero-optics effects encountered when employing a laser weapon on a fighter aircraft. Perform evaluation and demonstration of scalable technologies leading toward a high-energy laser weapon.			
(U)	In FY 2005: Develop and evaluate critical aeronautical technologies to enable directed energy weapons to be carried on future air vehicles, including maneuvering fighter aircraft, to improve combat effectiveness. Complete analysis of the tactical utility a high-energy laser on fighter aircraft. Continue measurements of the actual aero-optics effects encountered when employing a laser weapon on a fighter aircraft.			
(U)				
(U)	MAJOR THRUST: Develop and assess technologies for the next generation of multi-role large aircraft.	0.000	5.036	2.277
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop and assess aeronautical technologies to enable revolutionary re-fueling and transport aircraft designs for rapid global mobility. Develop technologies to enable multiple roles and missions for support aircraft. Complete innovative designs for re-fueling and transport aircraft to improve range and payload capacity. Complete investigation of an aerodynamic flow field behind re-fueling aircraft to improve modeling and simulation.			
(U)	In FY 2005: Continue efforts to develop and assess aeronautical technologies to enable revolutionary tanker and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2404 Aeromechanics and Integration**

transport aircraft designs for rapid global mobility, including multi-role designs. Continue to develop technologies to enable multiple roles and missions for delivery and support aircraft.

(U)	Total Cost	32.023	20.146	25.205

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603211F, Aerospace Technology Dev/Demo.									
(U)	PE 0604105F, Next Generation Bomber.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

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

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

(U) A. Mission Description and Budget Item Justification

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

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	76.707	66.795	68.693
(U)	Current PBR/President's Budget	75.229	87.143	71.483
(U)	Total Adjustments	-1.478	20.348	
(U)	Congressional Program Reductions		-0.005	
	Congressional Rescissions		-0.747	
	Congressional Increases		21.100	
	Reprogrammings			
	SBIR/STTR Transfer	-1.478		

(U) Significant Program Changes:
Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602202F Human Effectiveness Applied Research**	**1123 Warfighter Training**

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

(U) A. Mission Description and Budget Item Justification

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

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

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

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

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

thrust enables performance improvement techniques research in FY 2005.

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

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

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

(U)	Total Cost	10.640	10.537	11.116

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

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

(U) D. Acquisition Strategy

Not Applicable.

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

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

(U) A. Mission Description and Budget Item Justification

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

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

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

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

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

(U)

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

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

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

(U) D. Acquisition Strategy

Not Applicable.

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

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

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

(U) A. Mission Description and Budget Item Justification

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

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop interface technologies for multi-sensory adaptive controls and displays, performance metrics, and human speech processing and control solutions that promote intuitive interface design.	3.952	4.857	5.110
(U) In FY 2003: Evaluated methods for employing real-time measurement of crew workload as it changes with mission events to adjust automation and decision support in multi-ship, unmanned air vehicle missions. Developed concept for intelligent, on-line physical accommodation tools to optimize equipment fit, enabling future crew stations and equipment to adapt to human variability. Completed laboratory experiments exploring crew interface concepts for airborne command and control, demonstrated an advanced crew station for airborne early warning, and explored interface technologies for supervision of multiple autonomous unmanned air vehicles.			
(U) In FY 2004: Demonstrate a real-time ability to use on-line estimates of crew workload and situation awareness to adjust automation during future unmanned combat air vehicle missions. Perform laboratory demonstration of multi-sensory display concepts and technology for virtual air command in airborne early warning missions, and continue to assess the impact of near-term and far-term autonomous vehicle capability on the remote interface and decision support requirements of intelligent unmanned air vehicles. Perform research on speech signal processing and speech-based countermeasures for information operations, and explore the concept of a robust stressed-speaker identification capability.			
(U) In FY 2005: Demonstrate the feasibility of a situational awareness estimator to improve real-time task sharing during			

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

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

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

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

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

(U)

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

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

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

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

(U)

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

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

	airfields, and usable for developing in-flight tactics in vectored thrust aircraft to minimize acoustic detection by adversaries.			
(U)	In FY 2004: Continue technology development for acoustic remote threat detection in perimeter defense and recommend auditory symbology for security forces. Characterize the expected acoustic noise reduction achievable with earplugs for a high performance (50 dB) hearing protection system. Continue to develop a dynamic noise model that can be integrated with real-time visualization of the sound field, usable for environmental analysis to characterize the noise environment around airfields, and usable for developing in-flight tactics in vectored thrust aircraft to minimize acoustic detection by adversaries.			
(U)	In FY 2005: Complete technology assessment of acoustic remote threat detection in perimeter defense, and explore the use of acoustic detection capabilities by special tactics forces. Demonstrate the feasibility of combining active noise reduction with 3-D audio communications for a high performance (50 dB) hearing protection system. Identify and develop a concept to validate the dynamic noise model in terms of lowering the cost of collecting acoustic data, and explore acoustic modeling for environmental analysis. Begin to analyze how to minimize acoustic detection of vectored thrust aircraft. Begin to develop virtual audio interface technology using dynamic audio/visual interaction for use with helmet-mounted displays.			
(U)				
(U)	MAJOR THRUST: Develop integrated human-centered information operations technologies to provide quicker and more intuitive access to information, enhanced decision-making capabilities, and more effective training procedures.	0.713	5.947	6.003
(U)	In FY 2003: Refined human perception management tools for potential weaponization in offensive and defensive counter-information operations. Developed concepts of operation for effects-based planning, demonstrations of next-generation planning and decision aids, and warfighter-tailored information visualizations that specifically focus on information operations.			
(U)	In FY 2004: Conduct research to develop, distribute, and synchronize knowledge, training, and decision-making among various team members, multiple support teams, and reachback locations via advanced collaboration technologies and environments in order to enhance predictive battlespace awareness within information operations. Determine feasibility and technical approach for developing adversary cultural decision models, and development of training techniques and tools for information warriors.			
(U)	In FY 2005: Conduct research to develop information operations natural collaboration links, training, cultural modeling, and predictive battlespace awareness capabilities. Develop proof-of concept technologies to specify, measure, and model key parameters.			
(U)				
(U)	MAJOR THRUST: Develop human injury criteria and protective system technologies for use against risks encountered in crash and other hazardous environments. Research will develop technologies to ensure full aircrew population accommodation and safety during aircraft and vehicle operations including vibration, crashes, emergency	5.146	5.527	4.243

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

	escape, extended missions, and parachute opening shock.			
(U)	In FY 2003: Revised injury criteria based on data from actual mishaps with ejection seat data recorder. Developed adaptable restraint system technologies, ensuring safety and expedient accommodation of diverse warfighters in Air Force transportation platforms. Human performance research results from simulated dynamic flight environments will improve aircrew performance in the operational environment. Research provided cognitive performance and human information processing models that can be incorporated in war games and simulation-based acquisition models to accurately reflect the effects of physical stressors on human performance and mission effectiveness.			
(U)	In FY 2004: Revise injury criteria to account for variations in biodynamic response based on aircrew size and gender. Develop initial helmet weight and center of mass limits for symmetric and asymmetric Helmet-Mounted Display (HMD) systems based on crew performance in operational maneuvering environments. Human information processing in this dynamic environment will be quantified and applied to models that can be incorporated in wargaming and simulation-based acquisition models.			
(U)	In FY 2005: Investigate and evaluate technologies to ensure full aircrew population safety during aircraft and vehicle operations including vibration, crashes, emergency escape, extended mission, and parachute opening shock. Continue to revise injury criteria to account for variations in biodynamic response based on individual crewmember differences in size and gender. Investigate seating systems to improve crewmember comfort while maintaining safety during emergency escape or other mishap. Continue development of helmet weight and center of mass limits for symmetric and asymmetric HMD systems to ensure safety during emergency escape.			
(U)				
(U)	MAJOR THRUST: Quantify and model the effects of aerospace stressors on pilot performance, cognitive function, and safety in dynamic flight environments. Develop design criteria to ensure effectiveness and safety of helmet-mounted systems during maneuvering acceleration. Note: Broken out from previous major thrust due to increased emphasis in this area.	0.000	0.000	3.222
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue development of helmet-mounted systems design criteria for the full aircrew population based on crew performance in operational maneuvering environments. Refine models for human information processing in the dynamic environment and initiate incorporation into wargaming and simulation-based acquisition.			
(U)				
(U)	MAJOR THRUST: Develop technologies to counter Spatial Disorientation (SD) and improve pilot performance, resulting in increased mission effectiveness and decreased loss of lives and aircraft lives due to SD mishaps.	1.872	2.280	2.700
(U)	In FY 2003: Integrated emerging technologies such as three-dimensional (3-D) audio and pathway-in-the-sky displays to improve pilots' ability to maintain spatial orientation and to aid recognition and recovery from spatial disorientation if it should occur.			

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

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

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

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

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

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

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

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

and Personnel Protection Technology.

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

(U) PE 0604706F, Life Support Systems.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602202F Human Effectiveness Applied Research**	**7757 Bioeffects and Protection**

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

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

(U) A. Mission Description and Budget Item Justification

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

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Conduct laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while providing countermeasures for optical hazards/threats with and without laser eye protection.	5.567	5.368	5.402
(U) In FY 2003: Established feasibility of building a device to allow the evaluation of human vision impacts of multi-wavelength lasers. Completed study on the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-materiel and non-lethal weapons applications. Developed an in vitro cell culture to conduct threshold damage studies which will reduce reliance on in vivo experimentation. Demonstrated optical technology for information warfare and perception management applications.			
(U) In FY 2004: Begin developing technologies to evaluate human vision impacts of multi-wavelength lasers. Continue to investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-materiel and non-lethal weapons applications. Continue to explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Develop bioeffects-based safety criteria for test, deployment, and use of high-energy laser systems.			
(U) In FY 2005: Continue developing technologies to evaluate human vision impacts of multi-wavelength lasers. Begin development of technologies to improve combat vision and provide eye protection in an integrated concept. Continue to investigate the safety and effectiveness of emerging compact, ultrashort pulse laser technologies for both anti-material and non-lethal weapons applications. Continue to explore new methods of conducting threshold damage studies to reduce reliance on in vivo experimentation. Continue to develop bioeffects-based safety criteria for test, deployment, and use of high-energy laser systems.			
(U)			

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

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

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

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

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

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

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

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

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

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

(U) D. Acquisition Strategy

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602203F Aerospace Propulsion

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	135.403	126.988	92.650	109.833	119.329	116.730	117.834	0.000	0.000
3012	Advanced Propulsion Technology	14.701	13.790	12.211	19.872	25.186	23.526	22.812	0.000	0.000
3048	Fuels and Lubrication	17.621	16.612	12.841	14.691	16.940	13.392	13.704	0.000	0.000
3066	Turbine Engine Technology	36.092	36.533	31.749	32.782	32.489	35.282	36.111	0.000	0.000
3145	Aerospace Power Technology	31.738	35.162	24.946	29.535	28.976	32.585	33.220	0.000	0.000
4847	Rocket Propulsion Technology	35.251	24.891	10.903	12.953	15.738	11.945	11.987	0.000	0.000

Note: In FY 2003, only the space unique tasks in Projects 3012 and 4847 were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities. In Project 4847, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles.

(U) **A. Mission Description and Budget Item Justification**

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has five projects, each focusing on a technology area critical to the Air Force. The Advanced Propulsion Technology develops high-speed airbreathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies to enable revolutionary propulsion capability for the Air Force. The Fuels and Lubrication project develops new fuels, lubricants, and combustion concepts and technologies for new and existing engines and directly supports the Integrated High Performance Turbine Engine Technology (IHPTET) and the Versatile Affordable Advanced Turbine Engine (VAATE) programs. The Turbine Engine Technology project develops enabling capabilities to enhance performance and affordability of existing weapon systems to include efforts that are part of the IHPTET and VAATE programs. The Aerospace Power project develops efficient energy storage, power generation, and thermal management techniques for ground, air, and space military applications. Finally, the Rocket Propulsion Technology project pursues advances in rocket technologies for space access, space maneuver, and tactical and strategic missiles to include efforts that are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) and Technology for the Sustainment Systems (TSSS) programs. Note: In FY 2004, Congress added $3.0 million for Center for Security of Large-Scale Systems; $2.5 million for High-Power, Advanced Low-Mass Power (HPALM); $2.2 million for HVEPS for Supersonic Aircraft; $1.0 million for Cell-Level Battery Control; $4.3 million for Engineering Tool Improvement Program (ETIP); $1.0 million for Integrated High Payoff Rocket Propulsion Technology Program; $4.5 million for Advanced Vehicle and Propulsion Center; $1.0 million for Lightweight Photovoltaics for Portable Power and Hydrogen Generation; $3.0 million for Pulse Detonation Engine and Laser Induced Thermal Acoustics Instrument; $1.0 million for Hybrid Plastics; and $3.0 million for High Powered Electrical Aircraft Capabilities (HiPEAC).

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	132.285	101.575	88.859
(U)	Current PBR/President's Budget	135.403	126.988	92.650
(U)	Total Adjustments	3.118	25.413	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-1.087	
	Congressional Increases		26.500	
	Reprogrammings	5.500		
	SBIR/STTR Transfer	-2.382		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3012 Advanced Propulsion Technology**	

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3012	Advanced Propulsion Technology	14.701	13.790	12.211	19.872	25.186	23.526	22.812	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

This project develops combined/advanced cycle airbreathing high-speed (up to Mach 4) and hypersonic (Mach 4 to 8+) propulsion technologies to enable revolutionary propulsion options for the Air Force. These new engine technologies will enable future high-speed/hypersonic weapons and aircraft concepts. The primary focus is on hydrocarbon-fueled engines capable of operating over a broad range of flight Mach numbers. Technologies developed under this program enable capabilities of interest to both DoD and NASA. Efforts include modeling, simulators, and proof of concept demonstrations of critical components; advanced component development; and ground-based demonstrations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	3.454	0.000	0.000
(U) In FY 2003: This project previously included space unique funding, which was transferred to PE 0602500F, Project 5027. These funds represent the civilian salaries and in-house support for the work effort transferred.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop advanced hydrocarbon scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future warfighter needs.	11.247	13.222	7.441
(U) In FY 2003: Fabricated and ground tested world's first flight weight hydrocarbon fueled scramjet engine in a wind tunnel. Showed structural durability in 25 engine tests. Determined engine operability and performance.			
(U) In FY 2004: Continue developing flight weight engine components including flight weight fuel control valves, fuel pumps, and engine controllers. Initiate detailed analysis for mating scramjet flight engines with demonstrator vehicles. Perform trajectory optimization for flight test. Evaluate options for scramjet start, including gas generator/heat exchanger system barbotage fuel injection with plasma ignition, and silane injection with a mechanical throat or air throttle. Verify operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation. Initiate fabrication of a ground test engine with a fuel cooled structure incorporating a variable geometry inlet for a flight experiment. Note: In FY 2004, several of these activities were moved from PE 0602500F, Project 5027, to consolidate all 6.2 scramjet demonstration efforts.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3012 Advanced Propulsion Technology**

(U)	In FY 2005: Continue flight weight engine components development including flight weight fuel control valves, fuel pumps, and engine controllers. Continue detailed analysis mating scramjet flight engines with demonstrator vehicles. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system barbotage fuel injection with plasma ignition, and silane injection with a mechanical throat or air throttle. Continue verification of operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation. Complete fabrication of a ground test engine for a flight experiment. Initiate testing of the ground test engine for a flight experiment.			
(U)				
(U)	MAJOR THRUST: Conduct assessments, system design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies into future missiles and into manned and unmanned air and space vehicle concepts.	0.000	0.568	0.256
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate system trade studies to determine military payoff and establish component technology goals. Initiate defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and the Defense Advanced Research Projects Agency.			
(U)	In FY 2005: Continue system trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and the Defense Advanced Research Projects Agency.			
(U)				
(U)	MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies and integrate into advanced combined cycle engine designs for future missiles and for manned and unmanned aerospace vehicles. Note: In FY 2005, these activities will be moved from PE 0602500F, Project 5027 to consolidate all 6.2 scramjet development efforts.	0.000	0.000	4.514
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Develop techniques to decrease scramjet take-over from Mach 4.5 to Mach 3 to provide robust options for combined cycle engines. Support development of low internal drag flame stabilization devices and flight test engine components.			
(U)	Total Cost	14.701	13.790	12.211

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3012 Advanced Propulsion Technology**

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603211F, Aerospace Structures.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602203F Aerospace Propulsion**	**3048 Fuels and Lubrication**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3048 Fuels and Lubrication	17.621	16.612	12.841	14.691	16.940	13.392	13.704	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops improved fuels, lubricants, mechanical systems, and combustion concepts for advanced turbine engines, scramjets, pulse detonation, and combined cycle engines. Systems applications include missiles, aircraft, sustained high-speed vehicles, and responsive space launch. Analytical and experimental areas of emphasis include fuels and fuels logistics, lubricants, bearings, electromagnetic rotor, oil-less engine technology, optical diagnostics, fundamental combustion, and detonations. Fuels and lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Advanced combustion concepts must be cost-effective, durable, and reduce pollutant emissions.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop low-cost additive and fuel system approaches to improve fuel properties and to expand the flight envelope for manned and unmanned aircraft.	2.245	1.835	1.613
(U) In FY 2003: Developed flow-improving additives for low temperature properties to enable replacement of specialty fuels with JP-8. Developed fuel technologies to increase the temperature limit of JP-8 to 900 degrees Fahrenheit to reduce thermal-oxidative and pyrolytic deposits. Completed development of an initial computer model based on chemical structure-activity relationships for fuel additives design and performance modeling. Developed particulate reducing additives to reduce soot emissions and infrared signatures from propulsion systems.			
(U) In FY 2004: Continue development of additive packages to enable JP-8 to achieve jet propulsion thermally stable low temperature (high altitude) performance. Continue developing approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit, including thermal stability additives, fuel deoxygenation, and improved coatings. Enhance existing fuel modeling and simulation capabilities by incorporation of more realistic additive performance models and detailed fuel chemistry. Note: In FY 2004, the emissions and signature reduction activities became a separate effort in this Project.			
(U) In FY 2005: Optimize additive packages and test protocols to enable JP-8 to achieve jet propulsion thermally stable low temperature performance. Conduct lab-scale tests to increase JP-8 temperature capability to 900 degrees Fahrenheit, including thermal stability additives, fuel deoxygenation, and improved materials and coatings. Continue enhancing existing fuel modeling and simulation capabilities by incorporation of more realistic additive performance models. Develop engine thermal management models.			
(U)			
(U) MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature, including biotechnology, molecular imprinting, and nano-scale reactivity enhancement. Note: In FY 2004, the emissions and signature reduction activities became a separate effort in this Project.	0.000	1.026	1.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3048 Fuels and Lubrication**

(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop emission reduction additives. Verify additive performance in laboratory-scale combustion tests. Initiated development of improved diagnostics for sub-micron scale particulate emissions from combustors.			
(U)	In FY 2005: Continue assessing additive performance in laboratory scale combustion tests. Complete development and application of advanced diagnostics for sub-micron particulate emissions.			
(U)				
(U)	MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to simplify logistics and reduce cost, including field and on-board additive injections and improvements to existing fuel additive packages.	1.171	1.061	1.000
(U)	In FY 2003: Defined improvements in specific additive packages and fuel dispensing methods to reduce logistics footprint, including on-board fuel evaluation and additization. Completed screening candidate technologies for fuel field diagnostic techniques, including on-line quality assessments.			
(U)	In FY 2004: Develop improvements to existing fuel additive packages to simplify logistics and reduce cost. Assess performance of fuels from alternative (non-petroleum) sources, including Fischer-Tropsch fuels. Test candidate technologies for field-fuel quality diagnostics. Investigate the use of field-portable equipment to measure biological contamination in fuels.			
(U)	In FY 2005: Develop improvements to existing fuel additive packages to simplify logistics and reduce cost. Assess performance of fuels from alternative (non-petroleum) sources, including Fischer-Tropsch fuels. Continue testing field fuel quality diagnostics. Further investigate biological contamination in fuels and develop mitigation techniques.			
(U)				
(U)	MAJOR THRUST: Investigate hydrocarbon and other high energy density fuels for advanced and combined cycle engines for high-speed aerospace vehicles and low-cost access to space.	1.502	0.482	0.500
(U)	In FY 2003: Completed analyses and configuration trade studies to define and evaluate common fuels for future aircraft and military vehicles. Assessed additive approaches to improve thermal stability and ignition/combustion properties in reduced scale component testing.			
(U)	In FY 2004: Initiate development of fuel property and performance data for industry and Government use in selecting alternative hydrocarbon fuels for advanced propulsion. Investigate approaches to assess fuel thermal stability under high heat flux conditions relevant to advanced rockets and combined cycle engines.			
(U)	In FY 2005: Develop fuel property and performance database for industry and Government use in selecting alternative hydrocarbon fuels for space applications. Test approaches to assess fuel thermal stability under high heat flux conditions relevant to advanced rockets and combined cycle engines.			
(U)				
(U)	MAJOR THRUST: Develop, test, and evaluate revolutionary combustor and propulsion concepts for gas turbine, pulsed detonation, and combined-cycle engines for missiles, manned and unmanned systems, and reuseable access to space; perform payoff analyses and configuration trade studies for these systems; and evaluate the combustion and	3.901	3.268	3.485

	emissions characteristics of fuels and fuel additives.			
(U)	In FY 2003: Demonstrated an ultra-compact combustor at design operating conditions for use as an inter-turbine burner. Investigated incorporating pulsed detonation engine (PDE) propulsion technologies into gas turbine engines. Investigated inlet and nozzle configurations for a PDE. Performed modeling and simulation and initiated experiments to identify fuel additives and combustor designs to reduce emissions from gas turbine engines. Investigated non-traditional thermodynamic cycles for military propulsion systems through simulation/modeling and experimentation.			
(U)	In FY 2004: Evaluate advanced combustor concepts and the inter-turbine burner combustor at conditions that simulate turbine-wake and turbine-inlet interactions. Investigate the performance of a rudimentary combined-cycle PDE. Evaluate the technical issues associated with incorporating PDE propulsion technologies into gas turbine engines. Perform experiments to validate the high-speed performance of a pure PDE. Complete tests to evaluate promising fuel additives used to reduce particulates and emissions from gas turbine engines.			
(U)	In FY 2005: Evaluate the inter-turbine burner combustor at realistic operating conditions with rotating turbine machinery. Develop and evaluate combined-cycle PDE concepts. Address the operational issues associated with incorporating PDE propulsion technologies into gas turbine engines. Conduct experiments to extend the operability limits of pure PDE for application to high-speed missiles. Evaluate fundamental combustion issues associated with combustors fed by high-temperature fuel systems like those required for supersonic cruise aircraft.			
(U)				
(U)	MAJOR THRUST: Develop approaches to extend the life of endothermic fuels and fuel system components for sustained supersonic and reusable hypersonic cruise applications. Note: In FY 2004, the endothermic fuel activities in other parts of this Project were consolidated into this activity.	0.000	0.900	0.500
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop approaches to improve fuel heat sink capability. Develop systems to minimize regenerative cooling heat loads absorbed by endothermic fuel systems. Develop means to improve fuel combustion performance, especially during cold start and cycle transition. Improve fuel system modeling and simulation tools to better simulate endothermic fuel behavior.			
(U)	In FY 2005: Continue developing approaches to improve fuel heat sink capability. Test systems to minimize regenerative cooling heat loads absorbed by endothermic fuel systems. Test means to improve fuel combustion performance, especially during cold start and cycle transition. Continue improving fuel system modeling and simulation tools to better simulate endothermic fuel behavior.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary combustor and propulsion systems.	0.711	0.833	0.628
(U)	In FY 2003: Investigated specific pollutant emissions formation pathways through computational and experimental methods. Evaluated methods to reduce gaseous and particulate pollutant emissions from legacy and future gas turbine			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3048 Fuels and Lubrication**

	engines. Applied advanced diagnostics to combustors to evaluate performance. Preliminary evaluated high intensity laser light interaction with matter.			
(U)	In FY 2004: Investigate pollutant emission formation pathways through computational and experimental methods. Evaluate methods to reduce gaseous and particulate pollutant emission from legacy and future gas turbine engines. Continue investigating high intensity laser light interaction with matter for micromachining and diagnostic capabilities. Initiate development and demonstration of sensors for the control of combustor performance and extension of component life.			
(U)	In FY 2005: Continue developing and testing sensors for the control of combustor performance and extension of component life. Develop diagnostic tools to evaluate the combustion issues related to engines burning high-temperature fuels. Investigate the interaction of high intensity laser light with matter for micromachining and diagnostic capabilities.			
(U)				
(U)	MAJOR THRUST: Develop, test, and conduct qualification activities to provide the most reliable and affordable advanced turbine engine lubricants to the Air Force, Department of Defense (DoD), and commercial users.	1.320	1.799	1.940
(U)	In FY 2003: Supported field activities for aviation lubrication technologies and DoD operational units. Developed and tested advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Performed payoff analyses and configuration trade studies to define, focus, and evaluate research in lubricants and mechanical systems for combined cycle engines.			
(U)	In FY 2004: Continue field support activities for aviation lubrication technologies and DoD operational units. Continued development and testing advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Perform payoff analyses and configuration trade studies to define, focus, and evaluate research in lubricants and mechanical systems for man-rated, expendable, and unmanned air vehicle turbine engines. Begin transition of optimal ester lubricant to military and commercial turbine engines.			
(U)	In FY 2005: Continue field support activities for aviation lubrication technologies and DoD operational units. Expand development and testing of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Initiate testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and unmanned air vehicle turbine engines. Design test approaches for optimal ester lubricant to military and commercial turbine engines.			
(U)				
(U)	MAJOR THRUST: Develop and test advanced technology concepts for small, intermediate, and large-sized turbine engine applications.	2.796	2.481	2.175
(U)	In FY 2003: Developed advanced bearing concepts for small- and intermediate-sized turbine engine applications. Designed, fabricated, and tested electromagnetic rotor support and power generation concepts, components, and materials for advanced, oil-less engines. Developed and initiated testing of air and foil bearing technology for small-			

		FY 2003	FY 2004	FY 2005
	and intermediate-sized turbine engine applications. Initiated development of modeling and simulation capabilities to advance design, shorten development time, and reduce testing requirements for mechanical and electromagnetic rotor support and power generation systems. Commenced advanced rotor support and power generation studies for turbine engine. Matured hybrid (metal/ceramic) bearing technologies to Joint Strike Fighter (JSF) F136 engine.			
(U)	In FY 2004: Continue developing advanced bearing concepts for small- and intermediate-sized turbine engine applications. Perform full-scale rig testing of electromagnetic rotor support and a power generation system for advanced, oil-less engines. Begin study and testing of air/foil bearings for propulsion turbine engine application. Continue development and testing of affordable rotor support technology for small, intermediate, and large-sized turbine engine applications. Continue modeling and simulation capabilities to advance design, shorten development time, and reduce testing requirements for mechanical and electromagnetic rotor support and power generation systems. Start modeling rotordynamics of air/foil bearing supported engine shafts. Conduct advanced rotor support and power generation studies and start testing for turbine and combined cycle engines. Continue to mature hybrid (metal/ceramic) bearing technology that could be applied to JSF F135 engine.			
(U)	In FY 2005: Continue developing and initiate testing of advanced bearing concepts for small-, intermediate-, and large-sized turbine engine applications. Conduct realistic engine front-end simulation testing of electromagnetic rotor support and a power generation system for advanced, oil-less engines. Conduct air/foil bearing testing to determine load capacity and rotor size limitations of this technology. Develop and test affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications. Enhance modeling and simulation activities to advance design, shorten development time, and reduce testing requirements for mechanical and electromagnetic rotor support and power generation systems. Conduct modeling of air/foil bearings and iterate results with test activity. Conduct advanced rotor support and power generation studies and start testing for turbine and combined cycle engines. Support rig testing of hybrid bearing designs for F136 engine. Continue to mature hybrid (metal/ceramic) bearing technology that could be applied to JSF F135 engine.			
(U)				
(U)	MAJOR THRUST: Develop thermal management concepts and analysis tools for long-range strike applications of varying speed classes. Note: In FY 2004, these efforts were combined with the "additive and fuel system approaches" in this Project.	1.057	0.000	0.000
(U)	In FY 2003: Conducted fuel trade studies to identify fuel options and capability shortfalls for long-range strike applications. Developed diagnostic approaches and sensors for control of fuel/thermal management systems across the flight envelope. Developed of engine fuel system and thermal management components identified in the Versatile Affordable Advanced Turbine Engine program.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Pulse Detonation Engine (PDE) including Laser Induced Thermal Acoustics Instrument	2.918	2.927	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3048 Fuels and Lubrication**

efforts in FY 2004.

(U) In FY 2003: Established a design database relevant to the aerothermal and structural design of PDEs. Designed key components to include the inlet, intake valve, fuel injector, detonation initiator, controller, and thrust tube for an airbreathing PDE for use in subsonic and supersonic unmanned air vehicles. Performed ground demonstration testing of some of the key components and continued development of Pulse Detonation Engine (PDE) performance predictive models using experimental data. PDE's offer potential for low-cost propulsion systems that can be applied to unmanned vehicles and high-speed combined cycle engines.

(U) In FY 2004: Complete the design of key components to include the inlet, intake valve, fuel injector, initiator, controller and thrust tube for an airbreathing PDE for use in subsonic and supersonic unmanned air vehicles. Perform design validation testing of the key components and continue development of engineering models to guide the design. Continue the design of a demonstration vehicle for eventual flight test of the PDE.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	17.621	16.612	12.841

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602805F, Dual Use Science and Technology.									
(U)	PE 0603216F, Aerospace Propulsion and Power Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3066 Turbine Engine Technology**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3066 Turbine Engine Technology	36.092	36.533	31.749	32.782	32.489	35.282	36.111	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, augmentor and exhaust systems, integrated power and thermal management systems, engine inlet integration, mechanical systems, and structural design. This project supports the Integrated High Performance Turbine Engine Technology and Versatile Affordable Advanced Turbine Engine (VAATE) programs, which are joint DoD, NASA, and industry efforts to focus turbine propulsion technology on national needs. The FY 2004 program plan reflects the technology base support for the VAATE activity relative to the turbine-based combined cycle technology development applicable to sustained high-speed flight and responsive space launch.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and high-pressure turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports. These components, made with advanced materials like Titanium Matrix Composites and gamma titanium aluminides, enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost.	24.111	27.937	16.787

(U) In FY 2003: Completed preliminary testing on an advanced high-pressure ratio compressor for reduced fuel burn, and high reaction blading for reduced maintenance cost. Conducted testing on an active combustion control high response fuel valve reducing acoustically coupled fatigue and enhancing overall combustion efficiency resulting in fuel burn reduction. Modified the spar/shell turbine blade design system using component bench test results and transitioned this technology to engine demonstrator testing. Completed the sub-scale rotational intentional mistuning experiment and initiated the application of methodology to transonic rig hardware.

(U) In FY 2004: Complete airfoil design for a high-pressure ratio compressor to study unsteady flow interactions for reduced fuel burn, and high reaction blading and engine stall avoidance techniques for reduced maintenance cost. Begin full annular aerothermal tests of a trapped vortex combustor. Conduct design and begin fabrication of advanced high-pressure turbine rig hardware to evaluate advanced three-dimensional effects pm blade tip heat transfer for increased performance and durability. Develop advanced intentional mistuning methodology and begin experimental verification on transonic rig hardware.

(U) In FY 2005: Begin rig testing of a high-pressure ratio compressor including an assessment of unsteady flow interactions for reduced fuel burn, and high reaction blading and engine stall avoidance techniques for reduced maintenance cost. Continue full annular aerothermal tests of a trapped vortex combustor and begin rig testing of an integrated lightweight combustor with a ceramic matrix composite shell and advanced material panels representative of advanced combustor configurations. Complete fabrication and initiate tests of advanced high-pressure turbine rig

	hardware to evaluate advanced three-dimensional effects on blade tip heat transfer for increased performance and durability. Enhance advanced intentional mistuning methodology and complete experimental verification on transonic rig hardware.			
(U)				
(U)	MAJOR THRUST: Develop turbine engine components (i.e., fans, low pressure turbines, engine controls, exhaust nozzles, and integration technologies) for turbofan/turbojet engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports. These components enable aircraft engines to have higher performance, increased durability, reduced fuel consumption, and lower life cycle cost.	7.093	8.151	10.511
(U)	In FY 2003: Conducted testing of a non-linear control system to simplify control logic development and to provide the component performance trend data necessary for transitioning this technology to the demonstrator engine program.			
(U)	In FY 2004: Begin design of an advanced tandem, forward swept fan incorporating hybrid blade construction and composite reinforced disks to achieve high efficiency and stage loading with reduced weight and cost. Perform three-dimensional computational fluid dynamics (CFD) analysis and detailed design of multi-stage low pressure turbine rig hardware to assess performance of advanced turbine blade configurations applicable to high altitude, long endurance systems including Global Hawk. Initiate testing of advanced control system hardware using component life models to verify real-time computational capabilities for transitioning this technology to a demonstrator engine program. Begin analysis and testing of advanced, low-observable compatible augmentor designs, resulting in improved design rules and tools to improve augmentor operability and reduce screech.			
(U)	In FY 2005: Begin fabrication of an advanced tandem, forward swept fan incorporating hybrid blade construction and composite reinforced disks to achieve high efficiency and stage loading with reduced weight and cost. Perform post-test analysis of multi-stage low-pressure rig test data to assess performance of advanced turbine blade configurations applicable to high altitude, long endurance systems including Global Hawk. Continue testing of advanced control system hardware using component life models to verify real-time computational capabilities for transitioning this technology to a demonstrator engine program. Expand analysis and testing of advanced, low-observable compatible augmentor designs, resulting in improved design rules and tools to improve augmentor operability and reduce screech.			
(U)				
(U)	MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. These components enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, thereby greatly expanding the operating envelopes of missiles and unmanned vehicles.	3.297	0.294	3.342
(U)	In FY 2003: Completed rig testing of an enhanced fan flow control treatment for an all-composite, forward swept shrouded rotor. Designed rub tolerant ceramics for advanced turbine rotor blades.			
(U)	In FY 2004: Begin the conceptual design and conduct configuration studies of an advanced versatile and affordable			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3066 Turbine Engine Technology**

	high-pressure core and engine component configurations for expendable engines using rub tolerant ceramic blades to meet the small engine performance and cost reduction objectives.			
(U)	In FY 2005: Complete configuration studies and continue conceptual design of an advanced versatile and affordable high-pressure core and low-pressure component configurations for expendable engines using rub tolerant ceramic blades to meet the small engine performance and cost reduction objectives.			
(U)				
(U)	MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports.	1.591	0.151	1.109
(U)	In FY 2003: Conducted durability tests of Ceramic Matrix Composite turbine blades under high temperature/ high-pressure/high moisture conditions to validate composite integrity and life models. Performed rig tests to demonstrate the feasibility of a very high fuel/air ratio combustor with a supercritical fuel delivery system.			
(U)	In FY 2004: Begin conceptual design and conduct configuration studies of advanced versatile and affordable high-pressure compressor, combustor, and high-pressure turbine configurations for turboshaft/turboprop engines to meet the small engine performance and cost reduction objectives.			
(U)	In FY 2005: Enhance conceptual design of advanced versatile and affordable high-pressure core engine component configurations for turboshaft/turboprop engines to meet the small engine performance and cost reduction objectives.			
(U)	Total Cost	36.092	36.533	31.749

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Materials:									
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602102F, Materials.									
(U)	PE 0603216F, Aerospace Propulsion and Power Technology.									
(U)	PE 0602122N, Aircraft Technology.									
(U)	PE 0603210N, Aircraft Propulsion.									
(U)	PE 0603003A, Aviation Advanced Technology.									
(U)	This project has been									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3066 Turbine Engine Technology**

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

coordinated through the
Reliance process to harmonize
efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602203F Aerospace Propulsion**	**3145 Aerospace Power Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3145 Aerospace Power Technology	31.738	35.162	24.946	29.535	28.976	32.585	33.220	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops techniques for efficient power generation, energy storage, and thermal management for military aerospace applications. Power component technologies are developed to increase reliability, maintainability, commonality, and supportability of aircraft and flight line equipment. Research is conducted in energy storage technologies to enable the 10-20 year-long term energy storage goals of Air Force unmanned vehicles. Electrical power generation and thermal management technologies to enable all future military directed energy weapon systems. This project supports development of very high output power systems suitable for applications to air moving target indication radar and high power lasers for aerospace platforms. Lightweight power systems suitable for other aerospace applications are also developed.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop power generation/conditioning/distribution, energy storage, and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These technologies improve aircraft self-sufficiency, reliability, maintainability, and supportability, while reducing life cycle costs and enabling new capabilities.	8.380	11.874	12.208
(U) In FY 2003: Tested an advanced-switched reluctance machine controller. Fabricated and conducted tests on full-scale lithium-ion batteries and fuel cells for manned and unmanned vehicles. Improved the development of lithium polymer cells.			
(U) In FY 2004: Continue testing of an advanced-switched reluctance machine controller. Initiate development of lithium-based solid-state electrolyte battery technology. Perform a dynamometer test of a starter/generator applicable for mid-thrust class turbine engine high spool applications.			
(U) In FY 2005: Fabricate and test small-scale lithium based solid-state cells. Fabricate and test modular fuel cell systems for manned and unmanned vehicles. Verify dynamic engine models for power extraction. Complete testing of an advanced switched reluctance machine controller.			
(U)			
(U) MAJOR THRUST: Develop thermal management, energy storage and power conditioning components, and subsystem technologies for air and space applications.	4.480	2.479	2.870
(U) In FY 2003: Tested and demonstrated an integrated Power Management and Distribution system for space-based distributed power systems that are half the weight and volume of conventional approaches. Fabricated and tested full-scale lithium-ion batteries for air and spacecraft applications. Developed preliminary integrated vehicle health monitoring algorithms.			
(U) In FY 2004: Continue development of integrated vehicle health monitoring algorithms. Study advanced packaging			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

	techniques for silicon carbide power electronics.			
(U)	In FY 2005: Integrate vehicle health monitoring algorithms into power distribution unit. Fabricate and begin testing of a silicon carbide packaging concept for power electronic device development.			
(U)				
(U)	MAJOR THRUST: Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement to enable delivery of high power for operation of directed energy weapons	8.301	8.215	9.868
(U)	In FY 2003: Completed preliminary fabrication and testing of high-density power conditioning, to include capacitors and switches, for directed energy weapon systems. Tested a thermal management system with Yttrium Barium Copper Oxide coated wire and coils for cryogenic generator applications. Improved the development of higher rate (pulse power) lithium-ion batteries.			
(U)	In FY 2004: Design and fabricate advanced capacitors for pulsed power applications. Continue fabricating and begin testing liquid dielectric high voltage switches. Optimize processing techniques for long length Yttrium Barium Copper Oxide high temperature superconducting components. Fabricate and test small-scale, high rate lithium-ion cells.			
(U)	In FY 2005: Test advanced pulse power capacitors. Complete testing liquid dielectric high voltage switches. Test high temperature Yttrium Barium Copper Oxide superconducting coils in a rotating test rig for megawatt-class power applications. Scale-up and begin testing high rate lithium-ion (liquid) cells. Initiate preliminary design of proof-of-concept superconducting generator.			
(U)				
(U)	MAJOR THRUST: Develop high-density electrical power system and thermal management technologies for a next generation aerospace long-range strike vehicle.	1.826	0.000	0.000
(U)	In FY 2003: Developed power and thermal requirements for a long-range strike aircraft incorporating advanced weapon systems and performed preliminary compact high power conditioning, energy storage, and thermal management component designs that optimize secondary power system size, weight, and efficiency.			
(U)	In FY 2004: Not Applicable. Note: In FY 2004, funding for this effort was shifted to higher Air Force priorities.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: PBO (poly-based: p-phenylene-2, 6-benzobisoxazole) Membrane for Advanced High Performance Fuel Cells. Note: For developing and certifying this material for the Air Force UCAV.	2.430	0.000	0.000
(U)	In FY 2003: Developed poly-based membrane fuel cells that offer a lower cost, lighter weight, higher performance, and more energy efficient fuel cell over existing proton exchange membrane fuel cells. Using results from past single cell research, designed, and fabricated a preliminary model PBO-based membrane in multi-cell/stack configurations.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

(U)				
(U)	CONGRESSIONAL ADD: Lithium-ion Battery Development.	3.889	0.000	0.000
(U)	In FY 2003: Developed preliminary large ampere-hour cells for lithium-ion cell batteries that address cycle life technical issues for aircraft and Low Earth Orbit space applications and also addressed calendar life technical issues paramount for Geosynchronous Earth Orbit applications. Next generation, high energy density and high power density rechargeable lithium-ion cell batteries (for future lightweight, less expensive advanced spacecraft and aircraft (manned and unmanned) and possibly for high power weapons and ground support equipment) offer advantages over conventional, rechargeable systems by storing the same amount of energy at one-fourth the weight.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: High-Power, Advanced Low-Mass (HPALM).	1.459	2.479	0.000
(U)	In FY 2003: Developed component and system technologies for the HPALM solar thermionic power system, including inflatable concentrator materials and design, thermionic cell materials and advanced converter design, secondary concentrator design, thermal storage materials, and high temperature power conditioning aimed at supporting a ground demonstration of a 5 kW solar-thermionic power system. Potential HPALM applications in space are high power (>50 kW) orbital transfer propulsion, communication, radar or direct energy platforms. Performance analyses will continue with an emphasis on studying unique mission capabilities and comparing HPALM capabilities and launch characteristics (size, weight, and cost) to that of other space power systems.			
(U)	In FY 2004: Design, fabricate and test prototype components supporting a 5 kW HPALM solar-thermionic power system ground demonstration, including inflatable concentrator, thermionic inverted converter, secondary concentrator, thermal receiver with thermal storage and high temperature power conditioning. Investigate integration of prototype components as an initial ground demo system analysis. Continue performance and mission analysis of a conceptual 50kW HPALM space power system based on prototype data.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Unmanned Combat Air Vehicles (UCAV) Integral Starter/Generator.	0.973	0.000	0.000
(U)	In FY 2003: Provided hardware and technology supporting demonstrations, at an engine manufacturer, of integrated power extraction from an integral starter/generator for UCAV with a focus on anticipated Navy and Air Force Unmanned Combat Air Vehicles power requirements. The integral starter/generator allows the engine to be started electrically, provides electrical power to support aircraft operations, and fits internal to the case, thus requiring no aircraft volume.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3145 Aerospace Power Technology**

(U) CONGRESSIONAL ADD: Cell-Level Battery Control. Note: Only for SBIR Phase 3 cell level battery controller development.	0.000	0.992	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Design, fabricate, and test prototype components for monitoring and control of charge and temperature of battery energy storage systems of battery controller for Lithium Ion battery system to address cell level charge and thermal management.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Lightweight Photovoltaics for Portable Power And Hydrogen Generation.	0.000	0.992	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Investigate various photovoltaic solar cells to determine performance characteristics. Design, fabricate, test and integrate photovoltaic solar cells with a water electrolizer to generate hydrogen. Photovoltaics will be integrated into solar cell technology with a water electrolizer to generate hydrogen. This hydrogen can be used in a fuel cell to support applications ranging from low power special operations to high power, high altitude airships and long endurance unmanned aerial vehicles.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Hypersonic Vehicle Electric Power System (HVEPS) Technology.	0.000	2.181	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Design, fabricate, and test a small 10-100 kilowatt demonstration magnetohydrodynamic (MHD) generator. This demonstration includes the use of high temperature ceramic electrodes and modern commercial cryocoolers with superconducting magnets that are integrated, but thermally isolated from the high temperature MHD channel with active cooling.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: High Powered Electrical Aircraft Capabilities (HiPEAC).	0.000	2.975	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Perform system analyses of high-powered electrical systems including investigation of integrated subsystems and various component technologies. Design, fabricate, and test prototype components that are critical to high-powered electrical systems. HiPEAC is an electrical power system demonstrator and test bed that supports current and future high power systems, thus enabling new sensor, communications, and directed energy applications.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Center for Security of Large-Scale Systems.	0.000	2.975	0.000
(U) In FY 2003: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3145 Aerospace Power Technology**

(U) In FY 2004: Develop accurate, high-speed computations for the implementation of fast-acting on-line control to enhance security and survivability of military installations and applications. Develop advanced distributed heterogeneous simulation techniques and implement their application to the security of large scale systems. Configure and exercise predictive simulations, and develop and test prototype hardware to verify and validate the modeling and simulation accuracy.

(U) In FY 2005: Not Applicable.

(U) Total Cost	31.738	35.162	24.946

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602102F, Aerospace Flight Dynamics.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0602805F, Dual Use Science and Technology.									
(U) PE 0603605F, Advanced Weapon Technology.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602203F Aerospace Propulsion**	**4847 Rocket Propulsion Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4847 Rocket Propulsion Technology	35.251	24.891	10.903	12.953	15.738	11.945	11.987	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities. In this project, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles.

(U) A. Mission Description and Budget Item Justification

This project develops technologies for the sustainment of strategic systems (including solid boost/missile propulsion, Post Boost Control, aging and surveillance efforts) and tactical rockets. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Technologies are developed to reduce the weight and cost of components using new materials, and improved designs and manufacturing techniques. All efforts in this project are part of the Technology for the Sustainment of Strategic Systems program and support the Integrated High Payoff Rocket Propulsion Technology program.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	17.554	0.000	0.000
(U) In FY 2003: This project previously included space unique funding, which were transferred to PE 0602500F, Project 5026. These funds represent the civilian salaries for the work effort transferred.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Support Post Boost Control Systems (PBCS) and solid rocket motor development work being done in 0602500F, Project 5026. Efforts support the Technology for the Sustainment of Strategic Systems (TSSS) program - Phase I. Note: In FY 2005, the efforts in this activity will be moved to the Advanced Technology Development efforts in PE 0603216F, Project 4922.	0.000	1.650	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Complete risk reduction efforts supporting the Phase I missile propulsion demonstration. Continue Phase I full-scale risk reduction component developments and testing to support the advanced PBCS demonstration. Note: Note: In FY 2005, the efforts in this activity will be moved to the Advanced Technology Development efforts in PE 0603216F, Project 4922.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop missile propulsion and boost technologies for tactical and ballistic missile systems. Efforts support the Technology for the Sustainment of Strategic Systems program - Phase II. Note: This effort includes a FY 2003 Congressional Add of $5.7 million.	5.542	10.639	8.897

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

(U)	In FY 2003: Began component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Commenced verifying performance and weight improvements of rapid densification nozzle technology, using improved strategic propellants for future ballistic missiles. Demonstrated low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Commenced formulating and characterizing new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion.			
(U)	In FY 2004: Conduct component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Verify performance and weight improvements of rapid densification nozzle technology, using improved strategic propellants for future ballistic missiles. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Continue formulating and characterizing new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion. Initiate development and updates to solid rocket motor modeling and simulation tools to improve industry capability to design ballistic missile components (cases, nozzles, insulation, etc.) and motors. Continue development of advanced tactical propulsion components begun under PE 0602500F, Project 5026.			
(U)	In FY 2005: Enhance component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Continue verifying performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Continue formulating and characterizing new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion. Continue modeling and simulation tool developments for solid rocket motors. Initiate component development efforts for the Phase II missile propulsion demonstration. Continue development of advanced tactical propulsion components.			
(U)				
(U)	MAJOR THRUST: Develop missile propulsion technologies and aging and surveillance technologies for Intercontinental Ballistic Missile (ICBM). Efforts support the Technology for the Sustainment of Strategic Systems program- Phase II.	0.000	1.893	2.006
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiated Phase II aging and surveillance technology developments in analysis codes, tools, and inspection tools for improved assessment of ballistic missile aging characteristics and status.			
(U)	In FY 2005: Continue Phase II aging and surveillance technology developments in analysis codes, tools, and inspection tools for improved assessment of ballistic missile aging characteristics and status.			
(U)				
(U)	CONGRESSIONAL ADD: Cryogenic Installation for Jet and Rocket Engine Test Site. Note: Only for cryogenic propellant storage and delivery systems with related control and safety systems.	7.488	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology

(U)	In FY 2003: Upgraded the existing Jet Engine Test Cell, located on the former Norton Air Force Base in San Bernardino, to enable the development testing of larger rocket engines, including those needing cryogenic propellants. The capability installed will enable medium-size rockets to be tested and is complimentary to component test facilities at Edwards Air Force Base.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Vehicle and Propulsion Center. Note: For a common AFRL/SMC product center co-located with the Rocket Propulsion Laboratory.	2.430	4.462	0.000
(U)	In FY 2003: Performed initial Analysis of Alternatives at the Advanced Vehicle and Propulsion Center to enable the next stage of acquisition planning for the following key Air Force Space Command missions: prompt global strike capability, land-based strategic nuclear deterrent, and operationally-responsive space lift system.			
(U)	In FY 2004: Continue technical support for the Analysis of Alternatives for the following key Air Force Space Command missions: prompt global strike, land-based strategic deterrent, and operationally responsive space lift.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Reusable Launch Vehicle (RLV) Technologies. Note: To upgrade space infrastructure to support RLV development.	2.237	0.000	0.000
(U)	In FY 2003: Upgraded space infrastructure facilities at the Air Force Research Laboratory's Edwards Air Force Base research site to provide data on the responsiveness of candidate new Reusable Launch Vehicle system designs.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Hybrid Polymers.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Build a pilot plant for the scale-up of Polyhedral Oligomeric Silsesquioxane (POSS) polymers producing much larger quantities at much cheaper prices and accelerating the further development and application of this new class of polymers for applications in liquid and solid rocket engines and spacecraft engines.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Engineering Tool Improvement Program (ETIP). Note: Efforts expand upon activities initiated in a FY 2003 Congressional Add in PE 0602500F, Project 5026.	0.000	4.263	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop and improve modeling and simulation tools to address spacecraft component interactions and solid rocket motor component contributions and technology payoffs. Develop improvements identified from previous			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology

	work for liquid engine system modeling and simulation tools.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Integrated High Payoff Rocket Propulsion Technology.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct risk reduction efforts in the Technology for the Sustainment of Strategic Systems program-Phase I seeking a 25 percent cost reduction and 5:1 turndown ratio of a Post Boost Control Propulsion System using sustainable materials.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	35.251	24.891	10.903

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602114N, Power Projection Applied Research.									
(U)	PE 0602303A, Missile Technology.									
(U)	PE 0602805F, Dual Use Science and Technology.									
(U)	PE 0603311F, Ballistic Missile Technology.									
(U)	PE 0603401F, Advanced Spacecraft Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2004**

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	77.172	86.405	78.804	93.839	96.715	97.226	99.677	0.000	0.000
2002	Electronic Component Technology	19.956	17.126	15.072	17.021	19.255	19.813	20.185	0.000	0.000
2003	EO Sensors & Countermeasures Tech	11.881	18.680	14.657	15.649	16.139	16.701	17.061	0.000	0.000
4916	Electromagnetic Tech	11.906	12.151	9.536	9.876	10.273	10.694	11.134	0.000	0.000
5016	Photonic Component Technology	3.191	2.889	2.878	2.157	2.187	2.369	2.541	0.000	0.000
5017	RF Processing for ISR Sensors	7.400	6.643	7.362	7.726	7.336	7.599	7.789	0.000	0.000
6095	Sensor Fusion Technology	12.670	12.131	13.246	15.626	16.267	16.781	17.146	0.000	0.000
7622	RF Sensors & Countermeasures Tech	10.168	16.785	16.053	25.784	25.258	23.269	23.821	0.000	0.000

Note: In FY 2003, space unique tasks in this PE, Projects 2002, 6095, and 7622, transferred to PE 0602500F, Projects 5028 and 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program develops the technology base for Air Force aerospace sensors and electronic combat. Advances in aerospace sensors are required to increase combat effectiveness by providing "anytime, anywhere" surveillance, reconnaissance, precision targeting, and electronic warfare capabilities. To achieve this progress, this program pursues simultaneous advances in: 1) generating, controlling, receiving, and processing electronic and photonic signals for radio frequency (RF) sensor aerospace applications; 2) electro-optical aerospace sensor technologies for a variety of offensive and defensive uses; 3) RF antennas and associated electronics for airborne surveillance, together with active and passive electro-optical sensors; 4) technologies to manage and fuse on-board sensor information for timely, comprehensive situational awareness; and 5) technology for reliable, all-weather surveillance, reconnaissance, and precision strike radio frequency sensors and electronic combat systems. Note: In FY 2004, Congress added $2.4 million for Three-Dimensional (3-D) Packaging Technology for High Speed RF Communication, $3.2 million for the Watchkeeper Ultra Wideband Demonstration, $3.0 million for the Center for Advanced Sensor and Communication Antennas, and $3.0 million for the General Purpose reconfiguration Signal Processors System. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary sensor, electronics, and electronic combat technologies.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	76.743	75.577	84.110
(U)	Current PBR/President's Budget	77.172	86.405	78.804
(U)	Total Adjustments	0.429	10.828	
(U)	Congressional Program Reductions		-0.030	
	Congressional Rescissions		-0.742	
	Congressional Increases		11.600	
	Reprogrammings	1.227		
	SBIR/STTR Transfer	-0.798		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602204F Aerospace Sensors**	**2002 Electronic Component Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2002 Electronic Component Technology	19.956	17.126	15.072	17.021	19.255	19.813	20.185	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in photonic component technology moved from this project into this PE, Project 5016. Also in FY 2003, space unique tasks in this project transferred to
PE 0602500F, Projects 5028 and 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for radio frequency (RF) sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance (ISR), electronic warfare (EW), and precision engagement. The technologies developed include: solid state power devices and amplifiers; low noise and signal control components; high-temperature electronics; signal control and distribution; signal processing; multi-function monolithic integrated circuits; high-speed analog-to-digital and digital-to-analog mixed mode integrated circuits; power distribution; multi-chip modules; and high density packaging and interconnect technologies. This project also designs, develops, fabricates, and evaluates techniques for integrating combinations of these electronic component technologies. The project aims to demonstrate significantly improved military sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. The device and component technology developments under this project are military unique; they are based on Air Force and other Department of Defense weapon systems requirements in the areas of radar, communications, EW, navigation, and smart weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System, radar, EW, and other ISR sensors.	3.858	2.606	5.107

(U) In FY 2003: Tested Gallium Arsenide and Indium Phosphide RF components (analog-to-digital converters, filters, mixers, etc.) inserted into radar and EW digital receiver modules against environment scenarios. Demonstrated a brassboard low-power (< 1.0W), silicon-on-sapphire based analog-to-digital converter and completed ground-level radiation testing in a space-qualified package. Laboratory tested a silicon-on-insulator mixed-signal (digital, RF, microwave, etc.) integrated circuit, for reconfigurable signal conversion.

(U) In FY 2004: Develop receiver architecture and components addressing issues specific to digital beamforming (DBF) systems, such as multiple channel coherence of multi, digital true time delay support, channel equalization, and array calibration. Evaluate in a relevant environment affordable Gallium Arsenide (GaAs) RF components (analog-to-digital converters, filters, mixers, etc.), together with the technology upgrade plan for Indium Phosphide (InP) RF components into radar and EW digital receiver modules.

(U) In FY 2005: Develop a DBF receiver architecture addressing issues specific to DBF systems, such as coherence of multiple channels, support for digital true time delay, channel equalization, and array calibration. Evaluate affordable

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

	DBF-specific Gallium Arsenide (GaAs) RF components (ADCs, filters, mixers, etc.) with the technology upgrade plan for Indium Phosphide (InP) RF components into radar and EW digital receiver modules.			
(U)				
(U)	MAJOR THRUST: Develop microwave technologies for advanced radio frequency (RF) apertures and phased array antennas used in military intelligence, surveillance, and reconnaissance (ISR) sensors.	3.350	2.298	0.824
(U)	In FY 2003: Developed and demonstrated robust components for L-band and X-band transmitter and receiver channels that operate with limited environmental controls and under severe electromagnetic stress.			
(U)	In FY 2004: Develop and demonstrate the proof of concept of transmit and receive (T/R) channels that are able to withstand strong undesired electromagnetic signals.			
(U)	In FY 2005: Develop and demonstrate the proof of concept of limited subarrays and advanced device technologies that are able to withstand extreme temperature and signal environments.			
(U)				
(U)	MAJOR THRUST: Develop integration and assembly technologies for high performance aerospace phased array sensors.	4.050	2.039	1.921
(U)	In FY 2003: Demonstrated X-band, flexible RF membrane-based sub-assemblies that enable integrating low-cost and low-mass transmitter and receiver channels at the subarray level.			
(U)	In FY 2004: Develop and demonstrate large area (>0.5 m2) active apertures based on flexible RF membranes that lower the assembly costs and mass over conventional phased arrays by an order of magnitude.			
(U)	In FY 2005: Develop and demonstrate the complex integration of multiple functions on flexible RF substrates for application on conformal surfaces such as those found on aerospace vehicles.			
(U)				
(U)	MAJOR THRUST: Develop signal control and low-power consumption components and techniques to reduce both power loss and power consumption for future radar, electronic warfare (EW), and ISR sensors.	4.310	2.738	4.477
(U)	In FY 2003: Characterized and matured micro-electro-mechanical systems wideband phase shifters for extended switch lifetimes. Reduced the power consumption of low-noise amplifiers while maintaining high linearity over wide bandwidths.			
(U)	In FY 2004: Fabricate subarrays with T/R channels that feature a five-fold power consumption reduction, while maintaining high linearity over wide bandwidths.			
(U)	In FY 2005: Develop new T/R channel technology using advanced semiconductor integration techniques.			
(U)				
(U)	MAJOR THRUST: Refine materials and processes for two-dimensional and three-dimensional device interconnects and component protection from the environment.	2.430	1.300	1.097
(U)	In FY 2003: Verified that these interconnects and components perform on rigid, flexible, and conformal assemblies of high density mixed-signal technologies (digital, analog, microwave and millimeter wave devices and components).			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

	Tested interconnects and components in both packaged (non-hermetic multi-chip modules) and package-less (bare-die-chip on board) forms.			
(U)	In FY 2004: Develop and demonstrate mixed-signal receiver/processor multi-functionality on flexible arrays using advanced two-dimensional and three-dimensional interconnects, and package-less protection schemes. Verify the electrical performance of these mixed-signal assemblies and validate their hermetic-like protective qualities.			
(U)	In FY 2005: Demonstrate and evaluate a two-fold decrease in the cost and size of the mixed-signal assemblies.			
(U)				
(U)	MAJOR THRUST: Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, radio frequency (RF), microwave, etc.) component development in both advanced and emerging electronic component technologies.	0.000	0.893	1.646
(U)	In FY 2003: Not Applicable. In FY 2003, this work was performed under the previous major thrust area.			
(U)	In FY 2004: Laboratory test breadboard silicon-on-insulator and silicon-on-sapphire signal conversion components designed for precise positioning, navigation, and other aerospace applications			
(U)	In FY 2005: Evaluate system-in-a-package/system-on-a-chip tool suite for the modeling, simulation, design, and characterization of mixed-signal (digital, RF, microwave, etc.) components developed for advanced mixed-signal technologies (silicon-on-insulator (SOI), Silicon Germanium (SiGe), Antimonides, Indium Phosphide (InP)). Test in a laboratory environment breadboard SOI and SiGe signal conversion components designed for narrow band (Global Positioning System, air moving target indication) aerospace applications.			
(U)				
(U)	CONGRESSIONAL ADD: Wireless Surveillance of Hostile Threats.	0.979	0.000	0.000
(U)	In FY 2003: Developed low-temperature, high-efficiency, small-scale fuel cells to generate power for wireless micro-sensor systems that will provide "anytime, anywhere" ISR capabilities against emerging hostile threats.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Fourier Transform-Infrared (FT-IR) Gas Analysis.	0.979	0.000	0.000
(U)	In FY 2003: Demonstrated FT-IR spectrometric gas analysis techniques for applications in controlling reactant gases generated during the vapor phase epitaxial growth of semiconductor films on substrates. These techniques will also be used to monitor gas concentrations in nanostructure growths for electronic and optical devices, and in the development of new approaches to detecting chemical and biological agents.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: 3-D Packaging Technology for High Speed RF Communication.	0.000	2.326	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Design, fabricate, and demonstrate proof-of-principle experimental 3-D microcircuit packages for high speed electrical and high-power thermal military sensor applications.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: General Purpose Reconfiguration Signal Processors System.	0.000	2.926	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Accelerate the development and transition of new on-board sensor signal processors for time-critical intelligence, surveillance, and reconnaissance applications in unmanned aerial vehicles.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	19.956	17.126	15.072

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities: PE 0602500F,									
(U)	Multi-disciplinary Space Technology.									
(U)	PE 0603203F, Advanced Aerospace Sensors.									
(U)	PE 0603270F, Electronic Combat Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602204F Aerospace Sensors**	**2003 EO Sensors & Countermeasures Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2003 EO Sensors & Countermeasures Tech	11.881	18.680	14.657	15.649	16.139	16.701	17.061	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced electro-optical (EO) aerospace sensor technologies for a variety of offensive and defensive uses. The sensor technologies under development range from the ultraviolet through the infrared (IR) portion of the spectrum. Related efforts include improvements in avionics integration, digital processing, analysis tools, and sensor architectures. One of the project's main goals is to improve EO and related technologies for the detection, tracking, and identification of non-cooperative and difficult targets, such as those obscured by camouflage. This project also develops the passive and active hyperspectral imaging sensors and algorithms needed to enable precision targeting in severe weather. These technologies are critical to future aerospace surveillance and targeting. Other project goals include advanced EO threat warning and countermeasures.

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop technology for non-cooperative identification of airborne and ground-based platforms.	3.180	3.810	2.928

(U) In FY 2003: Conducted air-to-air and air-to-ground demonstrations of long-range combat identification (CID) sensors. Tested range-resolved coherent image processing and extraction algorithms, including 3-D block registration algorithms. Conducted long-range experiments using advanced 3-D sensors for CID applications. Continued passive hyperspectral model development, validation, and performance predictions, and assessed signature-based data processing performance based on ground demonstration data. Continued flights, analysis, and evaluation of multi-function laser radar for identification of ground targets.

(U) In FY 2004: Conduct ground- and air-based testing and demonstration of an advanced Combat Identification (CID) system with multi-spectral detection and cueing, and active electro-optical (EO) target long-range combat identification sensors. Integrate advanced, 3-D focal planes and algorithms in a concept design of a high altitude system to detect targets in relevant environments. Continue passive hyperspectral model development, validation, and performance predictions specifically supporting the flying testbed. Define technologies suited to layered sensing approaches for deep penetration and continuous target area coverage.

(U) In FY 2005: Continue ground- and air-based testing and demonstration of advanced CID systems with multi-spectral, polarization-based detection and cueing and active EO target long-range combat identification sensors. Complete integration of advanced 3-D focal planes and algorithms in concept design of high altitude system and perform technology demonstrations in relevant configurations. Extend passive hyperspectral model to emissive spectral region and perform validation experiments with flying testbed. Extend passive EO/IR enhancements by incorporating passive polarization techniques into both modeling and performance assessments. Develop electro-optical system architectures for layered sensing based on multiple platform types for deep penetration and continuous target area

	coverage.			
(U)				
(U)	MAJOR THRUST: Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification.	2.076	2.014	2.429
(U)	In FY 2003: Developed pulsed vibration sensing system for long-range combat identification (CID). Initiated developing flight-capable, multi-function architectures. Integrated platform compensation techniques into new architectures. Developed breadboard multi-spectral transmitter, and predicted performance for different types of targets.			
(U)	In FY 2004: Laboratory demonstrate a multi-function, pulsed vibration imaging sensing system for long-range CID. Test and evaluate sensors utilizing 3-D focal planes. Continue developing flight capable multi-function architectures. Continue fabricating a breadboard multi-spectral transmitter and evaluate performance for different types of targets.			
(U)	In FY 2005: Evaluate performance of multi-function pulsed vibration/imaging sensing system for long-range CID. Complete breadboard active multi-spectral transmitter and evaluate performance for both hard and extended targets. Initiate flight capable, long-range, multi-function brassboard sensor development. Tailor flight test platform to support testing of long-range air-to-air and air-to-ground systems under development. Perform initial flights for pulsed vibrometer CID sensor.			
(U)				
(U)	MAJOR THRUST: Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions.	4.029	7.510	7.636
(U)	In FY 2003: Continued utility analysis of high altitude active sensors, including platform trades. Performed tower tests of an active multi-spectral imaging system. Demonstrated imaging through weather and obscurants through flight test of active imaging sensors. Designed and demonstrated concepts based on high precision pointing, range gating, and image processing. Developed concepts for airborne application of non-mechanical beam steering devices, including mitigating aero-optical effects. Investigated concepts for combined radio frequency and electro-optical (EO) apertures.			
(U)	In FY 2004: Develop high altitude active sensor performance specifications and concept design. Integrate weather and obscurant penetration concepts. Initiate evaluating non-mechanical beam steering concepts for high altitude sensor applications including precision pointing, focusing, and wavefront correction. Perform an initial demonstration of a combined EO and radio frequency aperture. Perform tests, analyses, and evaluations of a specialized multi-function laser radar for the detection and characterization of difficult targets.			
(U)	In FY 2005: Complete high altitude active sensor performance specification and concept design. Complete the evaluation of and demonstrate non-mechanical beam steering concepts for high altitude sensor application including precision pointing, focusing, and wavefront correction. Continue development and demonstrations of a combined EO/radio frequency (RF) aperture. Continue tests, analysis and evaluation of specialized multifunction laser radar for			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

	detection and characterization of difficult targets. Collect simultaneous passive and multifunction active sensing phenomenology data for analysis of difficult target detection. Initiate architecture definition for advanced electro-optics unmanned aerial vehicle (UAV) based systems to find, fix, and identify difficult targets in difficult environments including the urban environment. Study integration techniques for combining active and passive EO/infrared for enhanced search, detection, location, and identification.			
(U)				
(U)	MAJOR THRUST: Develop countermeasure technologies for use against infrared (IR) guided missiles and electro-optical threats.	1.947	1.149	0.832
(U)	In FY 2003: Continued to design components and refine techniques to defeat imaging missile seekers. Continued the exploitation of advanced IR missile technology.			
(U)	In FY 2004: Complete an IR scene projector to assess imaging sensor capabilities. Initiate evaluating onboard and offboard techniques to defeat imaging missile seekers. Continue exploiting advanced IR missiles and IR sensor technologies			
(U)	In FY 2005: Develop specifications for countermeasure techniques to defeat first generation imaging missile seekers. Continue the exploitation of advanced infrared missiles and infrared sensor technology for countermeasure technique refinement. Initiate characterization of an imaging missile seeker to establish target-tracking capabilities.			
(U)				
(U)	MAJOR THRUST: Develop aerospace missile and laser warning technologies to accurately cue countermeasures.	0.649	0.997	0.832
(U)	In FY 2003: Laboratory tested temporal and spectral tracking algorithms focused on multi-spectral imaging techniques. Initiated the testing of an advanced laser warning receiver for application in a space environment.			
(U)	In FY 2004: Continue laboratory testing temporal and spectral tracking algorithms focused on multi-color imaging techniques. Continue testing an advanced laser warning receiver for application in a space environment, and expand testing to include airborne applications.			
(U)	In FY 2005: Evaluate advanced multi-color spectral sensor technologies and high spatial resolution imaging for enhanced clutter discrimination techniques for tactical missile warning. Continue developing an advanced laser warning receiver for space and airborne applications. Initiate developing a space-based laser threat scenario testbed for satellite-as-a-sensor technology evaluations. Initiate developing a laser warning sensor technologies to address ultra-short and tunable laser threats.			
(U)				
(U)	CONGRESSIONAL ADD: Watchkeeper Ultra-Wideband (UWB) Demonstration.	0.000	3.200	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop ultra-wideband radio frequency technology for an unattended ground sensor for perimeter defense.			
(U)	In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

	FY 2003	FY 2004	FY 2005
(U) Total Cost	11.881	18.680	14.657

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0603253F, Advanced Sensor Integration.									
(U) PE 0602301E, Intelligence System Program.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	0602204F Aerospace Sensors	4916 Electromagnetic Tech

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4916 Electromagnetic Tech	11.906	12.151	9.536	9.876	10.273	10.694	11.134	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops technologies for sensor systems that cover the electromagnetic spectrum--from radio frequency (RF) to optical. It develops RF antennas and associated electronics for airborne and space-based surveillance. It also investigates RF scattering phenomenology for applications in ground and air moving target indicators in extremely cluttered environments. The project develops active and passive electro-optical (EO) sensors for use in concert with RF sensors. It develops low-cost active sensors that use reliable high-performance solid state components for target detection and identification and missile threat warning. The project also develops passive multi-dimensional sensors to improve battlefield awareness and identify threats at long-range.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate detecting difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms.	2.824	2.269	2.510
(U) In FY 2003: Developed models and experimental techniques for characterizing RF scatter from targets, ground clutter, and foliage.			
(U) In FY 2004: Continue developing models and experimental techniques for the characterization of RF frequency scattering from targets, ground clutter, and foliage.			
(U) In FY 2005: Develop and validate target and clutter models and innovative measurement techniques for the parametric description of radar signal scattering from targets, terrain, and foliage.			
(U)			
(U) MAJOR THRUST: Design and develop antennas for airborne and space-based surveillance.	2.740	2.429	2.552
(U) In FY 2003: Designed, analyzed, and built advanced large, lightweight antenna arrays. Developed new algorithms for digital beam forming and limited-scan phased array antennas. Developed high-speed electronics for antenna front end applications and micro-electro-mechanical systems technology for delayed line switching in phased arrays.			
(U) In FY 2004: Evaluate advanced large, lightweight antenna arrays. Evaluate new algorithms for digital beam forming and limited-scan phased array antennas. Evaluate high-speed electronics antenna front end applications and micro-electro-mechanical systems technology for delayed line switching in phased arrays.			
(U) In FY 2005: Extend the design and analysis of advanced large lightweight array antennas. Initiate fabricating breadboard large lightweight array antennas. Develop new algorithms for multi-beam digital beam forming and limited-scan phased array antennas. Validate high-speed electronics antenna front-end applications and micro-electro-mechanical systems technology for delay line switching in phased arrays.			
(U)			
(U) MAJOR THRUST: Design and develop new EO techniques and components for detecting and identifying concealed	2.572	2.179	2.237

	targets.			
(U)	In FY 2003: Designed and fabricated multi-function sensor arrays and the associated materials and device technologies for optical beam steering. Designed and developed active components and integration techniques for autonomous 3-D ladar-guided munitions and other imaging applications. Developed optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.			
(U)	In FY 2004: Continue designing and fabricating multi-function sensor arrays and the associated materials and device technologies for optical beam steering. Continue designing and developing active components and integration techniques for autonomous 3-D laser radar-guided munitions and other imaging applications. Continue developing optical processing techniques that compensate for optical aberrations in aircraft-generated turbulence.			
(U)	In FY 2005: Evaluate multi-function, multisensor optical arrays and the associated materials and device technologies for optical beam steering. Evaluate active components and integration techniques for autonomous 3-D laser-radar-guided munitions and other imaging applications. Evaluate optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.			
(U)				
(U)	MAJOR THRUST: Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates.	2.791	2.274	2.237
(U)	In FY 2003: Established viability of tomographic hyperspectral sensing techniques for aerospace applications. Demonstrated the applicability of tomographic hyperspectral sensor concepts to characterizing explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.			
(U)	In FY 2004: Evaluate the viability of tomographic hyperspectral sensing techniques for aerospace applications. Evaluate the applicability of tomographic hyperspectral sensor concepts to characterizing explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.			
(U)	In FY 2005: Initiate developing technology for a new dual band tomographically based sensor system for characterizing energetic battlefield events in real-time. Develop techniques that use hyperspectral, simultaneous dual-band information to increase the validity of target declaration and to reduce false alarms.			
(U)				
(U)	CONGRESSIONAL ADD: Phased Array Antenna and Control System.	0.979	0.000	0.000
(U)	In FY 2003: Developed a phased array antenna control system by implementing computer algorithms that control the antenna's beam pointing, and by developing the computer hardware necessary to enable system operators to monitor antenna operations and the antenna's health and status.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Center for Advanced Sensor and Communication Antennas.	0.000	3.000	0.000
(U)	In FY 2003: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **4916 Electromagnetic Tech**

(U) In FY 2004: Develop innovative, low-cost designs and fabrication methods that achieve high performance and proliferation of advanced phased array antennas into new military applications.

(U) In FY 2005: Not Applicable.

(U) Total Cost	11.906	12.151	9.536

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0602702F, Command Control and Communications.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602204F Aerospace Sensors**	**5016 Photonic Component Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5016 Photonic Component Technology	3.191	2.889	2.878	2.157	2.187	2.369	2.541	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, photonic component technology work previously performed in this PE, Project 2002, transferred to this project.

(U) **A. Mission Description and Budget Item Justification**

This project focuses on designing and developing methods to generate, control, receive, transmit, and process opto-electronic (mixed) signals for radio frequency (RF) sensor aerospace applications. Enabling technologies developed under this project for intelligence, surveillance, reconnaissance, electronic warfare (EW), and precision engagement sensors include: low noise, aerospace environmentally-qualified signal control components (e.g., electro-optical (EO) switches, micro-opto-electronic mixed signals; electro-optical components for RF links; photonic signal control, distribution, and signal processing; multi-function, aerospace-qualified, opto-electronic integrated circuits; wideband photonic-based high-speed EO analog-to-digital and digital-to-analog converters; and opto-electronic intraconnects and interconnects. This project designs, develops, fabricates, and evaluates techniques for integrating various combinations of photonic and electronic technologies. The main purpose is to demonstrate significantly improved military sensors of smaller size, lower weight, lower cost, lower prime power, higher reliability, and improved performance -- as compared to current systems. The device, component, and subsystem technology developments under this project are military unique and based on Air Force and other Department of Defense weapon systems requirements in the areas of radar, sensors, communications, EW, navigation, and smart weapons.

		FY 2003	FY 2004	FY 2005
(U)	**B. Accomplishments/Planned Program ($ in Millions)**			
(U)	MAJOR THRUST: Develop integrated photonic technology components.	2.049	2.148	2.878
(U)	In FY 2003: Developed high-performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband RF phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.			
(U)	In FY 2004: Evaluate high-performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband radio frequency phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.			
(U)	In FY 2005: Laboratory test and validate high-performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband radio frequency phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.			
(U)				
(U)	MAJOR THRUST: Develop photonic analog-to-digital conversion component technology.	1.142	0.741	0.000
(U)	In FY 2003: Developed ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.			
(U)	In FY 2004: Evaluate, test, and validate ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5016 Photonic Component Technology**

(U) In FY 2005: Not Applicable. Work completed.

(U) Total Cost	3.191	2.889	2.878

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
	PE 0602500F,									
(U)	Multi-disciplinary Space Technology.									
(U)	PE 0603203F, Advanced Aerospace Sensors.									
(U)	PE 0603270F, Electronic Combat Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602204F Aerospace Sensors**	**5017 RF Processing for ISR Sensors**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5017 RF Processing for ISR Sensors	7.400	6.643	7.362	7.726	7.336	7.599	7.789	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in radio frequency (RF) processing for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this PE, Project 7622, transferred to this project.

(U) A. Mission Description and Budget Item Justification

This project develops and assesses radar technology for affordable, reliable, all weather aerospace ISR systems. Emphasis is on detecting and tracking surface and airborne targets that have difficult to detect signatures due to reduced cross sections, concealment and camouflage measures, severe clutter, or heavy jamming. Techniques exploited include the use of multiple radio frequency (RF) phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge-aided processing techniques.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop distributed airborne sensor systems to increase sensitivity and improve location accuracy.	1.038	0.498	0.407
(U) In FY 2003: Investigated RF processing techniques for implementing distributed airborne sensor systems to increase sensitivity and improve location accuracy. These techniques include sparse arrays with maneuvering platforms and improved location accuracy using interfermetric methods combined with knowledge-based responsive mode selections.			
(U) In FY 2004: Demonstrate, through computer simulation and emulation, the RF processing techniques for implementing distributed airborne sensing techniques for detecting, locating, and engaging airborne and ground targets.			
(U) In FY 2005: Demonstrate in the laboratory the proof of concept of RF processing techniques for implementing distributed airborne sensing techniques for detecting, locating, and engaging airborne and ground targets.			
(U)			
(U) MAJOR THRUST: Investigate techniques for multi-intelligence data acquisition from a single platform.	1.987	2.312	2.221
(U) In FY 2003: Investigated common waveform techniques, knowledge-based scheduling, and advanced target detection for both unconcealed and concealed targets. Determined the electromagnetic compatibility issues associated with simultaneously hosting and operating multiple radars, electronic support measure receivers, integrated communications, and electronic attack components on a single platform. Investigated methods to mitigate unintentional interference sources to multi-intelligence platforms from the ground and in the air, such as commercial broadcast assets, civilian radar assets, and commercial communications systems.			
(U) In FY 2004: Evaluate multi-function radar sensing through computer simulations and emulations. Evaluate the electromagnetic compatibility issues associated with hosting multiple radars, electronic support measure receivers,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5017 RF Processing for ISR Sensors**

integrated communications equipment, and electronic attack components on a single platform capable of operating simultaneously. Continue investigating methods to mitigate unintentional interferers on the ground and in the air such as commercial broadcast assets, civilian radar assets, and commercial communications systems on multi-intelligence platforms. Initiate investigating electronic counter-countermeasure techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing.

(U) In FY 2005: Validate multi-function radar sensing through computer simulations and emulations. Laboratory test radio frequency (RF) processing techniques to minimize the electromagnetic compatibility issues associated with hosting multiple radars, electronic support measure receivers, integrated communications equipment, and electronic attack components on a single platform capable of operating simultaneously. Evaluate methods to mitigate unintentional interferers on the ground and in the air such as commercial broadcast assets, civilian radar assets, and commercial communications systems on multi-intelligence platforms. Develop electronic counter-countermeasure techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing. Initiate research in advanced electronic counter countermeasure measures (ECCM) techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing.

(U)

(U) MAJOR THRUST: Develop multi-mission aerospace microwave processing algorithms to detect and locate advanced cruise missiles, slowly moving ground targets, and stationary targets in severe clutter and jamming environments.	2.568	3.052	1.899

(U) In FY 2003: Studied multi-mission adaptive radar algorithms to support various operational modes, including air and ground target detection, ground target imaging, electronic protection, and passive RF emission detection. Studied advanced waveforms for achieving transmitter adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversities in frequencies, delays, polarizations, modulations, and codings. Developed knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indication sensors.

(U) In FY 2004: Develop multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, and electronic protection. Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operations to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization and modulation, and coding. Evaluate and refine knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indication sensors.

(U) In FY 2005: Evaluate multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, and electronic protection. Continue developing advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, and modulation and

	coding. Laboratory test knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in multi-intelligence sensors.			
(U)				
(U)	MAJOR THRUST: Study and analyze technology for detecting and precisely locating concealed targets using standoff aerospace platforms.	0.530	0.781	2.211
(U)	In FY 2003: Initiated an investigation of emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Initiated the study of adaptive processing techniques for multi-mission conformal arrays. Initiated the study of wideband and polarization adaptive processing techniques for multi-function radar.			
(U)	In FY 2004: Develop emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Study and analyze adaptive processing techniques for multi-mission conformal arrays. Study and analyze wideband and polarization adaptive processing techniques for multi-function radar. Initiate investigating distributed processing technology for next generation, deep-reach target detection and tracking.			
(U)	In FY 2005: Evaluate emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Develop adaptive processing techniques for multi-mission conformal arrays. Develop and evaluate wideband and polarization adaptive processing techniques for multi-function radar. Continue investigating distributed processing technology for next generation deep-reach target detection and tracking.			
(U)				
(U)	MAJOR THRUST: Develop wideband integrated photonic components.	0.000	0.000	0.353
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Initiate developing high-performance, low loss, wideband integrated photonic link, interconnect, and switching components and subsystems for all weather space and airborne surveillance and reconnaissance systems. This work is an outgrowth of other work in this project.			
(U)				
(U)	MAJOR THRUST: Develop wideband photonic analog-to-digital mixed signal conversion component technologies.	0.000	0.000	0.271
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Initiate developing high-resolution, ultra-fast, multi-gigahertz wideband photonic analog-to-digital mixed signal conversion component technology for all weather space and airborne surveillance and reconnaissance systems. This work is an outgrowth of other work in this project.			
(U)				
(U)	CONGRESSIONAL ADD: AFRL Information and Sensors Directorate.	1.277	0.000	0.000
(U)	In FY 2003: Tested and evaluated Global Positioning System receivers to assess potential problems from spectrum encroachment by ultra-wideband devices.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5017 RF Processing for ISR Sensors**

(U) In FY 2004: Not Applicable.
(U) In FY 2005: Not Applicable.

(U) Total Cost	7.400	6.643	7.362

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602204F Aerospace Sensors**	**6095 Sensor Fusion Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
6095 Sensor Fusion Technology	12.670	12.131	13.246	15.626	16.267	16.781	17.146	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project transferred to PE 0602500F, Project 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

This project develops the technologies required to perform management and fusion of sensor information for timely, comprehensive situational awareness, automatic target recognition (ATR), integrated fire control, and bomb damage assessment. This project determines the feasibility of technologies and concepts for fire control that help to precisely locate, identify, and target airborne and surface targets. The project emphasizes finding reduced signature targets and targets of opportunity. It will enable new covert tactics for successful air-to-air and air-to-surface strikes.

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets.	3.789	3.709	1.614

(U) In FY 2003: Continued integrating and demonstrating single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. Continued integrating real-time ATR algorithms, for time-critical targets, on embedded high-performance computing systems. Completed laboratory demonstration of adaptive resource allocation methods. Continued integrating and evaluating algorithms and concepts for detecting and targeting targets under trees (TUT). Completed developing single sensor ATR performance assessment technology, and multi-sensor and sensor fusion assessment technology. Continued ATR performance evaluation theory research. Completed the first single sensor ATR performance prediction model.

(U) In FY 2004: Evaluate single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. Validate integrating real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Laboratory test algorithms and concepts for detecting and targeting targets under trees. Evaluate single sensor ATR performance assessment technology, and multi-sensor and sensor fusion assessment technology. Continue ATR performance evaluation theory research. Evaluate the first single sensor ATR performance prediction model.

(U) In FY 2005: Develop improvement in image formation and processing of Synthetic Aperture Radar (SAR) data from Research & Development (R&D) data collections. Develop automated image analysis and truthing tools. Employ synthetic data generation tools to augment and enhance existing R&D and operational data sets. Improve ATR R&D computer and networking infrastructure via software, hardware, and network integration enhancements. Assess the effectiveness of real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Laboratory test multi-sensor and sensor fusion assessment algorithms. Continue ATR performance

	evaluation theory research. Laboratory test the first multi-sensor ATR performance prediction model.			
(U)				
(U)	MAJOR THRUST: Develop, evaluate, and demonstrate target signature models to support automatic target recognition (ATR) and sensor fusion algorithm development and testing for reconnaissance and strike mission applications.	3.798	3.891	6.429
(U)	In FY 2003: Developed target signature models for signature exploitation of synthetic aperture radar, electro-optical (EO) multi-spectral systems, and signals intelligence sensors. Demonstrated the ability to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Developed modeling and simulation tools that can estimate warfighter effectiveness enhancements due to inserting ATR and sensor fusion aids into the reconnaissance and strike components of the time-critical targeting kill chain.			
(U)	In FY 2004: Laboratory test target signature models for signature exploitation of radio frequency (RF) sensors, electro-optical multispectral systems, and signals intelligence sensors. Generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Develop synthetic scene data generation capability to augment and enhance existing research and development and operational data sets. Evaluate modeling and simulation tools for estimating warfighter effectiveness enhancements enabled by inserting ATR and sensor fusion aids to the reconnaissance and strike components of the time-critical targeting kill chain.			
(U)	In FY 2005: Evaluate target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence sensors. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Evaluate preliminary two-class ATR for EO sensed vibration of tactical ground targets. Continue developing a synthetic scene data generation capability applicable to large area reconnaissance coverage. Upgrade fidelity of modeling and simulation tools that estimate warfighter effectiveness enhancements enabled by inserting ATR and sensor fusion aids to the reconnaissance and strike components of the time-critical targeting kill chain.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate enabling ATR, sensor management, and sensor fusion technologies for target detection, tracking, and identification in intelligence, surveillance, and reconnaissance (ISR) and combat identification (CID) applications.	4.321	4.531	5.203
(U)	In FY 2003: Completed evaluating adaptive learning techniques for target identification. Initiated laboratory demonstration of adaptive sensor management algorithms for target detection, tracking, and identification. Continued evaluating physics-based techniques for target detection and identification for ISR and CID applications.			
(U)	In FY 2004: Exploit adaptive learning techniques for target identification using three-dimensional sensors. Study exploitable radar features for target detection, tracking, and identification. Laboratory test physics-based techniques for target detection and identification for ISR and CID applications. Initiate laboratory demonstration of advanced			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT NUMBER AND TITLE 6095 Sensor Fusion Technology

algorithms for detection and identification of targets under trees in the presence of heavy camouflage, concealment, and deception.

(U) In FY 2005: Develop exploitable radar features for target detection, tracking, and identification. Continue laboratory demonstration of advanced algorithms for detection and identification of targets under trees and/or in the presence of heavy camouflage, concealment, and deception. Initiate technology development that will capitalize on precision time, position, attitude, and velocity sensor data to enable improved geo-location capabilities for future distributed time and distributed platform sensing. Develop capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy.

(U)

(U) MAJOR THRUST: Develop precision time, position, and velocity sensors capable of operating in jamming environments.	0.762	0.000	0.000

(U) In FY 2003: Completed developing Global Positioning System-specific jamming mitigation techniques for operation in hostile radio frequency environments, with an emphasis on synergistically integrating anti-jam technologies. Developed virtual flight test technology for improved assessment of reference sensors.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U) Total Cost	12.670	12.131	13.246

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602500F, Multi-disciplinary Space Technology.									
(U) PE 0603203F, Advanced Aerospace Sensors.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0603270F, Electronic Combat Technology.									
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.									
(U) PE 0603762E, Sensor and									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **6095 Sensor Fusion Technology**

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

Guidance Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

PROJECT NUMBER AND TITLE
7622 RF Sensors & Countermeasures Tech

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
7622 RF Sensors & Countermeasures Tech	10.168	16.785	16.053	25.784	25.258	23.269	23.821	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in radio frequency (RF) processing for intelligence, surveillance, and reconnaissance (ISR) sensors transferred from this project to this PE, Project 5017. Also in FY 2003, space unique tasks in this project transferred to PE 0602500F, Project 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops and assesses RF sensing concepts for aerospace applications through modeling and simulation. This project also develops and evaluates technology for fire control radar, electronic combat (EC), and integrated radar and EC systems. It emphasizes the detecting and tracking of surface and airborne targets with RF signatures that are difficult to detect due to reduced radar cross sections, concealment and camouflage measures, severe clutter, or heavy jamming. This project also develops the RF warning and countermeasure technology for advanced EC applications. Specifically, it develops techniques and technologies to detect and counter the links and sensors of threat air defense systems and hostile command and control networks. The project also exploits emerging technologies and components to provide increased capability for offensive and defensive RF sensors, including radar warning, RF EC, and electronic intelligence applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop affordable RF jamming technology and concepts that enhance aerospace vehicle survivability by degrading enemy radar, missile, and command and control systems.	4.583	5.036	4.086
(U) In FY 2003: Developed multi-function EW technique waveforms. Continued exploitation evaluations against new, advanced RF threats. Developed optimized EW techniques to degrade modern radar, communications, and missile threat systems. Initiated phase calibration development.			
(U) In FY 2004: Evaluate multi-function electronic warfare (EW) technique waveforms. Continue exploitation evaluations against new, advanced RF threats. Continue developing optimized EW techniques to degrade modern radar, communications, and missile threat systems. Perform laboratory demonstration of a phase calibration system for a monopulse countermeasure technique to protect all Air Force platforms.			
(U) In FY 2005: Develop a complex signal communication environment simulator that contains both adversary and friendly advanced spread spectrum signals. Develop technology for an advanced digital communications jammer. Continue exploitation evaluations against new, advanced RF threats. Evaluate results of a laboratory demonstration of phase calibration system for a monopulse countermeasure technique to protect all Air Force platforms.			
(U)			
(U) MAJOR THRUST: Develop technology to enable affordable upgrades to RF signal receivers.	1.649	2.064	1.268
(U) In FY 2003: Modeled threat identification algorithms for next generation threat warning receivers. Evaluated state-of-the-art radar and EW digital receiver subsystems with Gallium Arsenide and Indium Phosphide RF			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **7622 RF Sensors & Countermeasures Tech**

	components (analog-to-digital converters, filters, mixers, etc.) for laboratory environment scenario testing. Designed advanced very high frequency receiver improvements for detecting targets under trees.			
(U)	In FY 2004: Develop threat identification algorithms for next generation threat warning receivers. Continue designing advanced very high frequency receiver improvements for detecting targets under trees. Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, radio frequency (RF), microwave, etc.) component development in advanced and emerging technologies. Demonstrate breadboard electronic/photonic wideband digital receiver for multi-mode/multi-function applications.			
(U)	In FY 2005: Validate threat identification algorithms for next generation threat warning receivers. Develop affordable RF wideband RF cueing receiver technology. Evaluate the impact of mixed-signal (digital, RF, microwave, etc.) and mixed-technology (electronics, micro-electro-mechanical, photonics, etc.) component development using advanced and emerging technologies for digital receiver and exciter systems.			
(U)				
(U)	MAJOR THRUST: Develop robust, ultra-widebandwidth antenna technology for use in operational and future aerospace platform electronic apertures.	1.215	0.918	2.090
(U)	In FY 2003: Demonstrated breadboard wideband, high precision interferometric multi-mode direction finding antennas. Developed design tools to predict antenna performance installed on host platform models. Demonstrated components and techniques that increase five-fold the signal handling capability of an aperture.			
(U)	In FY 2004: Evaluate breadboard wideband, high-precision interferometric multi-mode direction finding antennas. Continue developing design tools to predict antenna performance installed on host platform models. Develop techniques that provide low-cost, lightweight phased arrays for low band applications.			
(U)	In FY 2005: Develop and laboratory demonstrate advanced wideband (3:1) transmit/receive (T/R) channel technology. Evaluate design tools to predict antenna performance installed on host platform models. Laboratory demonstrate techniques that provide low-cost, lightweight phased arrays for low band applications.			
(U)				
(U)	MAJOR THRUST: Develop multi-function RF sensing concepts.	2.721	6.560	4.685
(U)	In FY 2003: Developed and evaluated innovative multi-function RF sensing concepts for aerospace applications through modeling and simulation with an emphasis on system engineering.			
(U)	In FY 2004: Develop and evaluate advanced multi-function and multi-intelligence RF sensors for intelligence, surveillance, and reconnaissance and targeting of time-critical targets. Develop testbed integration techniques for advanced multi-intelligence sensor hardware and algorithms. Develop and evaluate multi-platform sensor coordination and synchronization techniques.			
(U)	In FY 2005: Model and simulate innovative multi-function RF sensing concepts for air and space applications. Develop and evaluate advanced multi-function and multi-intelligence RF sensors for intelligence, surveillance, and reconnaissance and targeting of time-critical targets with applications in unmanned aerial vehicles and manned			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **7622 RF Sensors & Countermeasures Tech**

	aircraft. Initiate testbed planning and experiment design to support validation of concepts and the subsystem requirements for advanced multi-intelligence sensors.			
(U)				
(U)	MAJOR THRUST: Develop digital radio frequency (RF) receiver/exciter technology to support digital beamforming.	0.000	2.207	2.054
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Analyze and develop approaches to address digital beamforming- (DBF) specific issues such as such as coherence of multiple channels, digital true time delay, channel equalization, distributed waveform generation, and array calibration. Develop techniques for integrating multi-intelligence radio frequency receiver/exciter subsystems into aperture and signal processing testbeds.			
(U)	In FY 2005: Develop and evaluate DBF-specific receiver/exciter technologies that stress reduced size, weight, and power consumption, affordability using advanced digital technologies, RF packaging, and functional integration of the RF receiver, analog-to-digital conversion, digital channelization, and digital time delay beamsteering subsystems. Perform testbed integration of multi-intelligence RF receiver/exciter, aperture, and signal processing subsystems.			
(U)				
(U)	MAJOR THRUST: Design exploratory outdoor time transfer experiments between multiple moving platforms for enhanced situational awareness.	0.000	0.000	1.196
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Develop experiments in assured reference to evaluate advanced navigation technologies for network centric warfare applications.			
(U)				
(U)	MAJOR THRUST: Develop advanced waveforms for achieving transmit adaptivity and simultaneous multi-mode operation to improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, and modulation and coding.	0.000	0.000	0.674
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Develop adaptive processing techniques for multi-mission conformal arrays.			
(U)	Total Cost	10.168	16.785	16.053

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602500F,									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **7622 RF Sensors & Countermeasures Tech**

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

Multi-disciplinary Space Technology.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603253F, Advanced Avionics Integration.

(U) PE 0602782A, Command, Control, Communications Technology.

(U) PE 0602232N, Navy C3 Technology.

(U) PE 0603792N, Advanced Technology Transition.

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

(U) **D. Acquisition Strategy**

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602500F MULTI-DISCIPLINARY SPACE TECH

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	95.779	101.360	84.581	81.118	101.359	123.236	122.071	0.000	0.000
5023	Laser & Imaging Space Tech	1.176	6.059	8.546	8.071	10.459	11.472	11.672	0.000	0.000
5024	Human Centered Applied Space Tech	0.475	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5025	Space Materials Development	17.625	19.447	21.499	20.797	26.531	36.390	35.919	0.000	0.000
5026	Rocket Propulsion Component Tech	22.410	51.909	40.961	42.123	44.413	45.360	46.357	0.000	0.000
5027	High Speed Airbreathing Prop Tech	4.014	4.549	0.180	0.250	0.255	0.260	0.264	0.000	0.000
5028	Space Sensors, Photonics & RF Proc	42.182	1.676	1.856	1.953	4.210	4.265	4.322	0.000	0.000
5029	Space Sensor & CM Tech	6.665	10.599	5.213	1.526	5.089	7.145	6.126	0.000	0.000
5030	Applied Space Access Vehicle Tech	1.232	0.000	0.000	0.000	3.907	8.246	7.321	0.000	0.000
5081	Space Antennas Tech	0.000	1.056	1.406	1.509	1.617	5.233	5.237	0.000	0.000
5082	Optical Networking Tech	0.000	6.065	4.920	4.889	4.878	4.865	4.853	0.000	0.000

Note: In FY 2003, this was a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities. In FY 2003, space unique efforts in the following PEs/Projects transferred to this PE in conjunction with the Space Commission recommendation: PE 0602102F, Projects 4347, 4348, 4349, and 5015, to Project 5025; PE 0602201F, Project 2403, to Project 5030; PE 0602202F, Project 7184, to Project 5024; PE 0602203F, Project 4847, to Project 5026; PE 0602203F, Project 3012, to Project 5027; PE 0602204F, Project 2002, to Project 5028; Projects 2002, 6095, and 7622, to Project 5029; PE 0602605F, Project 4866, to Project 5023. In FY 2004, efforts in Projects 5024 were terminated and efforts in Project 5030 were delayed until FY 2007 due to higher Air Force priorities. Also in FY 2004, space antenna efforts in PE 0602204F, Project 4916, were transferred to this PE, Project 5081, and the Air Force increased emphasis on developing optical networks for space-based applications in Project 5082. In addition, changes are due to adjustments based on recategorization of space unique tasks.

(U) **A. Mission Description and Budget Item Justification**

PE Description: This program advances the technology base in multiple disciplines for future space applications in eight projects, each focusing on a separate technology area including: 1) Laser and imaging space technologies develop concepts for advanced, very long-range optical systems and assess the vulnerability of satellites to the effects of high energy laser weapon systems. 2) Human centered applied space technologies focus on the human interface concepts that improve satellite operations during routine and on-demand space missions. 3) Space materials concentrate on the materials technology base for spacecraft and launch systems to improve affordability, maintainability, and performance. 4) Rocket propulsion component technologies advance technology in liquid propulsion rocket engines, solid rocket motors, spacecraft and upper stage propulsion, ballistic missiles, and application of advanced materials for rockets to achieve revolutionary launch capabilities. 5) High-speed airbreathing propulsion technologies develop advanced and combined cycle engine technologies for revolutionary low-cost access to space. 6) Photonics and radio frequency processes develop technologies to generate, control, process, receive, and transmit opto-electronic signals for space sensor applications. 7) Space sensors and countermeasures technologies focus on generation, control, reception and processing of electronic and electromagnetic signals for space sensor applications in intelligence, surveillance, reconnaissance, warning, electronic combat, and countermeasures. 8) Applied space access vehicle technologies develop advanced concepts for affordable on-demand access to space. 9) Lightweight satellite antenna technology and affordable antenna terminal technology for communications and surveillance. 10) Optical networking

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602500F MULTI-DISCIPLINARY SPACE TECH

technology focuses on the space-based laser communications to provide the warfighter with unlimited communications to any place at any time. Note: In FY 2004, Congress added $1.0 million for the Starfire Optical Range Coating Facility, $1.0 million for the Launch Vehicle Engine Project, $10.7 million for the Jet and Rocket Engine Test Site, and $1.0 million for Photonics Technology.

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 2003	FY 2004	FY 2005
(U)	Previous President's Budget	98.929	90.526	91.185
(U)	Current PBR/President's Budget	95.779	101.360	84.581
(U)	Total Adjustments	-3.150	10.834	
(U)	Congressional Program Reductions		-2.000	
	Congressional Rescissions		-0.866	
	Congressional Increases		13.700	
	Reprogrammings			
	SBIR/STTR Transfer	-3.150		

(U) Significant Program Changes:

This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities. In FY 2005, funding reductions due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5023 Laser & Imaging Space Tech**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5023	Laser & Imaging Space Tech	1.176	6.059	8.546	8.071	10.459	11.472	11.672	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602605F, Project 4866, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2004, increase is primarily due to the transfer of civilian salaries related to space unique activities into this project.

(U) **A. Mission Description and Budget Item Justification**

This project examines the technical feasibility of space-oriented laser and imaging technologies/concepts including advanced, very long-range optical system concepts for both imaging and beam projection applications. It also supports the modeling and analysis of satellite objects to assess vulnerability to laser radiation and to support the space situational awareness mission.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop advanced long-range optical technologies such as advanced beam control; beam acquisition, tracking, and pointing; adaptive optics; dual line of sight pointing; large, lightweight optics; and optical coatings (low energy and high energy) that support relay mirrors. Relay mirrors can greatly extend the range of high power laser weapons as well as low power imaging systems.	0.589	2.920	6.433
(U) In FY 2003: Developed advanced long-range optical technologies such as space-based relay mirrors to support beam projection and imaging applications. Developed technologies such as beam control; acquisition, tracking, and pointing; dual line of sight pointing; and beam stabilization. Developed a roadmap for relay mirror technology development. Developed lightweight, low power optics for space-based relay mirrors. Produced and tested one-meter class ultra-light mirror with near final curvature and demonstrated correction of the mirror surface.			
(U) In FY 2004: Develop technologies for lightweight primary mirrors applicable to bifocal relay mirrors. Investigate different solutions for spacecraft and optical control dynamics.			
(U) In FY 2005: Develop critical optical technologies. Transition mature technologies to a relay mirror system for developmental and field tests and ultimately a demonstration.			
(U)			
(U) MAJOR THRUST: Assess the vulnerability of satellites to the effects of high-energy laser weapons and maintain and update catalogued satellites.	0.587	2.139	2.113
(U) In FY 2003: Incorporated improved algorithms and hardware for rapidly characterizing new launches into current data fusion workstations for the space situational awareness mission.			
(U) In FY 2004: Develop finite state models for space systems that will enable rapid characterization of new launches and provide a better estimate of on orbit space systems capabilities for improved space situational awareness.			
(U) In FY 2005: Update target system response databases for continued improvement of predictive avoidance analyses			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5023 Laser & Imaging Space Tech**

and provide data to U.S. Space Command for the performance of Laser Clearinghouse functions. Update previously completed assessments on catalogued satellites. Enhance and refine finite state modeling process and models for space systems that will enable rapid characterization of new launches and provide a better estimate of on-orbit space systems capabilities for improved space situational awareness. Update lethality assessment methodology by anchoring modeling tools to empirical data. Perform finite state modeling of laser targets to better understand vulnerabilities and identify indicators of battle damage assessment. Incorporate improved algorithms and hardware for rapidly characterizing space objects and new launches into current data fusion workstations needed for satellite assessments and for the space situational awareness mission.

(U)				
(U)	CONGRESSIONAL ADD: Starfire Optical Range Coating Facility.	0.000	1.000	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop a mirror recoating chamber for the Starfire Optical Range 3.5 meter telescope primary mirror, with the capability to coat other large mirrors as needed. Design and build the equipment needed for washing, stripping, and vapor deposition aluminum coating of 2-4 meter diameter mirrors and integrate with large mirror coating room.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	1.176	6.059	8.546

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0603444F, Maui Space Surveillance Systems.									
(U)	PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.									
(U)	PE 0603605F, Advanced Weapons Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5023 Laser & Imaging Space Tech**

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

efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5024 Human Centered Applied Space Tech**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5024	Human Centered Applied Space Tech	0.475	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602202F, Project 7184, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2004, efforts in this project were terminated due to higher Air Force priorities within the Science and Technology Program..

(U) A. Mission Description and Budget Item Justification

This project identifies and develops human and crew interface concepts and technologies that improve satellite operations, satellite attack reporting, and crew situational awareness during routine and on-demand space missions. Payoffs include faster satellite reconfiguration for time-critical targeting, improved situational awareness of space battlespace, and lower cost for operations, training, and modernization due to reduced manning and control station standardization.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop new crew interface concepts and identify new human roles for space operations.	0.475	0.000	0.000
(U) In FY 2003: Developed and evaluated new crew interface concepts for satellite attack reporting, having the optimal mix of human interface technologies that maximize crew situational awareness. Identified new human roles for on-orbit servicing, prepared a satellite control station simulator as an evaluation testbed, and began to develop a multi-sensory control station interface usable across systems.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U) Total Cost	0.475	0.000	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5024 Human Centered Applied Space Tech**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5025 Space Materials Development**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5025 Space Materials Development	17.625	19.447	21.499	20.797	26.531	36.390	35.919	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts were transferred from PE 0602102F, Projects 4347, 4348, 4349, and 5015, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2004, the civilian salaries related to these space unique activities transfer into this project.

(U) A. Mission Description and Budget Item Justification

This project develops the materials and processing technology base for spacecraft and launch systems to improve affordability, maintainability, and performance of current and future Air Force space systems. Families of affordable lightweight materials are being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites, to provide new capabilities for spacecraft, ballistic missile, and propulsion systems to meet the future space requirements. Rocket propulsion materials development in this project supports the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program. Advanced high-temperature protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet space and ballistic missile requirements. Materials technologies are also being developed to enable surveillance and terrestrial situational awareness systems and subsystems for space and ballistic missile applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop materials and processes to dramatically improve performance, durability, and cost of rocket propulsion systems.	10.877	10.410	11.176
(U) In FY 2003: Evaluated new candidate materials for rocket engines such as metal matrix composites, ceramics, and advanced organic composites for use in liquid oxygen, liquid hydrogen, high-temperature, and high-pressure environments. Identified and began evaluating the applications of these materials to turbopump housings, ducts, valves, solid rocket casings, insulation, nozzle throats, and spacecraft propulsion. Developed material property databases and initiated demonstration of suitability for application using representative geometry and processing conditions for the intended rocket engine components.			
(U) In FY 2004: Develop candidate materials and improve processing capabilities to ensure consistent material characteristics for high-speed turbopump housings, ducts, valves, solid rocket casings, insulation, nozzle throats, and spacecraft propulsion. Evaluate high-temperature metals, ceramics, and composite materials by fabricating test articles with representative geometry to validate material characteristics and processing capabilities for solid rocket nozzles, throats, and spacecraft propulsion. Establish materials database and provide predictive modeling capability to anticipate materials performance and model life-cycle behavior of materials in a rocket propulsion environment. Identify new candidate materials suitable for spacecraft and rocket propulsion environments such as thrust chambers, nozzles, and propellant catalysts.			
(U) In FY 2005: Evaluate materials in an appropriate test environment for high-speed turbopump housings, ducts, valves,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5025 Space Materials Development**

	solid rocket casings, insulation, nozzle throats, and spacecraft propulsion. Establish performance of test articles with representative geometry using high-temperature metals, ceramics, and composite materials to validate material characteristics and processing capabilities for solid rocket nozzles, throats, and spacecraft propulsion. Evaluate engine component suitability using direct replacement of materials or enabling new design based on established material properties. Evaluate materials for pursuing applications such as thrust chambers, nozzles, and propellant catalysts at high-temperature, high-pressure and cryogenic environments.			
(U)				
(U)	MAJOR THRUST: Develop nanostructured materials technology for insertion into structures, propulsion, and subsystems applications such as rocket engine components and cryogenic components and structures to enable lighter weights, better performance, and lower costs.	0.000	0.200	1.289
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Investigate nanoparticle and nanostructured fabrication, characterization, processing techniques, and models for the efficient, low-cost assembly of nanomaterials.			
(U)	In FY 2005: Develop nanoparticle and nanostructured fabrication, characterization, processing techniques, and models for the efficient, low-cost assembly of nanomaterials.			
(U)				
(U)	MAJOR THRUST: Develop affordable, advanced structural and non-structural materials and technologies for Air Force space applications.	5.383	5.756	6.890
(U)	In FY 2003: Optimized processing methods for the metallic materials which are expected to be used for lightweight, high-strength components in future space vehicles. Tested non-autoclave composite materials and processes for composite cryogenic tank structures for future Air Force space platforms. Developed optically tailorable thermal control coatings with controlled heat dissipation for spacecraft thermal control. Established baseline effects of the space environment on polymer and thermal control coatings.			
(U)	In FY 2004: Mature processing methods for the metallic materials that are expected to be used for lightweight, high-strength components in future space vehicles. Develop and fabricate high-temperature metallic gamma-titanium-aluminide technologies for reusable access to space vehicles. Develop advanced and reproducible joining processes for large metallic cryotanks. Develop analytical understanding of the behavior of composites in liquid oxygen environments and in a simulated space environment facility. Develop novel high-temperature protection system concepts for high-Mach, reentry, and access to space vehicles. Integrate carbon foam materials into space thermal management applications. Integrate foams into heat-pipe efficient radiator applications. Evaluate high-temperature organic matrix composites for tanks and structures for space access and launch vehicle applications. Fabricate laboratory-level demonstrations of optically tailorable active thermal control coatings with controlled heat dissipation for spacecraft thermal control and three-fold increase in service life. Develop baseline effects of the space environment on thermal control coatings, space lubricants, and other organic/inorganic space materials. Identify			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5025 Space Materials Development**

	configurations suitable for use of non-oxide ceramic composites for standoff high temperature protection systems. Develop test procedures to validate candidate space materials. Develop repair processes for non-metallic space materials.			
(U)	In FY 2005: Establish performance of high-temperature metallic high-temperature protection systems using gamma-titanium-aluminide as an external skin for reusable access to space vehicles. Assess aluminum-lithium metallic cryotank materials for multiple mission access to space. Expand experimental data and analytical results of liquid oxygen compatibility research. Continue to derive a more representative test series for composite materials. Develop subscale novel high-temperature protection systems in conditions that simulate representative reentry and high-Mach vehicles flight profiles. Mature all-composite heat-pipe radiators for Air Force space systems. Explore oxidation-protected carbon-carbon materials. Establish capability of optically tailorable active thermal control coatings with controlled heat dissipation to provide three-fold increase in service life for spacecraft thermal control. Continue developing and evaluating baseline effects of the space environment on thermal control coatings, space lubricants, and other organic/inorganic space materials. Develop non-oxide ceramic composites for standoff high temperature protection systems. Evaluate rapid inspection techniques for both advanced ceramic tile and standoff high-temperature protection system materials. Assess techniques to validate candidate space materials performance. Establish suitability of repair processes for non-metallic space materials.			
(U)				
(U)	MAJOR THRUST: Develop materials and materials processing technologies to enable improved performance and affordability of surveillance, tracking, targeting, and situational awareness systems.	1.365	3.081	2.144
(U)	In FY 2003: Refined improved thin film processing techniques to optimize efficiency in solar cells. Validated and transitioned materials processing techniques and materials that will enable high performance optical control of phased array radar and satellite-to-satellite data links. Demonstrated alternative infrared detector materials for space applications capable of detecting very long wavelengths.			
(U)	In FY 2004: Identify higher performance materials, including optical nanocomposites and exotic ferroelectronics, for advanced optical architecture in phased array radar and satellite-to-satellite data links. Scale-up very long wavelength, alternative infrared detector materials to areas suitable for the fabrication of staring focal plane arrays.			
(U)	In FY 2005: Evaluate higher performance materials, including optical nanocomposites and exotic ferroelectronics, for advanced optical architecture in phased array radar and satellite-to-satellite data links. Establish the detection performance of very long wavelength alternative materials operating at 40ºK.			
(U)	Total Cost	17.625	19.447	21.499

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5025 Space Materials Development**

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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5026 Rocket Propulsion Component Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5026 Rocket Propulsion Component Tech	22.410	51.909	40.961	42.123	44.413	45.360	46.357	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602203F, Project 4847, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2004, civilian salaries transferred from PE 0602203F, Project 4847, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops advances in rocket propulsion technologies for space access, space maneuver, and ballistic missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, Technology for Sustainment of Strategic Systems (TSSS) Phase 1, and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of future space and missile launch subsystems. Technologies are developed to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, and reduced-toxicity monopropellants to increase space launch payload capability and refine new propellants synthesis methods. Develop and test monopropellants with performance equivalent to bipropellants.	1.919	2.670	3.363
(U) In FY 2003: Scaled-up initial selected propellants for laboratory and demonstrator engine evaluations. Developed high-energy-density oxidizers, nano-materials, and polymeric binders and optimizing paths for incorporating these materials into propellants with significantly enhanced performance. Evaluated reduced-toxicity ionic salt monopropellants towards reducing the cost of space access and space operations. Evaluated selected propellants in advanced combustion devices to determine materials compatibility and performance. Modeled and analyzed advanced propulsion concepts such as laser-propelled lightcraft with enhanced performance and reliability.			
(U) In FY 2004: Continue scale-up of selected propellants for laboratory and demonstrator engine evaluations. Continue developing high-energy-density oxidizers, nano-materials, and polymeric binders and optimizing paths for incorporating these materials into propellants with significantly enhanced performance. Expand evaluating reduced-toxicity ionic salt monopropellants towards reducing the cost of space access, space operations, and other Air Force applications. Begin development of advanced catalysts for new monopropellant formulations. Begin scale-up of promising high energy-density materials candidates. Continue to evaluate selected propellants in advanced combustion devices to determine materials compatibility and performance. Continue to model and explore advanced propulsion concepts with enhanced performance and reliability such as laser-propelled lightcraft and rocket-based			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5026 Rocket Propulsion Component Tech**

combined cycle engines. Formulated propellant ingredients for IHPRPT-Phase III solid propellant developments and begin transition to propellant formulation.

(U) In FY 2005: Continue scale-up of selected propellants for laboratory and demonstrator engine evaluations. Continue developing high-energy-density oxidizers, nano-materials, and polymeric binders (i.e., linked heterocyclic compounds) and optimize paths for incorporating these materials into propellants with significantly enhanced performance. Continue evaluating reduced-toxicity ionic salt monopropellants towards reducing the cost of space access and space operations. Continue development of advanced catalysts for new monopropellant formulations. Continue scaling-up of promising high energy-density materials candidates. Continue to evaluate selected propellants in advanced combustion devices to determine materials compatibility and performance. Continue to model and analyze advanced propulsion concepts with enhanced performance and reliability such as laser-propelled lightcraft and rocket-based combined cycle engines. Continue maturing solid propellants ingredients into solid propellant formulations.

(U)

(U) MAJOR THRUST: Develop advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles.	0.938	4.445	7.512

(U) In FY 2003: Characterized, studied, and evaluated specific injector performance to ensure chamber/injector compatibility and prevent damage to test and operational combustion devices. Developed, analyzed, and modeled advanced combustion devices and injectors compatible with new energetic propellants. Modeled and analyzed advanced propulsion concepts, such as rocket-based combined cycle engines and pulsed detonation engines, with enhanced performance and reliability.

(U) In FY 2004: Continue to characterize, study, and evaluate injector performance to ensure chamber/injector compatibility and prevent damage to test and operational combustion devices. Continue to develop, analyze, and model advanced combustion devices and injectors compatible with new energetic propellants. Begin analyzing and testing to characterize causes and issues that lead to combustion instability in hydrocarbon fueled liquid rocket engines reducing the need for conducting large numbers of costly full-scale component and engine tests. Develop and begin transitioning advanced hydrocarbon fuels for scale-up and testing. Continue modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as common aerovehicles and potential launch systems.

(U) In FY 2005: Continue to characterize, study, and evaluate injector performance to ensure chamber/injector compatibility and prevent damage to test and operational combustion devices. Continue to develop, analyze, and model advanced combustion devices and injectors compatible with new energetic propellants. Continue analysis and testing to characterize causes and issues that lead to combustion instability in hydrocarbon fueled liquid rocket engines reducing the need for conducting large numbers of costly full-scale component and engine tests. Continue working on transition issues, testing, scale-up of advanced hydrocarbon fuels. Continue modeling and analyzing

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5026 Rocket Propulsion Component Tech**

	advanced propulsion concepts with enhanced performance and reliability such as common aerovehicles and potential launch systems.			
(U)				
(U)	MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in rocket propulsion systems.	2.579	3.014	3.884
(U)	In FY 2003: Developed advanced ablative components with hybrid polymers for use in current and future launch systems. Characterized and developed new high temperature polymer components and carbon-carbon components for use in advanced combustion devices and propulsion systems to meet lower weight, increased strength, and lower cost requirements. Developed advanced motor casings and propellant system components for high-energy propellants.			
(U)	In FY 2004: Continue additional developing advanced ablative components with hybrid polymers for use in current and future launch systems. Continue to characterize and develop new processes for high temperature polymers and carbon-carbon materials for use in advanced combustion devices and propulsion systems to meet lower weight and increased strength requirements. Continue developing advanced material components for use with high-energy propellants. Commence transition of advanced high temperature material components to reduce system weight and cost, and increase performance. Initiate exploration of the use of nanocomposites for liquid rocket engine tanks.			
(U)	In FY 2005: Continue developing advanced ablative components using hybrid polymers for use in current and future launch systems. Continue to characterize and develop new high temperature polymers and carbon-carbon materials for use in advanced combustion devices and propulsion systems to meet lower weight and increased strength requirements. Continue developing advanced materials for use with high-energy propellants. Complete transition of specific advanced high temperature materials to air and space systems to reduce system weight and cost, and increase performance. Continue to explore using nanocomposites for liquid rocket engine tanks.			
(U)				
(U)	MAJOR THRUST: Develop propulsion component technologies for reliable, safe, and low-cost boost systems. Note: In FY 2005, these activities will be moved to the "advanced liquid engine technologies" effort in this Project.	5.079	1.386	0.000
(U)	In FY 2003: Completed development and began testing single stage hydrogen turbopump for advanced cryogenic engines. Developed components for hybrid propulsion technologies for space boosters and air-launched missiles. Tested preliminary injector for hydrocarbon or cryogenic fuel applications.			
(U)	In FY 2004: Complete testing of single stage hydrogen turbopump for advanced cryogenic engines. Complete development of components for hybrid propulsion technologies for space boosters and air launched missiles. Continue hydrocarbon fuel characterization test rig development and evaluation of potential hydrocarbon fuels.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop lightweight combustion devices and nozzle technologies for liquid rocket engines. Note: In FY 2004, the funding in this activity increased due to salary funds being transferred from PE 0602203F,	3.091	23.476	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5026 Rocket Propulsion Component Tech**

	Project 4847 and the reprioritization of efforts. In FY 2005, these activities will be moved to the "advanced liquid engine technologies" effort in this Project.			
(U)	In FY 2003: Developed advanced lightweight rocket engine nozzle for upper stage and space booster applications. Completed preliminary study for high-pressure turbopumps for use in advanced upper stage engines.			
(U)	In FY 2004: Continue development of an advanced lightweight altitude-compensating nozzle. Continue design studies for advanced liquid oxygen and liquid hydrogen turbopumps for the next phase of advanced upper stage engines.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop advanced liquid engine technologies for improved performance while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles. Note: Prior to FY 2005, these activities were conducted under other efforts earlier in this Project.	0.000	0.000	21.031
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue development of advanced cryogenic upper stage technologies - turbopumps, thrust chambers, and modeling tools. Continue hydrocarbon fuel characterization test rig development and evaluation of potential hydrocarbon fuels. Complete development of lightweight nozzle for liquid rocket engines. Initiate technology developments for future reusable hydrocarbon based engines.			
(U)				
(U)	MAJOR THRUST: Develop missile propulsion, aging, and surveillance technology for solid rocket systems for Intercontinental Ballistic Missile (ICBM) to include testing of missile propulsion technology and Post Boost Control Systems (PBCS). Efforts support Technology for Sustainment of Strategic Systems program - Phase I. Note: After FY 2004, the efforts in this activity will be moved to the Advanced Technology Development efforts in PE 0603500F, Project 5033.	2.383	0.500	0.000
(U)	In FY 2003: Integrated aging models results and testing a database for aging and surveillance technology for ICBM fleet. Completed tools to increase the capability to determine the service life of strategic systems and other solid rocket motors. Prepared components for demonstrations of advanced lightweight solid rocket motors. Commenced development of components for demonstrations of advanced full-scale, flight-like PBCS.			
(U)	In FY 2004: Continue development and fabrication of components for demonstrations of advanced full-scale, flight like PBCS.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites, microsatellites, and satellite	2.463	4.817	5.171

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5026 Rocket Propulsion Component Tech**

	constellations. Phases are referring to the Integrated High Payoff Rocket Propulsion Technology program phases.			
(U)	In FY 2003: Advanced small-scale Hall thruster development efforts to achieve Air Force orbit transfers using electric propulsion. Enhanced development of microsatellites propulsion systems (e.g., plasma thrusters) for advanced imaging missions. Developed solar thrusters and concentrators for future orbital transfer vehicles. Tested a controlled solid propellant. Completed development of high power solar thermal components.			
(U)	In FY 2004: Commence development of monopropellant thruster component technologies for chemical-based space propulsion - catalyst. Continue Hall thruster development efforts (Phase III) to achieve Air Force orbit transfers using electric propulsion. Continue development of microsatellites propulsion systems (e.g., plasma thrusters) for advanced imaging missions. Continue developing solar thrusters and concentrators for future orbital transfer vehicles. Continue testing of a controlled solid propellant.			
(U)	In FY 2005: Continue development of monopropellant thruster component technologies for chemical based space propulsion - catalyst and thrust chamber. Continue Hall thruster development efforts (Phase III) to achieve Air Force orbit transfers using electric propulsion. Continue this phase of development of microsatellites propulsion systems (e.g., plasma thrusters) for advanced imaging missions. Continue developing solar thrusters and concentrators for future orbital transfer vehicles. Continue testing of a controlled solid propellant.			
(U)				
(U)	CONGRESSIONAL ADD: Engineering Tool Improvement Program (ETIP).	1.979	0.000	0.000
(U)	In FY 2003: Assessed and verified tool performance for additional data requirements for the modeling and simulation tool against available data. Made recommendations for future modeling and data acquisition. These efforts will contribute to the ongoing development of modeling and simulation tools to analyze and predict the performance of aerospace engines and their components. Improved analytical tools associated with aerospace engines with the main focus on high performance, long life, advanced cooling techniques, and combustion stability.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Integrated High Payoff Rocket Propulsion Technology.	1.979	0.000	0.000
(U)	In FY 2003: Developed propellant formulations for space lift applications. Conducted additional risk reduction for liquid boost engine development.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Launch Vehicles Engine Project.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct studies and develop hardware for proof of concept for a low cost launch vehicle engine with			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5026 Rocket Propulsion Component Tech**

	400,000 pound of thrust using liquid oxygen and hydrogen as propellants. It will fill a gap in the assured access to space a potential alternative upper stage engine and as the main engine for a low-cost consumables booster that was defined in a Space Systems Loral study in FY 2002 under the California State Space Grant program.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Jet and Rocket Engine Test Site. Note: Efforts expand upon activities initiated in a FY 2003 Congressional Add in PE 0602203F, Project 4847.	0.000	10.609	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue further upgrades to the rocket engine test stands at the former Norton Air Force Base in San Bernardino. Expand testing to include thermal and vibrational test capability for satellite systems.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	22.410	51.909	40.961

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602114N, Power Projection Applied Research.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602303A, Missile Technology.									
(U)	PE 0602805F, Dual Use Science and Technology.									
(U)	PE 0603216F, Aerospace Propulsion and Power Technology.									
(U)	PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.									
(U)	This project has been									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5026 Rocket Propulsion Component Tech**

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

coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5027 High Speed Airbreathing Prop Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5027 High Speed Airbreathing Prop Tech	4.014	4.549	0.180	0.250	0.255	0.260	0.264	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602203F, Project 3012, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops revolutionary, airbreathing, hypersonic propulsion technology options to enable affordable, on demand access to space for the Air Force. The short-term focus is on hydrocarbon fueled engines capable of operating over a broad range of flight Mach numbers and longer term focus will be on hydrogen fueled scramjet powered engines that can enable the higher Mach numbers to achieve access to space. Technologies developed under this program enable capabilities of interest to both the Department of Defense and the National Aeronautical and Space Administration. Efforts include modeling and simulation, proof of concept tests of critical components, advanced component development, and ground-based tests.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Conduct studies and develop hypersonic flight demonstrator vehicle concepts. Note: In FY 2004, these activities were moved to PE 0602203F, Project 3012 to consolidate all 6.2 scramjet demonstration efforts.			
(U) In FY 2003: Developed preliminary flight demonstrator vehicle concepts. Conducted vehicle design trades for integration of hydrocarbon fueled scramjet engine.	0.223	0.000	0.000
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Conduct assessments, system design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies in support of the development of affordable, on-demand access to space vehicles to meet future warfighter needs.	0.288	0.568	0.180
(U) In FY 2003: Conducted assessment of advanced airbreathing engines and CCEs to establish and extend operability limits enabling development of low internal drag scramjet flowpath for reusable applications.			
(U) In FY 2004: Continue to conduct system trade studies to determine military payoff and establish component technology goals. Define component and engine performance objectives to enable development of affordable hypersonic CCEs.			
(U) In FY 2005: Conduct system trade studies to determine military payoff and establish component technology goals. Continue to define component and engine performance objectives to enable development of affordable hypersonic CCEs.			
(U)			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5027 High Speed Airbreathing Prop Tech**

(U)	MAJOR THRUST: Develop advanced hydrocarbon scramjet engine technologies to enable the broad application of hypersonics to meet future warfighter needs and to support flight demonstration. Note: In FY 2004, these activities were split with non-access to space activities moving to PE 0602203F, Project 3012 and access to space activities moving to the "robust hydrocarbon fueled scramjet" effort in this Project.	0.946	0.000	0.000
(U)	In FY 2003: Conducted initial feasibility assessment of variable geometry devices to increase scramjet operating range (Mach 3 to Mach 8+) to provide robust options for combined cycle engines.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies and integrate them into advanced combined cycle engine (CCE) designs for affordable, on-demand access to space vehicles. Note: In FY 2005, these activities will be moved to PE 0602203F, Project 3012 to consolidate all 6.2 scramjet development efforts.	2.557	3.981	0.000
(U)	In FY 2003: Developed initial critical components for advanced airbreathing engines and CCEs for robust performance over extended Mach range to include efforts to improve scramjet engine operability and scalability. Initiated development of high performance/low internal drag devices.			
(U)	In FY 2004: Complete initial feasibility assessments of variable geometry devices to increase scramjet operating range (Mach 3 to Mach 8+) to provide robust options for CCEs. Continue development of advanced engine components to improve operability, scalability, and structural durability for reusable applications. Continue developing and demonstrating low internal drag flame stabilization devices. Demonstrate advanced ignition systems for scramjets. Conduct assessment of current structural concepts and identify life-limiting factors and initiate development of multi-use components. Initiate the support for development of flight test engine components			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	4.014	4.549	0.180

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602203F, Aerospace									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5027 High Speed Airbreathing Prop Tech**

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

Propulsion.

(U) PE 0602602F, Conventional Munitions.

(U) PE 0602702E, Tactical Technology.

(U) PE 0603111F, Aerospace Structures.

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

(U) PE 0603601F, Conventional Weapons Technology.

(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5028 Space Sensors, Photonics & RF Proc**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5028 Space Sensors, Photonics & RF Proc	42.182	1.676	1.856	1.953	4.210	4.265	4.322	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602204F, Project 2002, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project focuses on developing methods of generating, controlling, receiving, transmitting, and processing photonic, optical, and opto-electronic (mixed) signals for radio frequency (RF) space sensor applications. The enabling technologies will be used for intelligence, surveillance, reconnaissance, electronic warfare, and precision engagement sensors based in space. The project aims to demonstrate significantly improved military space sensors of smaller size, lower weight, lower cost, lower power dissipation, higher reliability, and improved performance. This project also develops and assesses multi-dimensional adaptive techniques in radar technology for affordable and reliable space surveillance and reconnaissance systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Design and develop high performance integrated photonic technologies for use in space.	0.351	0.574	0.250
(U) In FY 2003: Designed and developed high performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband RF phased array antenna beamforming/control, and for high data rate space sensors and communication systems.			
(U) In FY 2004: Fabricate and evaluate high performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband radio frequency phased array antenna beamforming and control, and for high data rate space sensors and communication systems			
(U) In FY 2005: Test and evaluate high performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband radio frequency phased array antenna beamforming/control, and for high data rate space sensors and communication systems.			
(U)			
(U) MAJOR THRUST: Design and develop efficient, high coefficient chip-scale optical waveguide technologies.	0.191	0.242	0.335
(U) In FY 2003: Designed and developed efficient, high coefficient chip-scale optical waveguide technology for mixed signal component subsystems.			
(U) In FY 2004: Fabricate, test, and evaluate efficient, high coefficient chip-scale optical waveguide technology for mixed signal component subsystems.			
(U) In FY 2005: Test and evaluate efficient, high coefficient chip-scale optical waveguide technology for mixed signal component subsystems.			
(U)			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5028 Space Sensors, Photonics & RF Proc**

(U)	MAJOR THRUST: Perform independent modeling, test, and evaluation for space-based sensors.	0.333	0.242	0.183
(U)	In FY 2003: Performed independent modeling, test, and evaluation for space-qualified photonic components and integrated electro-optical devices for space-based sensors.			
(U)	In FY 2004: Apply the results of modeling, test, and evaluation for space-qualified photonic components and integrated electro-optical devices for space-based sensors to component architectures for high data rate space sensors and communication systems.			
(U)	In FY 2005: Design and develop photonic digital and analog mixed signal multi-gigahertz component architectures for high data rate space sensors and communication systems.			
(U)				
(U)	MAJOR THRUST: Study adaptive processing techniques for large, multi-mission, space-based conformal arrays.	0.096	0.618	1.088
(U)	In FY 2003: Studied adaptive processing techniques for large, multi-mission, space-based conformal arrays.			
(U)	In FY 2004: Continue to study and analyze adaptive processing techniques for large, multi-mission, space-based, adaptive conformal arrays.			
(U)	In FY 2005: Develop adaptive processing techniques suitable for implementation on space-qualified computing architectures for multi-intelligence ISR sensing from space-based platforms.			
(U)				
(U)	CONGRESSIONAL ADD: Defense Emergency Response Fund (DERF) Ground Moving Target Indication and Airborne Moving Target Indication Research	41.211	0.000	0.000
(U)	In FY 2003: Developed a system brassboard of the Active Electronic Scanned Antenna and On-Board Processor (AESA/OBP) to demonstrate the technology readiness of the most critical element of an affordable Space-Based Radar. Developed the processing architecture, adaptive signal processing algorithms, and fault tolerant, radiation resistant processing for OBP in a space environment. Developed Battle-Management Command, Control and Communications techniques for multiple satellite tasking, target tracking, and moving target exploitation. Refined and validated Space-Based Radar and Moving Target Exploitation simulation capabilities to serve as a development tool for both short term acquisition and longer term capability enhancement. Developed and validated both Ground Moving Target Indication and Airborne Moving Target Indication processing algorithms for environments with clutter and interference.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	42.182	1.676	1.856

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5028 Space Sensors, Photonics & RF Proc**

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5029 Space Sensor & CM Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5029 Space Sensor & CM Tech	6.665	10.599	5.213	1.526	5.089	7.145	6.126	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602204F, Projects 2002, 6095, and 7622, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2004, increases are due to the transfer of civilian salaries related to space unique activities into this project.

(U) A. Mission Description and Budget Item Justification

This project focuses on developing processes and techniques for electronic and electromagnetic signal processing for intelligence, surveillance, and reconnaissance (ISR) space sensor applications. This project develops the baseline technologies required to manage and perform on-board space sensor information fusion for timely and comprehensive communications and situational awareness. Through modeling and simulation, this project develops and evaluates innovative electromagnetic and electronic countermeasures for space applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System (GPS), radar, electronic warfare, and other Intelligence, Surveillance, and Reconnaissance (ISR) space sensors.	1.709	2.316	0.000
(U) In FY 2003: Fabricated critical components consisting of gallium arsenide, indium phosphide, silicon, and/or wide bandgap devices for use in multi-mode/multi-function digital receiver prototype modules, and demonstrated a feasible architecture for performing wideband direct digital synthesis from space platforms.			
(U) In FY 2004: Fabricate and test compact, affordable, multi-function receiver/exciter and phased array components for communications, GPS, radar, electronic warfare, and other ISR space sensors. Evaluate integrating these components into operational radar and electronic warfare digital receiver/exciter modules. Demonstrate a feasible architecture for performing wideband direct digital synthesis from aerospace platforms. Perform a component evaluation of an electronic/photonic digital receiver for Moving Target Indication and Synthetic Aperture Radar applications.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop and integrate microwave technologies for advanced radio frequency (RF) apertures and phased array antennas used in military ISR space sensors.	0.087	1.206	1.715
(U) In FY 2003: Developed robust components for L-band and X-band transmitter and receiver (T/R) channels that operate with limited environmental controls and under severe electromagnetic signals.			
(U) In FY 2004: Develop the proof of concept of T/R channels that are able to withstand radiation, limited or no active cooling, and strong, undesired electromagnetic radiation.			
(U) In FY 2005: Develop T/R channels that are able to withstand radiation, limited or no active cooling, and strong,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5029 Space Sensor & CM Tech**

	undesired electromagnetic radiation.			
(U)				
(U)	MAJOR THRUST: Develop X-band sub-assemblies based on flexible radio frequency (RF) membranes.	0.514	0.540	0.507
(U)	In FY 2003: Developed X-band sub-assemblies based on flexible RF membranes that enable low-cost and low mass band transmitter and receiver channels integrated at the subarray level for space applications.			
(U)	In FY 2004: Develop a large area (>0.5 m2) active aperture based on flexible RF membranes that lowers the assembly costs and mass over conventional phased arrays by an order of magnitude.			
(U)	In FY 2005: Develop and investigate approaches and techniques to produce large area (>40 m2) active spaceborne aperture using advanced highly integrated and lightweight radio frequency subassemblies. Demonstrate ten-fold reduction in assembly cost and aperture mass.			
(U)				
(U)	MAJOR THRUST: Develop space-qualified micro-electro-mechanical systems phase shifters.	0.101	0.000	0.000
(U)	In FY 2003: Characterized and matured space-qualified micro-electro-mechanical systems phase shifters for extended switch lifetimes and able to operate over a ten-to-one bandwidth.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop two- and three-dimensional interconnects for space applications.	0.514	0.433	0.456
(U)	In FY 2003: Refined materials and processes for two-dimensional and three-dimensional interconnects for space applications.			
(U)	In FY 2004: Develop mixed signal receiver/processor multi-functionality on flexible RF membranes using advanced two-dimensional and three-dimensional interconnects.			
(U)	In FY 2005: Perform environmental testing of the multi-functional flex assemblies two-dimensional and three-dimensional interconnect approaches to determine their applicability for operation in a hostile environment.			
(U)				
(U)	MAJOR THRUST: Develop techniques to accurately predict scattering phenomenology associated with electromagnetic radiation.	0.620	0.559	0.557
(U)	In FY 2003: Refined the accuracy of predictions of the scattering phenomenology associated with electromagnetic radiation returned from objects or backgrounds when viewed from space.			
(U)	In FY 2004: Further refine the accuracy of exploitation of the scattering phenomenology associated with electromagnetic radiation returned from objects or backgrounds when viewed from space.			
(U)	In FY 2005: Complete refinement of the accuracy of exploitation of the scattering phenomenology associated with electromagnetic radiation returned from objects or backgrounds when viewed from space. Evaluate performance and enhancements to target recognition using these techniques.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5029 Space Sensor & CM Tech**

(U)				
(U)	MAJOR THRUST: Develop space-qualified precision time, position, and velocity sensors capable of operating in jamming environments enabling multiple platform sensor-to-shooter operations.	1.530	3.203	1.638
(U)	In FY 2003: Developed Global Positioning System (GPS) specific jamming mitigation techniques for operation in hostile radio frequency (RF) environments with emphasis on synergistic integration of anti-jam technologies. Developed virtual flight test technology for improved assessment of reference sensors for space applications.			
(U)	In FY 2004: Design robust precision time, position, and velocity sensor technologies for multi-platform sensor-to-shooter network-centric engagement. Develop synergistic global positioning system jamming mitigation techniques for operation in hostile RF environments.			
(U)	In FY 2005: Develop robust precision time, position, and velocity sensor technologies for multi-platform network centric engagement. Evaluate synergistic GPS jamming mitigation techniques for operation in hostile RF environments			
(U)				
(U)	MAJOR THRUST: Develop technology to enable affordable upgrades to space-qualified radio frequency signal receivers.	1.590	0.342	0.340
(U)	In FY 2003: Modeled threat identification algorithms for next generation threat warning receivers. Evaluated state-of-the-art radar and electronic warfare (EW) digital receiver subsystems with Gallium Arsenide and Indium Phosphide radio frequency components (Analog-to-Digital Convertors, filters, mixers, etc.) for laboratory environment scenario testing.			
(U)	In FY 2004: Continue modeling threat identification algorithms for next generation threat warning receivers. Continue evaluating state-of-the-art digital and software receiver techniques for radar, electronic warfare, and narrowband space applications.			
(U)	In FY 2005: Model threat identification algorithms for next generation threat warning receivers. Evaluate state-of-the-art digital and software receiver techniques for radar, electronic warfare, and narrowband space applications.			
(U)				
(U)	MAJOR THRUST: Develop technology for an affordable Space-Based Radar.	0.000	2.000	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Further develop a system brassboard of the Active Electronic Scanned Antenna and On-Board Processor to demonstrate the technical readiness of the most critical element of an affordable Space-Based Radar. Note: In FY 2003 this work was started in Project 5028 under this program element.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	6.665	10.599	5.213

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5029 Space Sensor & CM Tech**

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5030 Applied Space Access Vehicle Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5030 Applied Space Access Vehicle Tech	1.232	0.000	0.000	0.000	3.907	8.246	7.321	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0602201F, Project 2403, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2004, efforts in this project were delayed until FY 2007 due to higher Air Force priorities.

(U) A. Mission Description and Budget Item Justification

This project develops technologies in areas of advanced structures, flight controls, and aerodynamics to enable affordable on-demand military access to space. Resulting technologies contribute significantly towards the development of reliable, responsive space access systems with aircraft-like operations. Payoffs to the warfighter include enhanced mission effectiveness, improved flight safety, improved maintenance, and decreased size, weight, and cost.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop advanced structure, flight control, and aerodynamic technologies to enable horizontal launch for affordable on-demand military access to space.	1.232	0.000	0.000
(U) In FY 2003: Developed advanced structure, flight control, and aerodynamic technologies to enable aircraft-like operations for affordable on-demand military access to space. Defined and developed integrated guidance and control laws to expand the launch vehicle performance envelope. Developed capability to simulate space access operability in a virtual environment.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U) Total Cost	1.232	0.000	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Funding:									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0602204F, Aerospace Sensors.									
(U) PE 0603211F, Aerospace									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5030 Applied Space Access Vehicle Tech**

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

Technology Dev/Demo.

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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5081 Space Antennas Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5081 Space Antennas Tech	0.000	1.056	1.406	1.509	1.617	5.233	5.237	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2004, space antenna efforts in PE 0602204F, Project 4916 transfer to this project.

(U) A. Mission Description and Budget Item Justification

This project develops the technology base for lightweight satellite antenna technology and affordable antenna terminal technology for communications and surveillance. Enabling antenna technologies developed under this project for satellite terminals and satellite tracking will focus on significantly lowering the life cycle cost of sensors and communications system ownership, while increasing performance. Novel antenna architectures based on emerging technologies such as Micro-Electro-Mechanical Systems, nanostructures, metamaterials, rigidizable systems, and adaptive polymers will be developed. The project will include new approaches to multi-layer microstrip and stripline feed networks for limited scan, and planar and conformal architectures using overlapped subarrays. Digital Beamforming (DBF) on transmit and receive will be implemented in order to achieve simultaneous multiple-beams, conformal array beamforming, array pattern synthesis, and neural beamforming.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop lightweight antenna technologies concepts that enable affordable deployment of space sensors for low life cycle cost communications, detection of air and ground moving targets, and remote sensing.	0.000	0.336	0.451
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Develop lightweight antenna technologies concepts that enable affordable deployment of space sensors for low life cycle cost communications, detection of air and ground moving targets, and remote sensing.			
(U) In FY 2005: Evaluate lightweight antenna technologies concepts that enable affordable deployment of space sensors for low life cycle cost communications, detection of air and ground moving targets, and remote sensing.			
(U)			
(U) MAJOR THRUST: Develop new lightweight radiators, transmission mechanisms, and control components and concepts for advanced wideband phased array antenna architectures.	0.000	0.316	0.429
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Develop new lightweight radiators, transmission mechanisms, and control components and concepts for advanced wideband phased array antenna architectures.			
(U) In FY 2005: Evaluate new lightweight radiators, transmission mechanisms, and control components and concepts for advanced wideband phased array antenna architectures.			
(U)			
(U) MAJOR THRUST: Develop concepts for Digital Beamforming on both transmit and receive cycles in order to implement simultaneous multiple-beams, conformal array beamforming, array pattern synthesis, and neural beamforming.	0.000	0.404	0.526

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5081 Space Antennas Tech**

(U) In FY 2003: Not Applicable.
(U) In FY 2004: Develop concepts for Digital Beamforming (DBF) on both transmit and receive cycles in order to implement simultaneous multiple-beams, conformal array beamforming, array pattern synthesis, and neural beamforming.
(U) In FY 2005: Evaluate Digital Beamforming on both transmit and receive cycles in order to implement simultaneous multiple-beams, conformal array beamforming, array pattern synthesis, and neural beamforming.

(U) Total Cost	0.000	1.056	1.406

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0603203F, Advanced Aerospace Sensors.									
(U)	PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602500F MULTI-DISCIPLINARY SPACE TECH**	**5082 Optical Networking Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5082 Optical Networking Tech	0.000	6.065	4.920	4.889	4.878	4.865	4.853	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2004, in Project 5082, the Air Force increased emphasis on developing optical networks for space-based applications.

(U) **A. Mission Description and Budget Item Justification**

This project develops the technology base for the next generation of ultra-wide- bandwidth, multi-channeled, space-based communications networks on and between platforms. As the application of laser-based, point-to-point communications between satellites emerges, space-based optical networks, whose communications capacities are thousands of times greater than current communications satellites, become a realistic possibility. A major thrust of this project is to assess and adapt the emerging communication and information technologies, being developed for next-generation Internet, for applications in space. This project will explore technologies for implementing photonic chip scale optical Code Division Multiple Access (CDMA) and Wavelength Division Multiplexed (WDM) transceivers and prototype networks, built to demonstrate the benefits associated with the advanced fiber optic, wireless, and satellite networks that can be built from them. This technology has potential applications in specific military systems including reliable, high bandwidth, jam-resistant communications at the theater level, and multiplexing of multiple DoD users onto a common networking infrastructure for reduced manning and logistics.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and assess optical network technologies for application in the space environment.	0.000	1.989	1.932
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Assess, explore, and adapt the emerging communication and information technologies being developed for next-generation Internet, for applications in space.			
(U) In FY 2005: Complete assessment of next generation Internet arrayed-waveguide grating technologies for application in the space environment. Initiate design and development of a multi-path interconnection network that provides for redundancy, fault tolerance, self-routing and non-blocking switching required for space-based networks. Develop heterogeneous, seamless, secure, self-configuring high capacity network technologies and study their applicability to integrated Air, Space, Ground Networks Supporting Network Centric Operations. Develop variable data rate, networked data link radio frequency/optical hardware and their associated ground stations. Develop transmission technology and control concepts to support optically networked communications.			
(U)			
(U) MAJOR THRUST: Develop and assess existing and emerging Optical Code Division Multiple Access and Wavelength Division Multiplexed modulation schemes and protocols for use in space-based optical networks.	0.000	2.061	2.002
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: In conjunction with industry and academia, develop or adapt appropriate standards to ensure the evolution of open systems architecture for space-based optical networks.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5082 Optical Networking Tech**

		FY 2003	FY 2004	FY 2005
(U)	In FY 2005: Develop or adapt, along with industry and academia, appropriate standards to ensure the evolution of open systems architecture for space-based optical networks. Investigate emerging terrestrial optical burst switching and optical label switching protocols for applicability to space-based optical networks.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Establish and maintain a capability to characterize, evaluate, and optimize network components and technologies for space applications. Note: In FY 2004, Congress added $1.0 million for Photonics Technology.	0.000	2.015	0.986
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop photonic chip scale optically implemented Code Division Multiple Access (CDMA) and Wavelength Division Multiplexed (WMD) transceivers and laboratory network into a capability to characterize, evaluate, and optimize optical network components and technologies for space applications.			
(U)	In FY 2005: Develop and evaluate performance of passive and active optical/electronic chip-scale networking components (transmitters, receivers, switches) for CDMA and WMD on board networks operating at gigabits per second.			
(U)	Total Cost	0.000	6.065	4.920

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602702F, Command, Control, and Communications.									
(U)	PE 0603789F, C3I Advanced Development.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602601F Space Technology 1

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	74.889	101.539	88.909	89.644	97.609	118.971	126.742	0.000	0.000
1010	Space Survivability & Surveillance	30.276	43.080	40.002	39.466	42.160	40.843	41.510	0.000	0.000
4846	Spacecraft Payload Technologies	12.431	16.937	19.553	20.608	20.735	35.740	39.529	0.000	0.000
5018	Spacecraft Protection Technology	4.355	4.011	2.630	2.442	2.303	2.434	2.516	0.000	0.000
8809	Spacecraft Vehicle Technologies	27.827	37.511	26.724	27.128	32.411	39.954	43.187	0.000	0.000

Note: In FY 2003, Project 1010 was split, with efforts focused on protecting spacecraft from manmade threats being transferred into Project 5018.

(U) A. Mission Description and Budget Item Justification

This PE focuses on four major areas. First, space environmental protection develops technologies to understand, mitigate, and exploit effects of weather and geophysics environments on the design and operation of Air Force systems. Second, spacecraft payload technologies improve satellite payload operations by investigating advanced component and subsystem capabilities. Third, spacecraft protection develops technologies for protecting U.S. space assets in potential hostile settings. The last major area, spacecraft vehicles focuses on spacecraft platform, payload, and control technologies, and their interactions. Note: In FY 2004, Congress added $5.0 million for High-frequency Active Auroral Research Program (HAARP) Space Technology, $2.1 million for Electromagnetic Gradiometer Research, $1.8 million for Mixed Signal Very Large Scale Integrated (Circuits) for Space Vehicle Communications Subsystems, $3.0 million for Technology Satellite of the 21st Century, $1.2 million for Substrates for Solar Cells, $1.0 million for Integrated Control for Autonomous Space Systems, $1.5 million for Elastic Memory Composites, $1.8 million for Elastic Memory Composite Materials, $1.5 million for Converted Silicon Carbide for High Performance Optic Structures, and $2.3 million for Affordable Multi-Junction Solar Cells.

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

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	76.239	83.240	90.810
(U)	Current PBR/President's Budget	74.889	101.539	88.909
(U)	Total Adjustments	-1.350	18.299	
(U)	Congressional Program Reductions	0.000	-2.032	
	Congressional Rescissions		-0.869	
	Congressional Increases	0.000	21.200	
	Reprogrammings	-0.006		
	SBIR/STTR Transfer	-1.344		

(U) Significant Program Changes:

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**

Changes to this PE since the previous President's Budget are due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **1010 Space Survivability & Surveillance**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
1010 Space Survivability & Surveillance	30.276	43.080	40.002	39.466	42.160	40.843	41.510	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, Project 1010 was split, with efforts focused on protecting spacecraft from manmade threats being transferred into Project 5018.

(U) A. Mission Description and Budget Item Justification

This project develops the technologies to exploit the space environment for the warfighter's benefit. The project focuses on characterizing and forecasting the battlespace environment for realistic space system design, modeling, and simulation, as well as the battlespace environment's effect on space systems' performance. It includes technologies to specify and forecast the environment from "mud to sun" for planning operations and ensuring uninterrupted system performance, optimize space-based surveillance operations, and allow the opportunity to mitigate or exploit the space environment for both offensive and defensive operations. Finally, this project includes the seismic research program that supports national requirements for monitoring nuclear explosions.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop technologies for specifying, monitoring, predicting, and controlling space environmental conditions hazardous to Department of Defense (DoD) operational space systems in order to improve performance, reduce cost, and increase operational lifetimes.	3.155	3.199	4.207

(U) In FY 2003: Validated algorithms for tracking solar plasma clouds to Earth and predicting onsets of adverse effects on DoD systems. Developed models and algorithms for propagation of solar/geomagnetic activity for spacecraft susceptibility to single event upsets. Completed initial dynamic radiation belt model with real-time data assimilation for spacecraft hazard forecasting.

(U) In FY 2004: Develop advanced space weather forecasting models combining remote sensing of interplanetary clouds with in situ plasma and fields data. Validate dynamic radiation belt model for satellite hazard forecasts with newly acquired data sets from operational DoD satellites. Develop advanced technology solar telescope for detecting and forecasting explosive solar events that generate spacecraft-damaging energetic particle events and initiate plasma clouds responsible for adverse communication and navigation effects. Develop capability to test sub-micron and nano-scale technology concepts for extremely small space hazard detectors.

(U) In FY 2005: Upgrade initial version of dynamic radiation belt specification and forecast model to include extreme solar shock events responsible for the worst radiation conditions. Complete conceptual design of advanced, high-resolution solar telescope and begin fabrication of next-generation solar hazard forecasting tool. Test novel concepts to detect high-energy space particles using micro- and nano-technology based sensors suitable for inclusion in microsatellite constellations to specify space weather. Build empirical solar flare forecast algorithms and initiate physics based model development to improve accuracy and lead-times for prediction of debilitating explosive events.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **1010 Space Survivability & Surveillance**

(U)	MAJOR THRUST: Develop real-time infrared backgrounds clutter code, spectral signature libraries, target detection techniques, and decision aids for application to space-based surveillance, laser weapons, and countermeasure systems, including detection of low-observable targets.	7.650	9.880	13.008
(U)	In FY 2003: Validated background models with new experimental data and applied to surveillance system design trades and performance analyses. From field measurements, determined trade space for space system for earliest detection of theater ballistic missiles in boost phase. Upgraded models of atmospheric turbulence sources and improved laser weapon performance prediction model of airborne and space-based systems. Developed advanced techniques to exploit hyperspectral data and validate hyperspectral performance modeling and simulation codes. Developed design requirements for space-based sensor to obtain sub-pixel, high spectral resolution measurements of optical/infrared backgrounds for next-generation operational surveillance, target identification, and damage assessment systems.			
(U)	In FY 2004: Develop all-altitude, sub-pixel infrared background radiance model for atmospheric transmission of extended radiance sources such as missile hard bodies and plumes. Test and validate decision aids and turbulence performance prediction tools, including theater ballistic missile boost phase negation, on airborne laser platform. Expand models for other high-energy laser systems and explore a forecasting capability for high altitude turbulence effects on aircraft platforms. Develop sensors, algorithms, and clutter removal techniques for space-based hypertemporal imaging sensor. Incorporate spectral signature variability into simulation codes to improve performance predictions. Collect high quality spectral data from existing systems and evaluate system requirements for theater surveillance and area search missions.			
(U)	In FY 2005: Validate and deliver all-altitude, sub-pixel infrared background radiance model for extended radiance sources. Upgrade and improve atmospheric turbulence models for use in decision aids for tactical high-energy laser systems. Improve turbulence forecast technology for a turbulence decision aid for high altitude air vehicles. Develop advanced on-chip digital signal processing technologies for real-time hypertemporal detection. Validate day/night spectral exploitation algorithms and related signature databases for specific environments such as littoral, agricultural, desert, and woodlands. Use validated simulations to evaluate candidate technologies for spectral theater surveillance and area search missions.			
(U)				
(U)	MAJOR THRUST: Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting, space-based geolocation demonstrations, and determination and prediction of radar degradation.	7.114	6.708	5.966
(U)	In FY 2003: Developed data processing software and hardware architecture for collecting and analyzing ground and space data to provide near-real-time nowcasts and forecasts of ionospheric hazards. Validated nowcast and forecast predictions using ground and space-based experimental databases and incorporated results into forecast tool risk reduction. Improved techniques to track the motion of the highly structured plasma in the polar region, to enhance the			

	reliability of ionospheric specification in high latitude theaters. Developed multi-scale algorithms to increase reliability of global ionospheric forecasts.			
(U)	In FY 2004: Develop nowcasting and forecasting validation algorithms applicable to concepts such as the Communication/Navigation Outage Forecasting System (C/NOFS) Advanced Concept Technology Demonstration. Integrate validation algorithms into ionospheric specification and forecast modeling architecture. Validate communication and navigation outage forecasts with C/NOFS satellite and ground-based data to demonstrate utility of outage warning due to scintillation. Integrate polar region plasma tracking models into global models of scintillation to provide seamless equator-to-pole outage specification. Validate multi-scale algorithms and data assimilation techniques to increase reliability of global ionospheric electron profile specifications and forecasts to improve radar and geolocation performance. Explore concept development of scintillation mitigation techniques to overcome satellite-to-ground link degradation in real-time.			
(U)	In FY 2005: Generate communication/navigation outage nowcasts and forecasts due to ionospheric scintillation to give the warfighter improved battlefield situational awareness and operational flexibility. Develop validated ionospheric specification and forecast models and products using results from military evaluation of C/NOFS Advanced Concept Technology Demonstration. Investigate ionospheric scintillation technologies to develop techniques for longer-term outage forecasting. Complete pole-to-equator scintillation specification model giving global real-time hazard alerts. Couple magnetospheric data assimilation and forecast models to validated ionospheric electron profile models to improve geolocation accuracy and increase forecast lead times for radar operations. Develop combined laboratory/field tests to demonstrate feasibility of receiver and transmitter technologies to mitigate hazardous scintillation conditions.			
(U)				
(U)	MAJOR THRUST: Develop High-frequency Active Auroral Research Program site transmitting and diagnostic instrument infrastructure.	0.000	9.684	10.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue populating the high frequency transmitter array to its full capacity of 180 array elements and 3.6 megawatt radiated output power.			
(U)	In FY 2005: Continue populating the high frequency transmitter array to its full capacity of 180 array elements and 3.6 megawatt radiated output power.			
(U)				
(U)	MAJOR THRUST: Develop basic seismic technologies to support national requirements for monitoring nuclear explosions with special focus on monitoring regional events located at distances less than 2,000 km from the sensors.	0.000	6.569	6.821
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct seismic research such as seismic energy partitions for local and regional events, magnitudes and source physics; seismic calibration and ground truth collection; and seismic detection, location, and			

discrimination technologies. Perform observational studies of seismic wave propagation and collect seismic propagation characteristics of the Eurasian landmass.

(U) In FY 2005: Provide updated seismic codes for operational use. Continue efforts on seismic energy partition, magnitudes, and source physics; seismic calibration; seismic detection, location and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Assess future direction of seismic research based on results obtained so far, and continue to conduct seismic research on these and other topics of interest to the Air Force.

(U)

(U) CONGRESSIONAL ADD: Seismic Monitoring Research.	2.920	0.000	0.000

(U) In FY 2003: Developed basic seismic technologies to support national requirements for monitoring nuclear explosions. Enhanced United States capabilities in seismic monitoring of nuclear explosions, with special focus on monitoring regional events located at distances less than 2,000 km from the sensors. Performed theoretical and experimental seismology studies to detect, locate, and characterize nuclear explosions.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: High-frequency Active Auroral Research Program (HAARP) Incoherent Scatter Radar (ISR).	2.529	0.000	0.000

(U) In FY 2003: Developed a modular approach for installation of an ISR diagnostic at the HAARP facility. Completed site infrastructure for the ISR and preliminary support structure. Acquired and installed a modular, eight-panel, ISR transmit/receive sub-array. Conducted a research program to characterize radio-wave interactions and processes in the ionosphere using the sub-array as a powerful radar diagnostic instrument in conjunction with the HAARP high power high frequency transmitting array.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: High-frequency Active Auroral Research Program (HAARP) Experimentation.	4.963	4.958	0.000

(U) In FY 2003: Develop the HAARP site transmitting and diagnostic instrument infrastructure. Provided facility management and environmental oversight. Performed research programs to assess the viability of exploiting Extremely Low Frequency/Very Low Frequency waves generated in the ionosphere for military applications. Conducted research programs to characterize high power radio wave interactions in the ionosphere and space, including the generation of irregularities and optical emissions and to exploit the HAARP diagnostic instruments for space weather specification. Developed real-time diagnostic and data analysis software and web displays.

(U) In FY 2004: Develop planned diagnostic infrastructure at the HAARP site. Provide facility management and

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **1010 Space Survivability & Surveillance**

	environmental oversight functions. Conduct research programs concentrating on the generation of Extremely Low Frequency/Very Low Frequency waves in the ionosphere and their applications to subsurface communications, the detection of underground structures, and the reduction of charged particle populations in the earth's radiation belts.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Electromagnetic Gradiometer Research.	1.945	2.082	0.000
(U)	In FY 2003: Investigated, enhanced, and tested electromagnetic radiometry technologies for the detection of underground structures. Conducted field demonstrations of a miniature and rugged man-portable hardware system using Very Low Frequency waves to detect underground structures. Designed a system with improved detection algorithms, frequency agility, and remote data access for unmanned aero vehicle/airborne applications. Developed techniques to enhance the operational viability of both the man-portable and airborne systems.			
(U)	In FY 2004: Miniaturize a recently completed, rugged, man-portable hardware system. Assess the viability of an unmanned ground-based, randomly distributed-array detection concept. Develop an airborne application.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	30.276	43.080	40.002

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0305160F, Defense Meteorological Satellite Program.									
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0305111F, Weather Systems.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **1010 Space Survivability & Surveillance**

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology 1**	**4846 Spacecraft Payload Technologies**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4846 Spacecraft Payload Technologies	12.431	16.937	19.553	20.608	20.735	35.740	39.529	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on four primary areas: (1) development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; (2) development of advanced space data generation and exploitation technologies, including infrared, Fourier Transform hyperspectral imaging, polarimetric sensing, and satellite antenna subsystem technologies; (3) development of high-fidelity space simulation models that support space-based surveillance and space asset protection research and development for the warfighter; and (4) development of advanced networking, radio frequency, and laser communications technologies to support next generation satellite communication systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop advanced infrared device technologies for space applications that support hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of bodies such as decoys, satellites, and warheads throughout their trajectory.	3.518	2.841	4.083

(U) In FY 2003: Evaluated two- and three-color detector and continued development of multi-color detectors and tunable and broadband gratings. Designed and fabricated selected concepts for future longer wavelength infrared detectors and infrared detectors with optimal background-limited performance for stressing, low photon noise, and space backgrounds. Completed design study of next generation long and very long wavelength infrared detector concepts, including quantum wells and strained layer superlattices, as lower cost, higher performance alternatives to mercury cadmium telluride. Evaluated delivered radiation-hardened cryogenic multiplexers for lower background, space infrared detector arrays.

(U) In FY 2004: Fabricate and characterize strained-layer superlattice detectors and use results to modify designs to improve absorption efficiency and eliminate manufacturing or operationally induced defects. Complete the two-dimensional focal plane array development effort by identifying, designing, and fabricating the appropriate cryogenic detector multiplexers required for transitioning the technology. Begin development of infrared detector and detector read-out circuit technologies for next generation surveillance systems with projected requirements for adaptive, re-configurable, and polarimetric capabilities.

(U) In FY 2005: Incorporate design changes into the fabrication process and continue wafer growth of strained-layer superlattice detector structures and other promising technologies. These alternatives to mercury cadmium telluride offer both improved performance at a given operating temperature and comparable performance at higher operating temperatures. Evaluate promising "on-focal plane array polarimetric" concepts developed to meet projected capability requirements of the next generation surveillance systems.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **4846 Spacecraft Payload Technologies**

(U)				
(U)	MAJOR THRUST: Develop spectral sensing and data exploitation methodologies for military imaging and remote sensing applications.	0.832	0.752	1.004
(U)	In FY 2003: Assessed technology and modeling for understanding the electro-optical/infrared polarimetric phenomenology. Evaluated initial polarimetric signature model capability and validated with measured data. Developed capability to integrate polarimetric models into modeling, simulation, and analysis for space-based surveillance applications.			
(U)	In FY 2004: Complete initial assessment of technology and modeling for understanding the electro-optical/infrared spectral polarimetric phenomenology. Demonstrate partially validated polarimetric signature model capability and continue validation with measured data from ongoing field collects. Integrate initial polarimetric models into modeling, simulation, and analysis architecture for space-based surveillance applications.			
(U)	In FY 2005: Complete assessment and documentation of electro-optical/infrared spectral polarimetric phenomenology understanding. Demonstrate validated polarimetric signature model capability and develop new code upgrades and validation with measured data from on-going field collections. Demonstrate integration of spectral polarimetric models into scene simulation architecture for space-based surveillance applications.			
(U)				
(U)	MAJOR THRUST: Develop technologies for space-based payload components such as low power, high performance, radiation-hardened electronic devices, micro-electro-mechanical system (MEMS) devices, and advanced electronics packaging for next generation high performance space electronics.	3.448	3.731	3.490
(U)	In FY 2003: Enhanced the switching speed and durability of the chalcogenide material by ten times for improved devices through additional silicon-on-insulator radiation research. Extended the design of the monolithically integrated low power, silicon-based quantum-sized devices to include non-traditional electronic materials. Improved the speed of the radiation-hardened nonvolatile digital memories. Characterized the analog memories and enhanced resolution to an eight-bit equivalent. Built space-qualified MEMS reliability test devices and chip-scale packages for ground and flight insertion. Built reconfigurable analog array packaging structures.			
(U)	In FY 2004: Research radiation effects in electronics components based on emerging silicon-on-insulator, sapphire, or other radio frequency and analog technology compatible substrates. Evaluate monolithically integrated low power, silicon-based quantum-sized devices for system-on-a-chip applications. Develop radiation hardening design techniques to enable fabrication of electronics on commercial lines. Evaluate architecture and components supporting analog memory. Build micro-electro-mechanical system based switches supporting complex switching harnesses in support of self-adaptable spacecraft hardware. Develop architectures and packaging approaches in support of reconfigurable space systems.			
(U)	In FY 2005: Research radiation effects in electronics built with hardness by design methods at state-of-the-art manufacturing plants. Evaluate chalcogenide-based reconfigurable electronics providing ten fold performance			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **4846 Spacecraft Payload Technologies**

	improvement and self-repair capabilities. Build monolithically integrated low-power, silicon-based quantum-sized devices for system-on-a-chip applications. Establish tools for hardness-by-design part manufacture and demonstrate ten-fold decrease in manufacturing cost. Design switches on chip, board, and intra-board level supporting self-adaptable, self-healing spacecraft hardware. Develop and evaluate architectures and packaging approaches in support of reconfigurable space systems.			
(U)				
(U)	MAJOR THRUST: Develop modeling, simulation, and analysis tools for space-based surveillance systems, rendezvous and proximity operations, optical/infrared imaging space systems, and distributed satellite architecture payloads.	2.347	1.255	2.874
(U)	In FY 2003: Extended simulation architecture to support flight experiment ground-to-space segment simulation including spacecraft bus and payload modeling development. The simulation architecture can be used for objective system-of-systems assessment.			
(U)	In FY 2004: Further extend simulation architecture to support flight experiment ground-to-space segment simulation. Extend the architecture for use in objective system-of-systems, military utility assessment. Develop extensions to the simulation architecture to address missions associated with responsive space, space capability protection, and counterspace. Develop enhancements to optical/infrared imaging system simulation to include polarimetric effects.			
(U)	In FY 2005: Ready the simulation architecture to support flight experiment simulation and data validation for experiments on deployable antenna technology, adaptive avionics, autonomous command/control software, and responsive space technologies. Continue to develop extensions to the simulation architecture to address missions associated with responsive space, space capability protection, and counterspace. Develop further enhancements to optical/infrared imaging system simulation to include polarimetric effects.			
(U)				
(U)	MAJOR THRUST: Develop advanced architectures and performance characterization tools for future large, lightweight, modular space antennas.	0.924	0.957	0.870
(U)	In FY 2003: Extended antenna architecture and algorithms developed for performance characterization of modular phased array antenna tiles to multi-beam, wider-bandwidth, multi-mode operation. Supported development of advanced low-power, low-noise amplifiers, integrated wide-bandwidth radiators, and active radio frequency manifold control technologies. Built a testbed to simulate performance of multi-beam, wide-bandwidth phased array antenna tiles and integrated antenna models.			
(U)	In FY 2004: Refine transmit/receive testbed, enhancing the performance of the phased-array antenna subsystems and integrated antenna modules using miniaturized active radio frequency components and planar wide-bandwidth radiators. Characterize performance of new wide-bandwidth antenna subsystems and correlate results to model predictions; update models based on actual performance. Develop algorithms for performance characterization of sparse cooperating apertures and for advanced antenna array calibration.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **4846 Spacecraft Payload Technologies**

(U)	In FY 2005: Investigate subsystems architectures for sparse membrane arrays for next generation agile beam control and a smart antenna that extends transmit/receive antenna technology to autonomous beam control. Design, fabricate, and characterize performance of autonomous beam control subsystem. Correlate results to model predictions and update models based on actual performance.			
(U)				
(U)	MAJOR THRUST: Develop bandwidth efficient modulation and high bandwidth communications technologies to support next generation satellite communication systems.	0.000	1.872	1.790
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Explore architecture studies and guide technology investment in support of satellite communications roadmap. Develop technology standards and system designs for integrating multiple airborne intelligence, surveillance, and reconnaissance assets into single space platforms.			
(U)	In FY 2005: Further explore architecture studies and guide technology investment in support of satellite communications roadmap. Expand development of technology standards and system designs for integrating multiple airborne intelligence, surveillance, and reconnaissance assets into single space platforms.			
(U)				
(U)	MAJOR THRUST: Develop technologies for multi-access laser communications terminals. Assess the maturity of single access terminal components and their applicability to a multi-access terminal design.	0.000	3.744	5.442
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop standards for combining multiple airborne intelligence, surveillance, and reconnaissance and space asset feeds into a single optical data path. Design a laboratory multi-access terminal testbed.			
(U)	In FY 2005: Further develop standards for combining multiple airborne intelligence, surveillance, and reconnaissance and space asset feeds into a single optical data path. Continue design of a laboratory multi-access terminal testbed.			
(U)				
(U)	CONGRESSIONAL ADD: Mixed Signal Very Large Scale Integrated (VLSI) [Circuits] for Space Vehicle Communication Subsystems.	1.362	1.785	0.000
(U)	In FY 2003: Developed radiation-hard analog circuit elements for mixed signal VLSI circuits for secure high-bandwidth intra-satellite and satellite-ground station communications. Radiation tested and characterized commercial state-of-the-art mixed signal components to determine the feasibility of employing commercial foundry technologies for space applications. Designed and fabricated innovative circuit configurations and test devices using new radiation-hard analog elements and circuit architectures.			
(U)	In FY 2004: Develop improved, radiation-hard, analog circuit elements for mixed-signal VLSI circuits. Refine and employ results from radiation testing and characterization of commercial state-of-the-art mixed-signal components to improve designs using commercial foundry technologies for space applications. Design and fabricate innovative			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **4846 Spacecraft Payload Technologies**

circuit configurations and test devices using new radiation-hard analog elements and circuit architectures.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	12.431	16.937	19.553

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology 1**	**5018 Spacecraft Protection Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5018 Spacecraft Protection Technology	4.355	4.011	2.630	2.442	2.303	2.434	2.516	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, Project 1010 was split with efforts focused on protecting spacecraft from manmade threats being transferred into Project 5018.

(U) A. Mission Description and Budget Item Justification

This project develops the technologies for protecting U.S. space assets in potential hostile environments to assure continued space system operation without performance loss in support of warfighter requirements. The project focuses on identifying and assessing spacecraft system vulnerabilities, developing threat warning technologies, and developing technologies to mitigate the effects of both intentional and unintentional threats.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop key satellite threat warning technologies and tools for high value satellite asset defense.	0.943	1.285	0.911
(U) In FY 2003: Developed initial components of a high performance multiple threat sensors satellite protection system, improving technical performance of the sensor suite while still minimizing cost, power, and weight. Investigated integration of the miniature radio frequency receiver, laser detector, and ionospheric specification system with advanced reconfigurable processor electronics for the first generation system. Assessed feasibility of using a single antenna for performing radio frequency (RF) geolocation from a low-earth-orbit satellite. Investigated laser and RF false alarm rejection/mitigation and anomaly resolution and management techniques.			
(U) In FY 2004: Develop and bench-test high performance multi-threat warning on-board sensors. Explore reconfigurable processor electronics capability and build testbed in support of multi-threat warning sensors. Analyze light, adaptable single antenna performance for threat detection and geolocation applications. Complete false alarm research for relevant threats. Select antenna technology for wide-band and narrow-band threat detectors for multi-threat capability space experiment.			
(U) In FY 2005: Update microsatellite threat characteristics. Select most promising proximity sensor technology and begin development of a experimental proximity sensor. Design and report ground and space demonstration plan for the purpose of confirming proximity sensor performance.			
(U)			
(U) MAJOR THRUST: Develop high value space asset defensive capabilities.	1.314	0.847	0.601
(U) In FY 2003: Conducted threat reporting risk reduction Space Shuttle experiment and performed post-experiment data and system performance analysis.			
(U) In FY 2004: Design and fabricate miniaturized narrowband RF attack reporting receiver with of goal of five times reduction in power and size.			
(U) In FY 2005: Select most promising defensive weapon technology and begin development of experimental defensive			

	capabilities. Design and report ground and space demonstration plan for the purpose of confirming defensive capability performance.			
(U)				
(U)	MAJOR THRUST: Develop techniques to exploit existing on-board inherent satellite resources, satellite-as-a-sensor, and self aware satellite technologies as a first-line threat detection system.	0.347	0.831	0.590
(U)	In FY 2003: Investigated use of systems on currently fielded or launch ready satellites for preliminary determination of radio frequency/laser illumination or kinetic impact. Assessed the use of telemetry, state-of-health data, and other appropriate data for event determination.			
(U)	In FY 2004: Develop technology for currently fielded or launch-ready satellites to detect anomalies that result from radio frequency/laser illumination or kinetic impact. Explore use of on board resources such as telemetry or state-of-health data for anomaly determination as a zero added power/weight solution and assess the limits of this technique. Conduct laboratory proof of concept for selected subsystems.			
(U)	In FY 2005: Conduct ground simulation demonstration of a combined satellite-as-a-sensor system. The simulation includes data fusion, unique radio frequency location tool, simulated laser sensor, simulated proximity sensor, and satellite as a sensor test bed.			
(U)				
(U)	MAJOR THRUST: Develop techniques for monitoring and assessing electromagnetic interference and compatibility between ultra-sensitive payload sensors for space systems that support space weather forecasting.	1.751	1.048	0.528
(U)	In FY 2003: Integrated payload for the Communications/Navigation Outage Forecast System (C/NOFS) Advanced Concept Technology Demonstration. Designed, developed, and tested serial communications hardware and software for command and data handling spacecraft sub-system risk reduction for real-time space weather forecasting. Validated data compression techniques with payload sensor data and apply to space flight software for demonstrating space weather forecasting.			
(U)	In FY 2004: Continued to prepare for the space experiment demonstration of C/NOFS.			
(U)	In FY 2005: Conduct space experiment demonstration of C/NOFS. Perform measurements of key ionospheric and scintillation parameters needed for input to ionospheric specification and forecast models. Assess data for electromagnetic interference effects on ultra-sensitive payload sensors. Assess payload performance in measuring ionospheric and scintillation parameters needed for space weather support in theater and for mission planners and other users.			
(U)	Total Cost	4.355	4.011	2.630

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **5018 Spacecraft Protection Technology**

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology 1**	**8809 Spacecraft Vehicle Technologies**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
8809 Spacecraft Vehicle Technologies	27.827	37.511	26.724	27.128	32.411	39.954	43.187	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project focuses on seven major space technology areas: spacecraft platforms (e.g., structures, controls, power, and thermal management); space-based payloads (e.g., survivable electronics); satellite control (e.g., software for autonomous distributed satellite formation flying, signal processing, and control); modeling and simulation of space-based systems; satellite protection technologies (e.g., space environment effects, debris prediction, and threat warning/attack reporting); microsatellite technologies; and integrated experiments of advanced technologies for transition to planned systems (e.g., payload/platform/launch vehicle merging).

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells and arrays, and innovative power generation concepts.	3.240	3.871	4.188
(U) In FY 2003: Improved accuracy of cryocooler modeling tools and the identification of mechanisms that limit operational life and degrade cryocooler subsystem performance. Fabricated and tested a 32% efficient solar cell. Proved production capacity for a 10% efficient thin-film solar cell.			
(U) In FY 2004: Complete identification of mechanical and long-term failure mechanisms for assessing cryocooler performance and reliability. Build first generation analytical performance prediction models, empirical measurements, and thermophysical fluid flow and heat transfer models for low-temperature cryocooler regenerator performance. Investigate technology development to improve cryocooler capability and performance for regenerative and recuperative cycle cryocoolers. Fabricate multijunction solar cells using lattice-mismatch technology on lower-cost silicon wafers with efficiencies that break even with the efficiency of current production multijunction 28% Germanium solar cells. Demonstrate 10% efficient thin-film solar cells on polymer substrates.			
(U) In FY 2005: Build second-generation empirically verified thermophysical performance models for cryocooler regenerators. Further investigate technology development to improve cryocooler capability and performance for regenerative and recuperative cycle cryocoolers. Build modeling and simulation capability for complex thermodynamic cycle coolers. Develop a 30% efficient crystalline multijunction solar cell based on lattice-mismatch technology. Fabricate 10% efficient thin-film, monolithically integrated solar cell.			
(U)			
(U) MAJOR THRUST: Develop technologies for advanced space platform structures such as structural controls for vibration suppression, multifunctional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures.	7.576	9.500	7.274
(U) In FY 2003: Flight tested full-spacecraft vibration suppression to better isolate and protect spacecraft from the harsh			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

launch vehicle environment. Potential to decrease vibration and acoustic stresses on spacecraft, thereby reducing overall cost of spacecraft design. Characterized performance of multifunctional bus structure for small spacecraft.

(U) In FY 2004: Complete characterization of multifunctional small spacecraft bus. Initiate development of tunable nanotechnology-enhanced lightweight space structures. Develop lightweight structures and precision structural controls for large-aperture space optics. Develop low-shock and precision deployment mechanisms.

(U) In FY 2005: Perform material characterization of tunable nanotechnology-enhanced lightweight space structures. Fabricate and test engineering concepts for lightweight structures and precision structural controls for large-aperture space optics. Fabricate and test low-shock and precision deployment mechanisms for satellite separation and subsystem deployment.

(U)

(U) MAJOR THRUST: Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. The innovative microsatellite architectures and advanced satellite bus technologies could enable applications such as space protection, counterspace capabilities, sparse aperture sensing, on-orbit formation flying, inter-satellite communications, distributed processing, and responsive payloads. 9.944 4.641 2.106

(U) In FY 2003: Completed fabrication and qualification testing of subsystem hardware, including avionics, Hall-effect thrusters, and high-density memory. Completed fabrication and environmental testing of bus structure. Conducted detailed studies for potential new mission payloads.

(U) In FY 2004: Note: The planned microsatellite technology program was re-oriented to apply modeling and simulation techniques to evaluate the technical feasibility, military utility, and cost effectiveness of a multi-aperture system to meet future space-based radio frequency intelligence, surveillance, and reconnaissance needs.

(U) In FY 2005: Plan to complete evaluation of the technical feasibility, military utility, and cost effectiveness of a multi-aperture system to meet future space-based radio frequency intelligence, surveillance and reconnaissance needs.

(U)

(U) MAJOR THRUST: Develop flight experiments to address key scientific and technological problems in order to improve the capabilities of existing operational space systems and to enable new transformational space capabilities. 0.000 7.303 13.156

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Evaluate structures, controls, and isolation technologies for maturity for space flight experiments. Design and develop a deployable structures space flight experiment for potential space-based radar applications. Develop initial efficient, large, deployable antennas for space-borne sensors for radiation belt remediation. Start initial designs for deployable thin film photovoltaic arrays suitable for middle-earth-orbit flight experiment.

(U) In FY 2005: Complete design of a deployable structures space flight experiment for potential space-based radar applications. Integrate lightweight deployable structures with efficient, large, deployable antennas for space-borne sensors and deployable thin film photovoltaic arrays for midele-earth orbit flight experiment of these technologies.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

		FY 2003	FY 2004	FY 2005
(U)	CONGRESSIONAL ADD: Lightweight and Novel Structures for Space.	0.975	0.000	0.000
(U)	In FY 2003: Developed technologies for advanced mirror systems and space structures, including improved advanced mirror fabrication techniques and methods for enhancing performance of the associated structural systems required to support sensors in space. Current fabrication methods are labor and time intensive, and the product is heavy, expensive, and falls short of achieving technical requirements. Investigated non-traditional and innovative composite fabrication techniques, focusing on accelerated fabrication techniques and dimensionally stable materials.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Carbon Foam for Aircraft and Spacecraft.	0.448	0.000	0.000
(U)	In FY 2003: Developed carbon foam-based structures for aircraft and spacecraft. Investigated the performance requirements of structures for currently planned airborne and space-based systems and assessed carbon foam blends and types for use in optical backing structures and the optical mounts for those systems. Downselected to the optimal carbon foam formulation and completed preliminary designs of an optical backing structure and optical mount.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Technology Satellite of the 21st Century (TechSat-21).	2.920	2.975	0.000
(U)	In FY 2003: Completed integration and test of microsatellite system flight software. Evaluated performance of flight navigation system with live Global Positioning Signals to support potential mission applications ranging from distributed aperture formations to space surveillance, threat warning, and protection.			
(U)	In FY 2004: Develop and ground test advanced subsystem flight units that could demonstrate responsive microsatellite bus technologies. Key advances in microsatellite bus technologies include high power density lithium polymer batteries, lightweight thin-film solar arrays with micro-gimbals, and a modular 160-640 Gbyte non-volatile mass memory subsystem. This microsatellite bus technology development program could support mission applications ranging from distributed aperture formations to space surveillance, threat warning, and protection.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Substrates for Solar Cells.	1.362	1.190	0.000
(U)	In FY 2003: Developed high temperature polymer substrates for thin film solar cells for next generation flexible, thin film solar arrays. These thin film arrays will be three to five times lighter, cost five times less, require five times less stowed volume, and be more radiation resistant than state-of-the-art rigid panel arrays. Current polymer substrates for Copper-Indium-Gallium-DiSelenide (CIGS) thin film solar cells do not survive the high temperature processing necessary for fabricating the highest efficiency solar cells. Developed, fabricated, and tested high temperature			

silicone resin films suitable for CIGS thin film solar cell substrates. Demonstrated the deposition of CIGS solar cells on the high temperature polymers.

(U) In FY 2004: Further the development of silicone resin high temperature polymer substrates for Copper-Indium-Gallium-DiSelenide (CIGS) thin film solar cells for next-generation flexible, thin film solar arrays and develop monolithic integration of Copper-Indium-Gallium-DiSelenide (CIGS) solar cells on these substrates. Monolithic integration, which is enabled by these non-conductive substrates, reduces the touch labor necessary for interconnection of individual cells into solar arrays. Demonstrate the roll-to-roll deposition of CIGS solar cells on free-standing high temperature polymers and demonstrate large area monolithically-integrated CIGS modules.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Integrated Control for Autonomous Space Systems (ICASS).	1.362	0.992	0.000

(U) In FY 2003: Developed advanced attitude and dynamic control technologies for next generation spacecraft. These technologies provide unprecedented levels of control over dynamic subsystem response, precision pointing and target tracking. Designed an integrated controls architecture, which includes flight computer, an advanced suite of dynamic sensors, and real-time system identification software that can characterize the capability enhancements for operational space platforms.

(U) In FY 2004: Develop advanced attitude and dynamic control technologies for future space platforms to provide unprecedented levels of control over dynamic subsystem response, precision pointing, and target tracking. Fabricate the engineering models of integrated controls architecture designs, initiate laboratory validation and verification, and incorporate the engineering models into a spacecraft design.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Elastic Memory Composites and Elastic Memory Composites Materials.	0.000	3.272	0.000

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Develop elastic memory composite material technologies for unconventional approaches in satellite component utility. These composite materials have unique properties that can be exploited to enable new types of spacecraft components and to enhance existing components. Design, build, and integrate elastic memory composite hinge hardware for possible on-orbit demonstration. Design and build a composite deploying gravity gradient boom as the primary attitude-stabilizing element for a satellite. Design and analyze large-scale rollout flexible solar array deployment mechanism.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Converted Silicon Carbide for High Performance Optic Structures.	0.000	1.487	0.000

(U) In FY 2003: Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

(U)	In FY 2004: Explore the application of silicon carbide processes developed for the semi-conductor industry to the fabrication of large, lightweight, space optics. Design, analyze, fabricate, and test a silicone carbide mirror. Assess the potential cost, fabricating speed, and performance of mirrors fabricated from silicon carbide.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Affordable Multi-Junction Solar Cells.	0.000	2.280	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop a process for affordable production of single crystal Germanium (Ge) wafers, a key component of multi-junction solar cells on all Department of Defense satellites, comprising approximately half the cost of the entire cell. Develop a domestic source of Ge wafers encompassing the establishment of a pilot/bench operation, including demonstration of a crystal growth and wafer fabrication capability, a plan to recycle Ge metal, and a production scale-up plan. The bench operation will include wafer grinding, polishing, etching, characterization, and the establishment of quality control procedures.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	27.827	37.511	26.724

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602102F, Materials.									
(U)	PE 0603311F, Ballistic Missile Technology.									
(U)	PE 0603401F, Advanced Spacecraft Technology.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology 1**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

(U) <u>C. Other Program Funding Summary ($ in Millions)</u>

efforts and eliminate
duplication.

(U) <u>D. Acquisition Strategy</u>

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602602F Conventional Munitions

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	62.802	46.061	52.251	50.260	54.704	52.684	53.998	0.000	0.000
2068	Advanced Guidance Technology	16.905	16.589	16.359	16.454	16.960	17.366	17.717	0.000	0.000
2502	Ordnance Technology	45.897	29.472	35.892	33.806	37.744	35.318	36.281	0.000	0.000

(U) A. Mission Description and Budget Item Justification

This program investigates, develops, and establishes the technical feasibility and military utility of advanced guidance and ordnance technologies for conventional air-launched munitions. The program includes two projects: (1) development of advanced guidance technologies, including seekers, navigation and control, target detection and identification algorithms, and simulation assessments; and (2) development of conventional ordnance technologies, including warheads, fuzes, explosives, munitions integration, and weapon lethality and vulnerability assessments.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	58.802	46.455	50.351
(U)	Current PBR/President's Budget	62.802	46.061	52.251
(U)	Total Adjustments	4.000	-0.394	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.394	
	Congressional Increases			
	Reprogrammings	4.000		
	SBIR/STTR Transfer			

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602602F Conventional Munitions**	**2068 Advanced Guidance Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2068 Advanced Guidance Technology	16.905	16.589	16.359	16.454	16.960	17.366	17.717	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project investigates, develops, and evaluates conventional munitions advanced guidance technologies to establish technical feasibility and military utility. This project includes development of advanced guidance including terminal seekers, navigation and control, signal and processing algorithms, and guidance and control simulations. Project payoffs include: adverse-weather and autonomous precision guidance capability; increased number of kills per sortie; increased aerospace vehicle survivability; improved reliability and affordability; and improved survivability and effectiveness of conventional weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate and develop advanced guidance component technologies for adverse weather, and autonomous seekers for air-delivered munitions, such as detectors and detector arrays, receiver electronics, signal pre-processing, target recognition, spatial target characteristics, optics, and low-cost beam scanning and shaping technologies. These technologies will enable the development of next generation seekers that will increase a weapon's kill probability, reduce pilot workload, and enhance sortie effectiveness.	6.779	6.471	6.100
(U) In FY 2003: Tested in-house, high-throughput, parallel processing target acquisition algorithms. Evaluated laser ranging and detection seeker components to quantify operational range, target detection and identification, aim-point selection, and weather penetration effectiveness. Designed a low-cost, synthetic aperture radar seeker to assess future advanced guidance applications.			
(U) In FY 2004: Develop a low-cost, synthetic aperture radar seeker to assess future advanced guidance applications. Initiate demonstration of a laser ranging and detection seeker with the capability to perform 'single-shot' imaging technology.			
(U) In FY 2005: Continue testing laser ranging and detection seeker with the capability to perform 'single-shot' imaging technology. Begin ground testing a low-cost, synthetic aperture radar seeker to assess future advanced guidance applications. Initiate design of an optical seeker using multiple discriminates to improve performance against obscured or hidden targets.			
(U)			
(U) MAJOR THRUST: Investigate and develop advanced navigation and control technologies for air-delivered munitions to include nonlinear controllers, biomimetic guidance, clutter rejection modules, detection and segmentation modules, and micro-electromechanical gyros. These technologies will allow a more efficient flight path to target, increase stand off ranges, and enhance strike aircraft effectiveness and survivability.	4.758	4.500	4.204
(U) In FY 2003: Completed laboratory field-testing of a reliable, accurate, miniaturized, and low-cost anti-jam weapon guidance system capable of operating in highly dynamic flight environments in the presence of Global Positioning			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT NUMBER AND TITLE **2068 Advanced Guidance Technology**

System jamming devices. Designed new technologies for tactical munitions flight control systems. Advanced development of novel ways to enhance weapon system effectiveness through higher levels of integration of guidance, navigation, control, and estimation algorithms. Investigated neuro-physiology of insects for applications to guidance. Investigated clutter and multi-discriminate rejection to defeat camouflage, concealment, and deception.

(U) In FY 2004: Continue evaluating new design technologies for tactical munitions flight control systems. Continue developing novel ways to enhance weapon system effectiveness through higher levels of integration of guidance, navigation, control, and estimation algorithms. Continue investigating the neuro-physiology of insects for applications to guidance. Investigate concepts for penetrator guidance below the ground.

(U) In FY 2005: Continue developing new design technologies for tactical munitions flight control systems. Complete a modeling and simulation testbed for developing novel ways to enhance weapon system effectiveness through higher levels of integration of guidance, navigation, control, and estimation algorithms. Continue investigating the neuro-physiology of insects for applications to guidance. Continue investigating concepts for penetrator guidance below the ground.

(U)

(U) MAJOR THRUST: Investigate and develop advanced optical and digital processors and target detection, classification, and identification algorithms for improved seeker performance to allow greater air-delivered weapon autonomy. These seekers will deny an enemy the ability to hide or camouflage a target while also decreasing the pilot's workload. 2.005 1.892 2.250

(U) In FY 2003: Evaluated highly innovative concepts and approaches in guidance and control. Investigated biomimetic principles and concepts, including foveal vision and neuromorphic imaging systems, for use in advanced seekers for moving target scenarios. Investigated algorithms to perform flight trajectory shaping that reduce human workload.

(U) In FY 2004: Enhance development of highly innovative concepts and approaches in guidance and control to include advanced seekers for moving target scenarios. Using digital simulation and hardware in the loop testing, transition biomimetic principles developed by the Air Force Office for Scientific Research for variable resolution sensors. These sensors will emulate biological or human characteristics for use in advanced seeker components for moving target scenarios. Complete investigation of algorithms to perform flight trajectory shaping that reduces human error design effects. Initiate investigating polarization measurement to differentiate the properties of manmade materials from natural backgrounds.

(U) In FY 2005: Continue developing highly innovative concepts and approaches in guidance and control. Continue transitioning biomimetic principles developed by the Air Force Office for Scientific Research for variable resolution sensors. These sensors will emulate biological or human characteristics for use in advanced seeker components for moving target scenarios. Continue investigating polarization measurement to differentiate the properties of manmade materials from natural backgrounds. Develop an in-house capability to evaluate contractor-developed optic-flow algorithms.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT NUMBER AND TITLE **2068 Advanced Guidance Technology**

(U)	MAJOR THRUST: Investigate and develop detailed six-degree-of-freedom and hardware-in-the-loop simulations including synthetic aperture radar, automatic target recognition, and biomimetic processing. Technologies also include trajectory optimization algorithm and polarization sensing and models to analyze guided munitions and their components that will enable requirement studies, design iteration and evaluation, and experiment risk reduction. These simulations will shorten development time, reduce development costs, and provide more effective munitions.	3.363	3.726	3.805
(U)	In FY 2003: Analyzed efforts and multi-sensor modeling to improve target signature prediction models, expedite development, and reduce the acquisition cycle expense for state-of-the-art seekers. Investigated the long-term technology and strategy for developing an advanced laser radar scene projector. Provided detailed performance estimates of guidance-related component technology, using six-degree-of-freedom simulations, for guided weapon systems. Enhanced modular, system-level, analysis tools development to provide comprehensive comparisons among inventory, planned, and conceptual munitions to identify high pay-off technologies and weapon attributes.			
(U)	In FY 2004: Continue analysis efforts and multi-sensor modeling to improve target signature prediction models, expedite development, and reduce the acquisition cycle expense for state-of-the-art seekers. Complete investigating the long-term technology and strategy for developing an advanced laser ranging and detection scene projector capability. Complete developing two-dimensional laser arrays for laser ranging and detection scene projectors. Complete providing detailed performance estimates of guidance-related component technology, using six-degree-of-freedom simulations, for guided weapon systems. Continue developing modular, system-level, analysis tools to provide comprehensive comparisons among inventory, planned, and conceptual munitions to identify high pay-off technologies and weapon attributes.			
(U)	In FY 2005: Continue analysis efforts and multi-sensor modeling to improve target signature prediction models, expedite development, and reduce the acquisition cycle expense for state-of-the-art seekers. Continue development of simulation model, reusable end system simulation tools. Develop a prototype waveform generator, meeting DoD simulator requirements, using a commercial synthesizer chip.			
(U)	Total Cost	16.905	16.589	16.359

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603601F, Conventional Weapons Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT NUMBER AND TITLE **2068 Advanced Guidance Technology**

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

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT NUMBER AND TITLE **2502 Ordnance Technology**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2502 Ordnance Technology	45.897	29.472	35.892	33.806	37.744	35.318	36.281	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project investigates, develops, and evaluates conventional ordnance technologies to establish technical feasibility and military utility to include technologies for advanced conventional weapon dispensers, submunitions, safe and arm devices, fuzes, explosives, warheads, and weapon airframe and carriage technology. The project also assesses the lethality and effectiveness of current and planned conventional weapons technology programs and assesses target vulnerability. The payoffs include: improved storage capability and transportation safety of fully assembled weapons; improved warhead and fuze effectiveness; improved submunition dispensing; low-cost airframe/subsystem components and structures; and reduced aerospace vehicle/weapon's drag.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate and develop high fidelity analytical tools such as computational mechanics models for predicting weapons' effects and assessing target vulnerability. These analysis tools will reduce air-delivered munitions development costs and provide weapons that can generate maximum lethality against a given target class.	6.507	6.321	7.125
(U) In FY 2003: Developed new hydro-code to improve predictive warhead performance capabilities by adding metal cutting, detonation waves, shear banding, and phase transitions. Upgraded and refined basic models describing fragmentation effects against various target facilities, including weapons of mass destruction (WMD). Performed phenomenology tests to provide data for the development of lethality and vulnerability codes for ground-fixed WMD targets. Applied campaign analysis tools to compare inventory, budgeted, and conceptual munitions to identify high payoff technologies.			
(U) In FY 2004: Continue upgrading and refining basic models describing fragmentation effects against various target facilities, including WMD. Continue applying campaign analysis tools to compare inventory, budgeted, and conceptual munitions to identify high payoff technologies. Develop improved engineering level predictive methods for blast effects, combined effects environment, and target structural response. Improve methodologies for predicting the penetration performance of unitary penetrating materials into complex target structures.			
(U) In FY 2005: Continue upgrading and refining basic models illustrating fragmentation effects against various target facilities, including hardened facilities and WMD. Continue using campaign analysis tools to compare inventory, budgeted, and conceptual munitions to identify high payoff technologies. Continue developing improved engineering level predictive methods with a simplified finite element model that estimates the damage from collapse and instability caused by direct weapon hits. Develop models to assess the failure of blast doors and other hardened assets in deep underground facilities.			
(U)			
(U) MAJOR THRUST: Investigate and develop more efficient, affordable explosives including inert dense metal	5.206	4.050	5.119

additives, tungsten-laden explosives, cast and cure high energy composite explosives, and nano-scale metal fuels that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. These technologies will enable safer, less expensive explosive fills for inventory and future weapons.

(U) In FY 2003: Completed creation of new, advanced, intermolecular energetic materials using micro-scale and nano-scale fuel and oxidizer particles. Completed efforts to develop a new class of materials for use in fragments, shaped charges, and explosively formed projectiles. Enhanced a highly energetic material development with twice the power density of conventional explosives, but exhibiting insensitive munition attributes. Evaluated materials for explosive capable of surviving Mach 4 impacts that will still functions as desired when initiated by the fuze. Completed research of dense reactive metal explosives and investigated cost-effective methods to improve current explosives.

(U) In FY 2004: Continue developing a highly energetic material that has twice the power density of conventional explosives, while still exhibiting insensitive munition attributes. Complete development of an explosive capable of surviving Mach 4 impacts that still functions as desired when initiated by the fuze. Develop characterization and evaluation methodologies to test the munition application performance of high energy density materials developed in other laboratories. Initiate increasing the energy output while maintaining the producible capability of cast and cure composite explosives by using advanced energetic materials, plasticizers techniques, and formulation techniques.

(U) In FY 2005: Continue developing a highly energetic material with twice the power density of conventional explosives, while still exhibiting insensitive munition attributes. Continue increasing the energy output while maintaining the producibility of cast/cure Plastic Bonded Explosives (PBX) composite explosives, by using advanced energetic materials, plasticizers, and formulation techniques. Complete an effort to add dense metal powders to PBX to enhance near-field lethality when low collateral damage is required.

(U)

(U) MAJOR THRUST: Investigate and develop advanced fuze technologies for air-delivered munitions, such as commercially available micro-mechanical systems, shock-hardened fuzes, low energy detonators, light activated and modular firing systems for advanced single-point initiation, switches, capacitors, power sources, and safe-arming components. These advanced fuze technologies will enhance lethality through precise selection of burst-height at, above, or below the surface to increase weapon safety and tactical performance while simultaneously decreasing procurement costs and system supportability requirements. 7.116 6.340 6.705

(U) In FY 2003: Designed a high resolution, electromagnetic countermeasure-hardened, active imaging fuze that calculates warhead burst direction and detonation time. Determined the benefits of developing a high-speed, hard target fuze using sensors such as micro-electromechanical system gyroscopes. Investigated technologies that communicate battle damage assessment information through hardened mediums.

(U) In FY 2004: Continue developing a high resolution, electromagnetic countermeasure-hardened, active imaging fuze that calculates warhead burst direction and detonation time. Complete investigating technologies that communicate battle damage assessment information through hardened mediums. Develop miniaturized fuze to effectively control the release of anti-agent and submunition for defeating weapons of mass destruction.

(U) In FY 2005: Continue developing a high resolution, electromagnetic countermeasure-hardened, active imaging fuze that calculates warhead burst direction and detonation time. Continue developing a miniaturized fuze to effectively control the release of anti-agent for defeating weapons of mass destruction. Begin developing a miniaturized fuze to provide safe and arm, burst point sensor and low power initiator in a 4 cubic inch package. Develop a wireless communication system to fuze a hard target munition.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Investigate and develop control and carriage technologies for ordnance packages for advanced air-delivered munitions in order to enhance weapon lethality. Examples of these technologies include high-energy explosives, mass-focus fragmentation, and multi-sensor fuzing. These technologies will increase weapon systems effectiveness by contributing to increased weapon load-out on strike aircraft and enhanced sortie effectiveness. Note: This effort includes $1.1 million in FY2003 Congressional Add funding for defense against Weapons of Mass Destruction.	13.146	5.567	8.745

(U) In FY 2003: Investigated and compared subsystem technologies necessary to develop an optimum kill missile against low-observable, air targets. Investigated technologies, such as microbots and nano-encapsulation, to disrupt, deny, destroy, or damage facilities containing chemical and biological weapons. Investigated technologies that can defeat hard and deeply buried targets by simultaneously placing multiple, precise, time-of-arrival guided munitions on target.

(U) In FY 2004: Continue investigating subsystem technologies necessary to develop an optimum kill missile against low-observable, air targets. Perform concept trade studies to determine the technologies necessary to deny adversary operations over long, stand off ranges.

(U) In FY 2005: Finish investigating specific missile subsystem technologies to counter low-observable, air targets. Begin an effort to design and ground test precise time-of-arrival munitions. Begin to identify the critical technologies needed for an advanced next generation, low cost mini-cruise missile. Begin developing technologies to deny enemy operations through loitering low-cost multi-shot munitions.

(U)

(U) MAJOR THRUST: Investigate and develop advanced warhead kill mechanisms, such as adaptable warhead, directional control and fragmenting ordnance, and application of reactive metals. The investigation includes characterization of the dynamic response of metals and geologic materials, adjustable yield ordnance packages, and distributed multi-point fire set to enhance air-delivered munition lethality. This enhanced lethality supports the development of smaller munitions with effectiveness similar to current inventory weapons and with a corresponding increase in aircraft load-out and sortie effectiveness.	13.922	7.194	8.198

(U) In FY 2003: Evaluated initiation-based, adaptable, and multi-mode warheads using enhanced lethality materials and miniaturization technologies for the advanced warhead kill mechanism. Evaluated ordnance technology to reduce fratricide in urban warfare scenarios. Completed assessment of multi-mode warheads using heavy metal liners to enhance lethality. Completed in-house experiments to characterize the interaction of munitions with chemical and

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT NUMBER AND TITLE **2502 Ordnance Technology**

biological weapon and storage containers. Conducted design trades to improve the attributes of penetrating munitions by focusing on improving warhead case survivability, control of depth of burial, trajectory control methodologies while penetrating hardened material and decreasing case thickness to allow a greater amount of energetic material to be carried to required depth of target.

(U) In FY 2004: Complete evaluating initiation-based, adaptable, and multi-mode warheads using enhanced lethality materials and miniaturization technologies for the advanced warhead kill mechanism. Continue evaluating an ordnance package designed for low collateral damage with high near-field and minimum far-field lethality. Continue an effort to improve the attributes of penetrating munitions by focusing on improving warhead case survivability, control of depth of burial, trajectory control methodologies while penetrating hardened material and decreasing case thickness to allow a greater amount of energetic material to be carried to the required depth of target. Begin evaluating tungsten to be used for high-speed, penetrating-warhead case material. Develop the design constraints to provide adaptable warhead technologies to better attack mobile ground targets. Develop experimental data analysis techniques to characterize the dynamic response of metals used for warhead cases. Investigate effectiveness of large blast explosive mechanisms.

(U) In FY 2005: Continue evaluating an ordnance package designed for low collateral damage with high near-field and minimum far-field lethality. Complete evaluation of low collateral damage, multi-mode warheads. Continue in-house effort to improve penetrating warhead case survivability, depth of burial, and trajectory control, with lower case thickness. Continue evaluating tungsten for high-speed penetrating weapons. Evaluate high energetic materials for adaptable warheads to attack mobile ground targets.

(U) Total Cost	45.897	29.472	35.892

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602605F DIRECTED ENERGY TECHNOLOGY

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	35.661	42.077	36.532	38.540	44.413	43.223	43.065	0.000	0.000
4866	Lasers & Imaging Technology	20.966	27.478	20.991	23.231	26.715	26.146	25.939	0.000	0.000
4867	Advanced Weapons & Survivability Technology	14.695	14.599	15.541	15.309	17.698	17.077	17.126	0.000	0.000

Note: In FY 2003, space unique tasks in Project 4866 were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program covers research in directed energy technologies, primarily lasers and high power microwaves, that are not space unique. In lasers, this includes moderate to high power lasers (solid state and chemical) and associated optical components and techniques. In advanced weapons, this program examines technologies such as narrowband and wideband high power microwave devices and antennas. Both areas also provide vulnerability/lethality assessments of representative systems. Note: In FY 2004 Congresses added $2.5 million for the 975 millimeter Stabilized Fiber Laser Pump Development, $2.1 million for the Stabilized Fiber Laser Pump Development, $2.0 million for Adaptive Optics Lasercom, and $0.5 million for the National High Energy Laser Consortium.

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 2003	FY 2004	FY 2005
(U)	Previous President's Budget	37.547	35.359	36.239
(U)	Current PBR/President's Budget	35.661	42.077	36.532
(U)	Total Adjustments	-1.886	6.718	
(U)	Congressional Program Reductions		-0.022	
	Congressional Rescissions		-0.360	
	Congressional Increases		7.100	
	Reprogrammings	0.383		
	SBIR/STTR Transfer	-2.269		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602605F DIRECTED ENERGY TECHNOLOGY**	**4866 Lasers & Imaging Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4866 Lasers & Imaging Technology	20.966	27.478	20.991	23.231	26.715	26.146	25.939	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in Project 4866 were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project examines the technical feasibility of moderate to high power lasers and associated optical components required for Air Force missions including long- and short-range weapons, weapon support such as aimpoint selection, and force protection. The technologies developed in this project are not uniquely space-oriented. Technologies applicable for a wide range of vehicles including unmanned combat air vehicles and fighters are being developed. High power solid state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, laser target vulnerability assessment techniques, and advanced optical processes and techniques are developed. Advanced, short-wavelength laser devices for applications such as illuminators and imaging sources for target identification and assessment are developed.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.			
(U) In FY 2003: This project previously included space unique tasks which have been transferred to PE 0602500F, Multi-disciplinary Space Technology. These funds represent the associated civilian salaries that were inadvertently left behind.	2.484	0.000	0.000
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop advanced laser remote optical sensing technology to support standoff detection of chemical/biological aerosols for signature intelligence on weapons of mass destruction; bomb damage assessment; target characterization; and theater intelligence, surveillance, and reconnaissance.	1.661	0.000	0.000
(U) In FY 2003: Developed design and hardware for differential absorption laser radar applications. Investigated issues for an airborne system. Effort was terminated in order to fund higher priority efforts.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop high power chemical laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications.	4.222	4.594	5.121
(U) In FY 2003: Improved high pressure ejector nozzle performance and iodine atom generation for potential long-range			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

technology insertion into applications such as airborne lasers. Investigated low-flow rate basic hydrogen peroxide and zero-gravity singlet delta oxygen generators for airborne applications. Investigated a combustor-driven one kilowatt supersonic all gas-phase iodine laser. Improved the efficiency of the radio frequency-pumped overtone carbon monoxide laser in various spectral bands of interest for infrared countermeasure and remote sensing applications.

(U) In FY 2004: Perform sub-scaled evaluation of optimized high pressure ejector nozzles and integrated iodine atom generation for airborne applications. Evaluate the feasibility of low-flow rate basic hydrogen peroxide and zero-gravity singlet delta oxygen generator concepts for airborne applications. Investigate the feasibility of electrical regeneration of laser consumables to reduce chemical laser logistics tail.

(U) In FY 2005: Evaluate enhanced scaled-up versions of the high pressure ejector nozzles incorporating iodine atom generation as appropriate for potential long-range technology insertion into airborne laser applications. Investigate scalability of high performance zero-gravity singlet delta oxygen generator concepts for airborne laser applications. Demonstrate chemical regeneration techniques or single pass singlet delta oxygen generators to reduce the weight of chemicals required for each mission.

(U)

(U) MAJOR THRUST: Develop high energy laser technologies for airborne tactical applications, including air-to-air and surface-to-air scenarios. Technologies being addressed include lasers for long-range detection of targets in clutter; high power, high-brightness, multi-wavelength compact lasers; and advanced beam control techniques to minimize platform vibration, atmospheric jitter, and aero-optical effects.	4.726	4.252	4.677

(U) In FY 2003: Investigated laser sources and supporting technology for detecting, identifying, tracking, and defeating electro-optic targets. Demonstrated 30-watt, near-diffraction-limited, 1.5 micron eye-safe laser. Addressed packaging issues for advanced tactical applications. Conducted research on solid state laser technologies that support the enhanced Battlefield Air Operations Kit.

(U) In FY 2004: Collect aero-optical data from tactical aircraft to anchor computer models. Address thermal management issues and packaging/integration/test issues for tactical laser weapon applications on airborne platforms. Demonstrate improvements in semiconductor laser efficiency and operating temperatures that could enable future tactical systems and combat identification systems.

(U) In FY 2005: Address and evaluate system-level solutions for detecting, identifying, tracking, and defeating electro-optic targets. Evaluate potential system-level solutions to issues involving tactical laser weapons applications on airborne platforms.

(U)

(U) MAJOR THRUST: Perform vulnerability assessments on potential high-energy laser targets to provide critical design data for laser systems to defeat these targets.	1.387	0.522	0.560

(U) In FY 2003: Updated lethality assessment methodology by anchoring modeling tools to empirical data. Performed

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

	finite state modeling of laser targets to better understand vulnerabilities and identify indicators for battle damage assessment.			
(U)	In FY 2004: Identify system constraints and performance in degraded situations, including battlefield conditions and weather.			
(U)	In FY 2005: Identify additional laser system constraints and performance in real world situations, including battlefield conditions and weather.			
(U)				
(U)	MAJOR THRUST: Develop scalable, high power fiber laser, conventional bulk solid state laser, and high-brightness diode laser technologies for next-generation electric laser device applications such as unmanned aerial vehicle designators/imagers and tactical airborne lasers.	6.210	7.367	6.611
(U)	In FY 2003: Demonstrated coherent beam combining of multiple high-power fiber amplifiers in a master oscillator, power amplifier configuration with free space optics.			
(U)	In FY 2004: Demonstrate all-fiber approach to beam combining at tens of watts with ytterbium-doped fiber lasers/amplifiers.			
(U)	In FY 2005: Demonstrate one kilowatt packaged breadboard fiber laser module demonstrating the building-block technology of future directed energy, megawatt-class electric lasers. Demonstrate wavelength versatile integrated laser/nonlinear optics at five watt power levels.			
(U)				
(U)	MAJOR THRUST: Develop broadly applicable technologies to support future tactical and strategic relay mirrors systems.	0.276	0.873	0.361
(U)	In FY 2003: Developed light weight, low power optics for relay mirrors.			
(U)	In FY 2004: Select the best lightweight, low power optics candidate technologies for airborne relay mirrors and start development of these optics for potential evaluation on a small-scale (with 50-cm primary optics) bifocal relay testbed.			
(U)	In FY 2005: Investigate and integrate technologies onto an airborne relay mirror breadboard for further evaluation.			
(U)				
(U)	MAJOR THRUST: Develop optical and beam control technologies to enhance high energy laser beam propagation over long distances in the atmosphere.	0.000	2.770	3.661
(U)	In FY 2003: Not Applicable. Funds were redirected for FY 2003 to support higher Air Force priorities.			
(U)	In FY 2004: Evaluate the performance of various wavefront sensors to maximize the ability to correct atmospheric effects on laser beams through laboratory demonstrations. Evaluate a compensated beacon illumination technique. Evaluate novel tracking algorithms. Anchor wave optics propagation code to actual beam control performance.			
(U)	In FY 2005: Develop optical components and complete active tracking experiments. Demonstrate advanced tracking methods and adaptive optics compensation techniques that double the Strehl ratio (peak intensity on target) in			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

	stressing atmospheric turbulence. Anchor wave optics propagation code to recent actual beam control performance.			
(U)				
(U)	CONGRESSIONAL ADD: National High Energy Laser Consortium.	0.000	0.500	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop a comprehensive five-year plan to create a joint government - industrial partnership to sustain the national industrial base in high powered lasers.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Stabilized Fiber Laser Pump Development.	0.000	4.600	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop single mode devices (optical fibers) to allow wavelength stabilized operation at ytterbium absorption peaks by integrating a grating into the optical fiber structure to control its operating frequency and to make it less susceptible to temperature changes.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Adaptive Optics Lasercom.	0.000	2.000	0.000
(U)	In FY 2003: Not Applicable:			
(U)	In FY 2004: Design, develop, integrate, and test a technique for air-to-air optical communication. Package existing technology for airborne evaluation using unmanned air vehicle simulator aircraft and ground facilities at the North Oscura Peak, White Sands Missile Range, New Mexico, test site. Performance goal is 2.5 gigabit per second to be verified by in-house analysis.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	20.966	27.478	20.991

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0601108F, High Energy Laser Research Initiatives.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602890F, High Energy									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

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

Laser Research.

(U) PE 0603444F, Maui Space Surveillance System.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) PE 0603924F, High Energy Laser Advanced Technology Program.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602605F DIRECTED ENERGY TECHNOLOGY**	**4867 Advanced Weapons & Survivability Technology**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4867	Advanced Weapons & Survivability Technology	14.695	14.599	15.541	15.309	17.698	17.077	17.126	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project explores high power microwave (HPM) and other unconventional weapon concepts using innovative technologies. Technologies are developed that support a wide range of Air Force missions such as the potential disruption and degradation of an adversary's electronic infrastructure and military capability. This effect can often be applied covertly with no collateral structural or human damage. Targeted capabilities include local computer and communication systems, as well as large and small air defense and command and control systems. This project also provides for vulnerability assessments of representative U.S. strategic and tactical systems to HPM weapons, HPM weapon technology assessment for specific Air Force missions, and HPM weapon lethality assessments against foreign targets.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate and develop technologies for narrowband and wideband HPM components to support multiple Air Force applications such as the disruption of electronic systems and subsystems.	5.992	7.070	7.450

(U) In FY 2003: Developed technology for compact repetitively operated sources. Further improved the electrical efficiency of wideband HPM sources in order to achieve greater range, longer lifetime, and smaller packaging. Conducted pulsed atmospheric breakdown experiments. Conducted explosive generator development experiments to support compact single-shot HPM sources. Conducted a sub-scale (laboratory) repetitively pulsed gigawatt class experiment. Developed conformal phased array antenna for HPM systems. Selected a repetitively pulsed multi-gigawatt technology for HPM breadboard munitions and airborne electronic attack proof-of-concept. Utilized nanotechnology components (nanotubes) to develop cathodes and anodes for repetitively pulsed HPM experiments. Developed target identification concept using wideband technology.

(U) In FY 2004: Develop compact repetitively operated source technologies. Conduct pulsed atmospheric breakdown experiments. Integrate explosive generator development experiments with compact single-shot HPM sources. Investigate conformal phased array antenna for HPM systems. Develop sub-scale (laboratory) repetitively pulsed multi-gigawatt technology for HPM breadboard munitions and airborne electronic attack proof-of-concept. Conduct laboratory evaluation of nanotechnology developed cathodes and anodes for repetitively pulsed HPM experiments. Utilize nanotechnology and other technologies to reduce the HPM source weight. Conduct a sub-scale (laboratory) wideband technology target identification experiment.

(U) In FY 2005: Investigate compact repetitively operated sources. Further improve the electrical efficiency of wideband HPM sources in order to achieve greater range, longer lifetime, and smaller packaging. Conduct pulsed atmospheric breakdown experiments. Conduct explosive generator development experiments to support compact single-shot HPM

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4867 Advanced Weapons & Survivability Technology**

	sources. Conduct a sub-scale (laboratory) repetitively pulsed gigawatt class experiment. Develop conformal phased array antenna for HPM systems. Select a repetitively pulsed multi-gigawatt technology for HPM breadboard munitions and airborne electronic attack proof-of-concept. Utilize nanotechnology components (nanotubes) to continue development of cathodes and anodes for repetitively pulsed HPM experiments. Develop target identification concept using wideband technology. Further develop wideband technology target identification source to demonstrate increased standoff range.			
(U)				
(U)	MAJOR THRUST: Develop and use the ability to assess the effects/lethality of HPM directed energy weapon technologies against representative air and ground systems.	2.567	2.160	2.315
(U)	In FY 2003: Conducted susceptibility tests of representative command and control warfare targets. Conducted susceptibility tests to determine relative importance of source parameters in causing the desired effects on targets. Implemented effects data and results into narrowband and wideband HPM experiments. Refined codes for better prediction of probability of effect on experimental targets and to guide program direction. Developed better modeling techniques to incorporate HPM technologies into warfighting/wargaming activities. Validated specific computer codes' ability to adequately predict the electromagnetic coupling to, and probability of effect on, experimental targets within complex structures. Supported implementation of predictive models into existing engagement models.			
(U)	In FY 2004: Conduct susceptibility tests to determine relative importance of source parameters in causing the desired effects on targets. Use current effects data and results in narrowband and wideband HPM experiments. Refine HPM codes to predict probability of effect on target equipment and to guide experiment direction. Develop better modeling techniques to incorporate HPM technologies into warfighting/wargaming activities. Further validate additional/modified computer codes' ability to adequately predict the electromagnetic coupling to, and probability of effect on, target equipment within complex structures.			
(U)	In FY 2005: Conduct further susceptibility tests to determine relative importance of source parameters to cause desired effects on targets. Proceed with the refinement of codes to predict probability of effect on target equipment and to guide experiment direction. Refine modeling techniques to incorporate HPM technologies into warfighting/war gaming activities. Proceed with validation of computer codes' ability to adequately predict the electromagnetic coupling to, and probability of effect on, target equipment within complex structures.			
(U)				
(U)	MAJOR THRUST: Develop and apply the theory of advanced computation to enhance the development of HPM and related technology.	0.760	0.752	0.791
(U)	In FY 2003: Investigated numerical dispersions and enhanced plasma models and physics algorithms for HPM technologies. Performed virtual prototyping for HPM component technologies.			
(U)	In FY 2004: Investigate plasma models and develop physics algorithms for HPM technologies. Develop improved algorithms for higher frequency wideband HPM modeling. Perform further virtual prototyping for HPM component			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4867 Advanced Weapons & Survivability Technology**

	technologies.			
(U)	In FY 2005: Investigate/enhance plasma models and develop the physics algorithms for use with HPM technologies. Develop improved algorithms for higher frequency wideband HPM modeling. Investigate methods for integration of electromagnetic and acoustic software with thermal and electron transport codes for high-fidelity surface simulations. Apply virtual prototyping for HPM component technologies.			
(U)				
(U)	MAJOR THRUST: Investigate HPM technologies that support offensive advanced airborne tactical applications made possible by the increased power available on future aircraft.	4.512	4.617	4.985
(U)	In FY 2003: Studied enhanced source components of promise and began modeling and simulation of a complete source. Determined effect of air breakdown on transmitted HPM pulse over time. Studied aircraft integration issues of interest to determine effectual lethality of various concepts.			
(U)	In FY 2004: Investigate enhanced source components of promise, especially plastic-laminate pulse forming lines, with an integrated Marx pulser. Model and perform simulation of the complete source. Complete determination of effect of air breakdown on transmitted HPM pulse over time. Finish initial aircraft integration report on source effects on the aircraft and command and control issues between the HPM source and the aircraft.			
(U)	In FY 2005: Improve the HPM effects modeling and simulation database so it is warfighter friendly. Produce a model of a complete HPM source. Upgrade source models to include aircraft concept of operations. Proceed with source self-mitigation efforts, so as not to interfere with host platform. Begin source to aircraft command and control efforts. Complete current source component study of plastic-laminate pulse forming lines with integrated Marx pulser. Test source upgrades and their effect of the aircraft, as well as the command and control interface.			
(U)				
(U)	MAJOR THRUST: Further develop active denial technologies to support airborne agile combat support applications.	0.864	0.000	0.000
(U)	In FY 2003: Developed computational physics algorithms for next-generation airborne millimeter wave sources by modeling sub-scale pieces of existing active denial sources to verify validity of computational approach. Developed preliminary design of a ground-based megawatt-class airborne source demonstrator. Transferred to PE 0603605F in FY 2004 for a ground-based demonstration of airborne applicable technologies.			
(U)	In FY 2004: Not Applicable. Note: Transferred to PE 0603605F for FY 2004 and out for a ground-based demonstration of airborne applicable technologies.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	14.695	14.599	15.541

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4867 Advanced Weapons & Survivability Technology**

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

(U) PE 0602202F, Human Systems Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	77.637	79.594	82.147	82.865	90.866	88.794	90.720	0.000	0.000
4519	Communications Technology	14.268	16.532	17.235	17.141	17.604	18.129	18.667	0.000	0.000
4594	Information Technology	23.109	28.600	25.511	25.557	28.224	28.610	28.484	0.000	0.000
4917	Collaborative Information Tech	15.530	7.746	5.637	5.197	5.297	5.456	5.616	0.000	0.000
5581	Command and Control (C2) Technology	24.730	26.716	33.764	34.970	39.741	36.599	37.953	0.000	0.000

(U) A. Mission Description and Budget Item Justification

This program develops technology for Air Force Command, Control, and Communications (C3). Advances in C3 are required to increase warfighter readiness by providing the right information, at the right time, anywhere in the world. The program has four projects. The Communication Technology project develops assured and secure communications technology. The Information Technology project develops improved and automated capabilities to generate, process, fuse, exploit, interpret, and disseminate timely and accurate information. The Collaborative Information Technology project develops high payoff emerging technologies for the next generation of distributed, collaborative command and control systems. The Command and Control Technology project investigates and develops planning, assessment, and knowledge base technologies to allow the warfighter to plan, assess, execute, monitor, and re-plan on the compressed time scales required for tomorrow's conflicts. Note: In FY 2004, Congress added $1.2 million for the Griffiss Institute, $4.0 million for Measures and Signatures Intelligence Warfighter Visualization Tools, $2.4 million for Secure Knowledge Management for Collaborative Enterprise Management, and $1.0 million for Effects Based Planning Execution and Assessment.

This program is 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 2003	FY 2004	FY 2005
(U)	Previous President's Budget	78.204	71.674	82.764
(U)	Current PBR/President's Budget	77.637	79.594	82.147
(U)	Total Adjustments	-0.567	7.920	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.680	
	Congressional Increases		8.600	
	Reprogrammings			
	SBIR/STTR Transfer	-0.567		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602702F Command Control and Communications**	**4519 Communications Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4519 Communications Technology	14.268	16.532	17.235	17.141	17.604	18.129	18.667	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The Air Force requires technologies that enable assured, worldwide communications for an agile Expeditionary Aerospace Force (EAF). These communication technologies will provide en route and deployed reachback communications for distributed collaborative command and control (C2). A rapidly deployed EAF requires assured connectivity with reliable, responsive, affordable information exchange via all available communications media. This project provides the technologies for: multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques; lightweight, phased array antennas; and modular, programmable, low-cost software radios. It includes technologies for advanced processors and devices, advanced network protocols and services, intelligent communications management and control, advanced communications algorithms, and enabling communication signal processing techniques.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop assured and survivable information and networking technologies enabling worldwide C3 operations for the Air Force Task Forces.	5.254	5.583	6.022
(U) In FY 2003: Developed technologies to improve quality of service for globally distributed information systems. Completed development of assured networking and information systems technologies to improve survivability against critical infrastructure attacks. Developed securely managed enterprise network technology to develop assured network services across multiple network security domains. Developed programmable networking algorithms that enable the dynamic creation of advanced information delivery services, independent of the underlying physical infrastructure devices.			
(U) In FY 2004: Continue to develop technologies to improve quality of service for globally distributed information systems (e.g., Joint Battlespace Infosphere (JBI)). Continue development of assured networking and information systems technologies to improve survivability against critical infrastructure attacks. Continue development of securely managed enterprise network technology to develop assured network services across multiple network security domains and coalitions. Continue development of programmable networking algorithms that enable wide area dynamic creation of advanced information delivery services that are independent of the underlying physical infrastructure devices			
(U) In FY 2005: Continue to develop technologies to improve quality of service and survivability for globally distributed information systems (e.g., JBI). Complete development of assured networking and information systems technologies to improve survivability against critical infrastructure attacks. Complete development of securely managed enterprise network technology to develop assured network services across multiple network security domains. Continue development of programmable networking algorithms that enable wide area dynamic creation of advanced			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4519 Communications Technology**

information delivery services, independent of the underlying physical infrastructure devices. Initiate development of capabilities for self-organizing, self-healing, autonomous networking.

(U)

(U)	MAJOR THRUST: Develop improved, higher bandwidth communications and signal processing technologies to provide secure, adaptive, covert, anti-jam, and assured global battlespace connectivity to highly mobile aerospace forces while reducing the equipment footprint.	4.136	4.427	4.510

(U) In FY 2003: Developed techniques to improve information assurance capabilities for mobile wireless networks by precluding information attacks aimed at denial of service and quality of service degradation. Developed assured communication technologies that enable a full spectrum of information superiority capabilities in wireless networks in a joint/coalition environment. Investigated high performance wireless device and waveform technologies for improving affordability of critical Air Force command and control networks.

(U) In FY 2004: Continue development of information assurance technologies that will improve the robustness of the Global Information Grid in both wired and wireless networks for ground, air, and joint/coalition environments to preclude information systems attacks, such as denial of service and degradation of device quality. Continue to develop high performance, adaptable, and re-configurable wireless devices to implement new waveform technologies for improved robustness, security, and affordability of critical Air Force command and control networks. Initiate development of higher performance video compression and modulation techniques that enable critical objectives for high bandwidth information transmission and exploitation capabilities over wireless channels.

(U) In FY 2005: Continue development of information assurance technologies that improve the robustness of the Global Information Grid in both wireline and wireless networks for air, space, ground, and joint/coalition environments to preclude information systems attacks such as distributed denial of service and degradation of device quality. Continue to develop high performance, adaptable, and reconfigurable wireless devices to implement new waveform technologies for improved robustness, security, and affordability of critical Air Force command and control networks. Continue development of higher performance video compression and modulation techniques that enable critical objectives for high bandwidth information transmission and exploitation capabilities over wireless channels. Explore the feasibility of implementation of above technologies, where applicable, to Joint Tactical Radio System or compatible software radios.

(U)

(U)	MAJOR THRUST/CONGESSIONAL ADD: Develop cyber operations technologies for enabling worldwide command, control, communications and intelligence. Note: This effort includes $1.2 million in FY 2004 Congressional Add funding for the Griffiss Institute.	4.878	6.522	6.703

(U) In FY 2003: Developed automated capabilities for damage assessment and recovery techniques. Developed computer and network forensics tools and data mining tools to assess coordinated information warfare attacks. Developed detection and eradication techniques for malicious software. Investigated active response technologies,

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4519 Communications Technology**

detection of hidden data, and early assessment of complex information warfare attacks.

(U) In FY 2004: Continue to develop automated capabilities for damage assessment and recovery techniques. Continue development of network forensics and data mining tools for detecting adversary information warfare attacks and to provide early warning notification. Continue to develop detection and eradication techniques for malicious code. Continue development of active response technologies. Complete work in detection of hidden data. Initiate the development of advanced correlation fusion techniques for defensive course of action analysis. Initiate development of intrusion detection techniques for wireless networks. Initiate the development of new tools and techniques to protect command, control, communications, intelligence, and information systems, and allow for integration of coalition information elements.

(U) In FY 2005: Continue to develop automated capabilities for damage assessment and recovery techniques. Complete development of network forensics. Continue development of data mining tools for detecting adversary information warfare attacks and provide early warning notification. Continue to develop detection and eradication techniques for malicious code. Continue development of active response technologies. Continue development of advanced correlation fusion techniques for defensive course of action analysis. Continue development of intrusion detection techniques for wireless networks. Continue the development of tools and techniques to protect C4I and information systems and allow for integration of coalition information elements.

(U) Total Cost	14.268	16.532	17.235

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0603789F, C3I Advanced Development.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**		PROJECT NUMBER AND TITLE **4594 Information Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4594 Information Technology	23.109	28.600	25.511	25.557	28.224	28.610	28.484	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

The Air Force requires technologies that improve and automate their capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. This project improves global awareness at all levels, enabling warfighters to understand relevant military situations on a consistent basis, with the timeliness and precision needed to accomplish their missions. Global awareness is achieved by exploiting information provided by the Air Force and other government agencies. The information is fused to support the dynamic planning and execution cycle via the global information enterprise. Knowledge, information, and data are all archived in the global information base for continued use and historical analysis. The information technologies required to achieve this capability are developed under this project in an affordable manner and include appropriate access mechanisms for our coalition partners.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop innovative multi-sensor collaborative fusion technologies in a fully distributed air and space environment.	5.538	6.637	6.813
(U) In FY 2003: Developed techniques to quantitatively evaluate fusion algorithms. Developed multi-source fusion techniques for continuous tracking of militarily significant vehicles in the battlespace. Developed and evaluated fusion technologies for enemy threat prediction based on multi-source fusion.			
(U) In FY 2004: Continue to develop techniques to quantitatively evaluate fusion algorithms that support the analysis of a new emerging information era. Continue development of optimized multi-source fusion techniques for continuous tracking of militarily significant vehicles in the battlespace. Continue development and evaluation of fusion technologies for enemy threat prediction through the use of multi-source fusion.			
(U) In FY 2005: Evaluate fusion techniques to determine optimal algorithms based upon data available that support the analysis of a new emerging information era. Continue to develop optimized multi-source fusion techniques for positive identification and continuous tracking of militarily significant vehicles in the battlespace. Continue development and evaluation of fusion technologies for enemy threat prediction based on the use of multi-source fusion.			
(U)			
(U) MAJOR THRUST: Develop higher level fusion and the enabling information/knowledge base technologies to achieve situational awareness at all command levels for the dynamic planning and execution process.	4.612	5.531	5.694
(U) In FY 2003: Developed intermediate information extraction techniques that will reduce data overload and increase time allocated to analysis and decision-making, enabling the ability to populate knowledge base systems. Developed techniques for a self-organizing, data repository, and content-based extraction. Developed advanced web-based			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4594 Information Technology**

search techniques and information aggregation methods required for rapid situational understanding.

(U) In FY 2004: Continue development of intermediate information extraction techniques to reduce data overload and increase time allocated to analysis and decision-making, enabling the ability to populate knowledge base systems. Continue development of data mining techniques for a self-organizing data repository and content-based extraction to support prediction of potential events in the world. Continue development of advanced web-based search techniques, data filtering techniques, and information aggregation methods required for rapid situational understanding.

(U) In FY 2005: Continue development of intermediate information extraction techniques to decrease analysis time for decision-making and enabling the ability to populate knowledge base systems. Continue development of data mining techniques for self-organizing data repositories and content-based extraction to support identification of potential events in the world. Continue development of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available data on the Web required for rapid situational understanding.

(U)

(U) MAJOR THRUST: Develop automatic and dynamically reconfigurable, affordable, scalable, distributed petaflop processing technologies for real-time command and control (C2) global information systems.	2.886	3.606	3.948

(U) In FY 2003: Completed the processor-in-memory, content-addressable architecture for rapid extraction of information from globally distributed knowledge bases. Evaluated architecture to support real-time requirements for dominant battlespace awareness.

(U) In FY 2004: Develop and demonstrate architectures for rapid extraction of information from globally distributed knowledge bases. Continue evaluation of architectures to support real-time requirements for dominant battlespace awareness. Initiate study of next generation information technologies (e.g., quantum computing and bio-molecular computing) for C2 systems.

(U) In FY 2005: Demonstrate architecture for rapid extraction of information from globally distributed knowledge bases. Demonstrate architecture to support real-time requirements for dominant battlespace awareness. Continue study of next generation information technologies (e.g., quantum computing and bio-molecular computing) for C2 systems.

(U)

(U) MAJOR THRUST: Develop modeling and simulation technologies for the next generation of planning, execution, and assessment environments.	2.908	1.916	2.006

(U) In FY 2003: Evaluated, exploited, and developed model abstraction and multi-resolution modeling techniques to reduce the complexity of existing high-resolution models and simulations for next generation distributed collaborative decision support environments, such as the Joint Synthetic Battlespace.

(U) In FY 2004: Complete model abstraction and multi-resolution modeling techniques to reduce the complexity of existing high-resolution models and simulations for next generation distributed collaborative decision support environments. Initiate development of decision support technologies, and their theoretical foundation, to support

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4594 Information Technology**

high-profile system concepts, such as the Joint Synthetic Battlespace and the Global Strike Task Force.

(U) In FY 2005: Continue to develop modeling and simulation technologies to support next generation planning execution and assessment environments. Develop adversarial behavior models and modeling techniques for course of action assessment and prediction. Prototype and demonstrate decision support technologies and the theoretical foundation to support high-profile system concepts; such as the Joint Synthetic Battlespace and Air Force Concepts of Operations.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop digital information exploitation technologies for electronic communications and special signals intelligence, imagery and measurement signatures to increase accuracy, correlation and timeliness of the information value to the decision maker. Note: This effort includes $4.0 million in FY 2004 Congressional Add funding for Measurement and Signature Intelligence Warfighter Visualization Tools.	5.766	10.910	7.050

(U) In FY 2003: Developed advanced multi-sensor open systems techniques and automated analyst tools for exploiting hyperspectral imagery, on-board video processing, new electronic signals, and speech intelligence products to achieve improved situational awareness.

(U) In FY 2004: Continue development of advanced multi-sensor open systems techniques and automated analyst tools for exploiting measurement and signature intelligence, hyperspectral imagery, on-board video processing, new electronic signals, moving target indicator, and speech intelligence products for improved situational awareness, indication and warning, and reporting capabilities. Research techniques in steganography, steganalysis, and watermarking of imagery, video and speech for information protection and authentication, intelligence exploitation, and analysis tool aids.

(U) In FY 2005: Continue development of advanced multi-sensor and automated analyst tools for exploiting measurement and signature intelligence, commercial sources and hyperspectral imagery, on-board video processing, new digital electronic signals, moving target indicator, and speech intelligence products to feed an information fusion process in support of the decision maker. Continue development of techniques in steganography, steganalysis, watermarking and digital data forensics for imagery, video and speech information protection and authentication, intelligence exploitation, and analysts' tool aids. Initiate investigation of new techniques to improve open systems techniques for multi-sensor exploitation for enhanced indications and warning and situational awareness.

(U)

(U) CONGRESSIONAL ADD: Information Protection and Authentication.	1.399	0.000	0.000

(U) In FY 2003: Developed information hiding, steganography, and digital watermarking to protect and authenticate data within Air Force and DoD information systems. Developed and evaluated steganographic detection, decoding, and countermeasure techniques for data embedding, tamper detection and proofing, image and video content authentication, and secure information dissemination.

(U) In FY 2004: Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4594 Information Technology**

(U) In FY 2005: Not Applicable.

(U)	Total Cost	23.109	28.600	25.511

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603789F, C3I Advanced Development.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602702F Command Control and Communications**	**4917 Collaborative Information Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4917 Collaborative Information Tech	15.530	7.746	5.637	5.197	5.297	5.456	5.616	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

To implement the Global Strike Task Force and other task force concepts, the Air Force requires a distributed, collaborative command and control (C2) system, allowing the majority of the C2 center to remain in the continental United States, while only a small command element is deployed forward. This project accomplishes the initial exploration of high payoff emerging technologies for the next generation of distributed collaborative C2 systems. This program develops technologies for platform connectivity, distributed collaboration, and embedded information systems. Platform connectivity technologies focus on advanced modulation waveforms for bandwidth efficiency, assured aerospace platform connectivity for C2, and conceptual design approaches for seamless integration of aerospace weapon systems into the information grid. Distributed collaboration technologies advance collaboration science, virtual environments, and predictive simulation tools to facilitate the development and fielding of next generation operational collaborative decision support systems. Embedded information systems technologies explore high payoff technologies for the next generation of distributed information integration architectures, which will provide cross disciplinary products/capability to a decision maker when, where, and how it is needed. It also provides embedded information system technologies for affordable and adaptable design and development of complex C2 systems, facilitated by an open system architecture approach.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems' C2, intelligence, surveillance, and reconnaissance data/information.	1.808	1.989	2.012
(U) In FY 2003: Developed assured secure communications technology, leveraging the commercial infrastructure, for positive C2 of aerospace assets in civilian airspace. Developed secure, wide-band wireless information transfer technology for assured communications between munitions and aircraft.			
(U) In FY 2004: Continue the development of assured communications technology, leveraging commercial infrastructure, for positive C2 of aerospace assets in commercial airspace. Continue the development of secure, wide-band wireless miniaturized transceiver information transfer technology for assured communications between munitions and aircraft.			
(U) In FY 2005: Continue the development of assured communications technology, leveraging commercial infrastructure, for positive command and control of aerospace assets in commercial airspace. Complete the design and development of secure, wide-band wireless miniaturized transceiver information transfer technology for assured communications between munitions and aircraft. Develop, test, and assess exploratory information transfer technologies.			
(U)			
(U) MAJOR THRUST: Develop processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems.	2.533	1.388	1.505
(U) In FY 2003: Developed dynamically reconfigurable aerospace systems using adaptive computing techniques.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4917 Collaborative Information Tech**

	Developed concepts, designs, and models for the next generation C2 global information systems, which will allow affordable design and development of highly complex aerospace systems. Developed methods and processes for determining the suitability of Java and Real-Time Java to support open system architectures for real-time, embedded information systems.			
(U)	In FY 2004: Continue to develop dynamically reconfigurable aerospace systems using adaptive computing techniques. Define and develop algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms.			
(U)	In FY 2005: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques. Continue to develop algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms. Develop methods and processes for implementation of Java and Real-Time Java Virtual Machines using adaptive computing techniques.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop advanced information technologies for collaborative decision support, knowledge management, and rapid adaptation/re-allocation of assets in response to the continually changing threat environment. Note: This effort includes $3.5 million in FY 2003 Congressional Add funding for Secure Knowledge Management and $2.4 million in FY 2004 Congressional Add funding for Secure Knowledge Management for Collaborative Enterprise Management.	7.728	4.369	2.120
(U)	In FY 2003: Investigated techniques to perform the collaborative planning for the seven Air Force Concepts of Operations (AF CONOPS). Developed distributed decision-making technology for joint battlespace information environment. Developed technology to support a sensor-to-shooter scenario stressing the time-critical target requirement, which will result in denying the enemy the sanctuary of time.			
(U)	In FY 2004: Develop techniques to assist in performing the collaborative planning for the seven AF CONOPS. Initiate development of distributed collaborative environment technology for effects-based operations and predictive battlespace awareness. Continue to develop technology to support a sensor-to-shooter scenario stressing time-critical target requirement, which will deny the enemy sanctuary of time.			
(U)	In FY 2005: Continue development of techniques to perform collaborative, capability based planning required by the seven AF CONOPS. Continue development of distributed collaborative environment technology for effects based operations and predictive battlespace awareness. Complete work to develop technology to support a sensor-to-shooter scenario stressing time-critical target requirement, which will deny the enemy sanctuary of time.			
(U)				
(U)	CONGRESSIONAL ADD: Agile Research and Development/Science and Technology Center of Excellence.	3.461	0.000	0.000
(U)	In FY 2003: Developed simulation-based acquisition (SBA) technologies for application to integrated aerospace systems design and analysis. Developed an enhanced collaborative technology architecture supporting the tenets of SBA. Demonstrated the enhanced architecture in an experiment for collaborative spiral requirements and capability			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4917 Collaborative Information Tech**

based planning.
(U) In FY 2004: Not Applicable.
(U) In FY 2005: Not Applicable.

(U) Total Cost	15.530	7.746	5.637

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0603789F, C3I Advanced Development.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy
Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **5581 Command and Control (C2) Technology**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5581	Command and Control (C2) Technology	24.730	26.716	33.764	34.970	39.741	36.599	37.953	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The Air Force requires command and control (C2) technologies, that will provide the next generation of weapon systems with improved processing and presentation of information for real-time, distributed battle management. Technologies being developed in this project will increase capability and quality, while reducing the cost of C2 systems and infrastructure. Technology development in this project focuses on planning and assessing techniques, knowledge bases, distributed information systems, and information management and distribution services. Advances in planning and assessment technologies will vastly improve the military decision making process within C2 systems. Advances in the ability to detect, classify, identify, and track objects and events will improve the understanding and prediction of enemy intentions, allowing the development of various courses of action to counter their intentions. Advances in the development of very large comprehensive knowledge bases to rapidly formulate and create new knowledge are needed by the Expeditionary Aerospace Force. Advances in distributed intelligent information systems will allow automatic rapid reconfiguration of C2 centers to respond to varying crisis levels, as required, by the Expeditionary Aerospace Force. Advances in robust information management and distribution technologies will ensure the delivery of high-quality, timely, secure information to the warfighter.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems.	4.930	6.576	7.393
(U) In FY 2003: Developed tools that will automate intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Developed enhanced reasoning techniques for complex inferencing and performance of C2 systems.			
(U) In FY 2004: Continue to develop tools that will automate the intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Investigate and develop ultra-large, all-source information repositories and associated privacy protection technologies. Complete development of enhanced reasoning techniques for complex inferencing and performance of C2 systems.			
(U) In FY 2005: Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Continue to develop tools that will automate the intelligent extraction, correlation and classification of link patterns for discovering relevant linkages between entities. Continue development of ultra-large all-source information repositories and associated privacy protection technologies.			
(U)			
(U) MAJOR THRUST: Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by the Expeditionary Aerospace Force.	7.031	7.385	8.228

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **5581 Command and Control (C2) Technology**

(U)	In FY 2003: Developed a dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing Air Operation Center (AOC) command and control (C2) process. Developed advanced interactive displays suitable for deployment with C2 applications and command centers. Developed techniques and applications for information visualization for use in conjunction with multiple, heterogeneous data sets.			
(U)	In FY 2004: Continue to develop a dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing AOC C2 process. Continue to develop advanced interactive displays suitable for deployment with C2 applications and command centers. Complete the development of techniques and applications for visualization of multiple, heterogeneous data sets. Develop technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies.			
(U)	In FY 2005: Continue to develop dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing AOC C2 process. Continue to develop advanced interactive displays suitable for deployment with C2 applications and command centers. Initiate development of advanced techniques and AOC-based applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Continue to develop technologies to improve the fidelity, accuracy, and interconnection of computer-based wargames used to prepare contingency plans and response strategies.			
(U)				
(U)	MAJOR THRUST: Investigate and develop technologies to securely share information via publish, subscribe, and query within a coalition environment. Note: Broken out from the next major thrust below due to the increased emphasis on C2 in a coalition environment.	0.000	0.000	5.276
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Initiate investigation and development of technologies to dynamically filter and fuse information and produce customized coalition information products. Start development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition Joint Battlespace Infosphere (JBI). Initiate development of technology approaches that will rapidly incorporate coalition force structure units into an operational infosphere.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Investigate and develop technologies to implement flexible, secure, and survivable information management and distribution services to enable a JBI. Note: This effort includes $3.0 million in FY 2003 Congressional Add funding for Information Management for Crisis Response.	6.238	2.671	2.904
(U)	In FY 2003: Developed techniques for integrating legacy client-server C2 systems into the next generation of agile, web-enabled information management environments. Investigated approaches to enable a JBI to service thousands of			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **5581 Command and Control (C2) Technology**

participating C2 and intelligence, surveillance, and reconnaissance clients exchanging millions of information objects. Investigated and developed technologies that will ensure availability, integrity, and survivability of information within a Joint Battlespace Infosphere.

(U) In FY 2004: Continue to develop techniques and tools for integrating legacy client-server command and control (C2) systems into a publish, subscribe, and query infosphere.

(U) In FY 2005: Complete development of techniques and tools for integrating legacy client-server C2 systems into a publish-subscribe and query infosphere. Continue to investigate and develop publish, subscribe, and query technologies enabling a secure infosphere that can support thousands of C2 and intelligence, surveillance, and reconnaissance clients, and can operate within a coalition warfighting environment. Investigate techniques to optimize publish, subscribe, and query mechanisms within bandwidth limited environments.

(U)

(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop next generation monitoring, planning, execution, and assessment technologies and tools enabling distributed aerospace commanders to efficiently and collaboratively develop effects based campaigns. Note: This effort includes $1.0 million of FY 2004 Congressional Add funding for Effects-Based Planning Execution Assessment.	6.531	10.084	9.963

(U) In FY 2003: Developed the next generation of planning and assessment technologies and tools enabling aerospace commanders to determine and create the desired operational effects at the right place and at the right time. Developed technologies to dynamically assess the battlespace, determine measures to create the desired effects, and provide near-real-time command of forces to execute those measures. Developed tools to visualize the probability of success of qualitatively different courses of action. Developed intelligent agent technologies capable of supporting joint/coalition C2 systems for various missions. Developed and assessed active template technologies for use in dynamic mobile C2 applications. Developed tools to increase situational awareness through intelligent information push and pull in dynamic environments.

(U) In FY 2004: Develop the next generation of monitoring, planning, execution, and assessment technologies and tools enabling aerospace commanders to efficiently and collaboratively develop effects-based campaigns. Continue to develop technologies to dynamically and rapidly assess the battlespace, and provide near-real-time command of manned and unmanned forces to execute the required missions. Investigate developments in decision support science for incorporation into command and control (C2) tools. Continue to develop tools to visualize the probability of success of qualitatively different courses of action. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions. Develop and assess active template and semantic ontology technologies for use in mobile C2 applications. Continue to develop tools to increase situational awareness through intelligent information push and pull in dynamic environments.

(U) In FY 2005: Continue to develop technologies to dynamically and rapidly assess the battlespace, and provide near-real-time command of manned and unmanned forces to execute the required missions incorporating

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **5581 Command and Control (C2) Technology**

developments in decision support science. Complete development of tools to visualize the probability of success of qualitatively different courses of action. Continue to develop intelligent information systems capable of supporting joint/coalition command and control (C2) for various missions. Continue to develop and assess active template and semantic ontology technologies for use in C2 applications. Continue to develop tools to increase situational awareness through intelligent information push and pull in dynamic environments. Initiate investigation of intelligent information processing techniques to enhance the C2 decision making process.

(U)	Total Cost	24.730	26.716	33.764

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603617F, C3 Applications.									
(U)	PE 0303401F, Communications-Computer Systems (C-CS) Security RDT&E.									
(U)	PE 0603789F, C3I Advanced Development.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	10.075	10.496	5.151	2.961	5.147	5.317	5.480	0.000	0.000
4770	Dual Use Science and Technology (S&T)	10.075	10.496	5.151	2.961	5.147	5.317	5.480	0.000	0.000

(U) A. Mission Description and Budget Item Justification

This program seeks to leverage industry investments with interests in advanced technologies of mutual advantage to the Air Force and the commercial sector. A key objective of this program is for the Air Force to stimulate the development of dual use technologies so as to provide greater access to commercially developed technologies and to promote more affordable defense systems that maintain battlespace superiority. A critical component of this program is the cost-sharing requirement from industry and specific Air Force programs. The cooperative funding assures joint commitment to the transition and dual use development efforts of successfully demonstrated technologies. Specific projects are determined through annual competitive solicitations. Technology areas considered may include advanced materials and manufacturing; sensors; advanced propulsion, power, and fuel efficiency; information and communications technologies; and weapon systems sustainment.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	10.395	10.586	8.864
(U)	Current PBR/President's Budget	10.075	10.496	5.151
(U)	Total Adjustments	-0.320	-0.090	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.090	
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer	-0.320		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are a result of higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602805F Dual Use Science & Technology**	**4770 Dual Use Science and Technology (S&T)**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4770	Dual Use Science and Technology (S&T)	10.075	10.496	5.151	2.961	5.147	5.317	5.480	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program seeks to leverage industry investments with interests in advanced technologies of mutual advantage to the Air Force and the commercial sector. A key objective of this program is for the Air Force to stimulate the development of dual use technologies so as to provide greater access to commercially developed technologies and to promote more affordable defense systems that maintain battlespace superiority. A critical component of this program is the cost-sharing requirement from industry and specific Air Force programs. The cooperative funding assures joint commitment to the transition and dual use development efforts of successfully demonstrated technologies. Specific projects are determined through annual competitive solicitations. Technology areas considered may include advanced materials and manufacturing; sensors; advanced propulsion, power, and fuel efficiency; information and communications technologies; and weapon systems sustainment.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Advance materials and manufacturing technologies.	2.015	2.663	1.306
(U) In FY 2003: Explored processes and technologies relative to Air Force and commercial air and space vehicles and launch systems. Technology areas of interest included: non-destructive/non-intrusive evaluation techniques; smart and adaptive skins; corrosion resistant coatings; micro- and nano-scale electronics; durable, lightweight materials for space launch; and agile materials for use in force protection.			
(U) In FY 2004: Enhance the capability, performance, durability, and affordability of Air Force and commercial air and space systems. Technology areas of interest include: smart and adaptive skins; corrosion resistant and genetically designed coatings; evaluation techniques; nano-scale electronics; specialized materials for space launch; and agile materials for use in force protection.			
(U) In FY 2005: Continue to enhance the capability, performance, durability, and affordability of Air Force and commercial air and space systems. Technology areas of interest include: smart and adaptive skins; corrosion resistant and genetically designed coatings; evaluation techniques; nano-scale electronics; specialized materials for space launch; and agile materials for use in force protection.			
(U)			
(U) MAJOR THRUST: Design and develop advanced sensors and associated technologies.	2.015	1.728	0.848
(U) In FY 2003: Enabled affordable advanced sensors and technologies tied to commercial and military air and space platforms. Technology areas of interest included: timely, high quality, precision imaging; sensitive electromagnetic (i.e., infrared) detection; and high-speed, precision temporal, spatial, and attitude sensors and controllers.			
(U) In FY 2004: Expand the design and development of affordable advanced sensors and related technologies to enhance			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**	PROJECT NUMBER AND TITLE **4770 Dual Use Science and Technology (S&T)**

	the capabilities of military and commercial air and space platforms. Technology areas of interest include real-time, high-resolution, precision imaging; sensitive ambient electromagnetic (e.g., infrared) detection; and high-speed, precision temporal, spatial, and attitude sensors and controllers.			
(U)	In FY 2005: Continue to expand the design, efficiency, and affordability of advanced sensors and associated technologies for military and commercial air and space platforms. Technology areas of interest include real-time, high-resolution, precision imaging and tracking devices; sensitive, multi- and cross-environmental electromagnetic sensors; and high-speed, high-precision spatial and attitude sensors and multi-component controllers.			
(U)				
(U)	MAJOR THRUST: Develop propulsion, power, energy, and fuel efficiencies and affordability.	2.015	2.614	1.283
(U)	In FY 2003: Improved the performance, increased the life, and reduced the cost of military and commercial air and space operations. Technology areas of interest included: performance and emissions of airbreathing and rocket propulsion systems; advanced gas turbine combustion and blades; electric propulsion alternatives; energy processing, storage, and conversion; lasers; and smart engine health monitoring techniques.			
(U)	In FY 2004: Continue to enhance the operational capability, expand the life, and reduce the cost of military and commercial air and space operations. Technology areas of interest include: airbreathing and rocket propulsion systems; gas turbine engines and blades; electric propulsion alternatives; energy processing, storage, and conversion; lasers; and smart engine health monitoring techniques.			
(U)	In FY 2005: Continue to enhance the operational capability, expand the life, and reduce the cost of military and commercial air and space operations. Technology areas of interest include: engine and motor performance and emissions; turbine and hypersonic engine combustion and dynamics; power processing, storage, and conversion; and smart engine health monitoring techniques.			
(U)				
(U)	MAJOR THRUST: Advance information and communication technologies.	2.015	1.762	0.865
(U)	In FY 2003: Enhanced the collection, processing, dissemination, security, accuracy, and presentation of information to U.S. and coalition military decision-makers and corresponding commercial industry sectors. Technology areas of interest include: collecting, synthesizing, and encoding pertinent information; securing the high-speed and reliable fusion, accuracy, security, and transmission of information; and presenting the appropriate information in an efficient, timely, consistent, and easily understood manner.			
(U)	In FY 2004: Further enhance the collection, processing, dissemination, security, accuracy, and presentation capabilities of military and commercial information systems. Technology areas of interest include collecting, synthesizing, and encoding pertinent information; securing high-speed and reliable fusion, accuracy, security, and transmission of information; and presenting relevant information in an efficient, timely, consistent, and easily understood manner.			
(U)	In FY 2005: Promote new technologies to collect, collate, process, distribute, recall, and secure high-accuracy data			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**	PROJECT NUMBER AND TITLE **4770 Dual Use Science and Technology (S&T)**

		FY 2003	FY 2004	FY 2005
	on and across military and commercial platforms. Technology areas of interest include data/information gathering, synthesizing, and encoding; processing, fusion, and security; as well as timeliness, accuracy, and precision.			
(U)				
(U)	MAJOR THRUST: Enhance weapon systems sustainment to prolong system life and reduce life-cycle costs.	2.015	1.729	0.849
(U)	In FY 2003: Extended the life and improved performance, efficiency, reliability, and maintainability of both Air Force and commercial air and space systems. Technology areas of interest include avionics; materials fatigue and fracture; corrosion; cost-effective techniques for non-invasive, real-time monitoring of system health/performance; and associated environmental impacts.			
(U)	In FY 2004: Prolong and enhance the performance capabilities, reliability, and maintainability while extending the life of both Air Force and commercial air and space systems. Technology areas of interest include avionics; materials fatigue and fracture; corrosion; cost-effective techniques for non-invasive, real-time monitoring of system health/performance; and associated environmental impacts.			
(U)	In FY 2005: Enhance sustainability, reliability, maintainability, operability, efficiency, and affordability of military and commercial air and space propulsion. Technology areas of interest include materials fatigue, fracture, and corrosion; real-time health monitoring; as well as avionics, electronics, and associated technologies.			
(U)	Total Cost	10.075	10.496	5.151

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602102F, Materials.									
(U)	PE 0602201F, Aerospace Flight Dynamics.									
(U)	PE 0602202F, Human Effectiveness.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0602500F, Multi-Disciplinary Space									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**	PROJECT NUMBER AND TITLE **4770 Dual Use Science and Technology (S&T)**

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

Technology.

(U) PE 0602601F, Space Technology.

(U) PE 0602602F, Conventional Munitions.

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0602702F, Command Control and Communications.

(U) PE 0603112F, Advanced Materials for Weapon Systems.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603211F, Aerospace Structures.

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

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

(U) PE 0603270F, Electronic Combat Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0603601F, Conventional Weapons Technology.

(U) PE 0603605F, Advanced

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**	PROJECT NUMBER AND TITLE **4770 Dual Use Science and Technology (S&T)**

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

Weapons Technology.

(U) PE 0603789F, C3I Advanced Development.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE **February 2004**

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602890F High Energy Laser Research

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	41.498	45.333	48.316	51.699	52.143	53.053	Continuing	TBD
5096 High Energy Laser Research	0.000	41.498	45.333	48.316	51.699	52.143	53.053	Continuing	TBD

Note: In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the High Energy Laser (HEL) Joint Technology Office (JTO).

(U) A. Mission Description and Budget Item Justification

This program funds DOD HEL applied research through the HEL JTO. HEL weapon systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DOD HEL Science and Technology program. In general, efforts funded under this program are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid-state lasers, beam control, optics, propagation, and free electron lasers.

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 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	41.854	45.452
(U)	Current PBR/President's Budget	0.000	41.498	45.333
(U)	Total Adjustments	0.000	-0.356	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.356	
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the HEL JTO.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602890F High Energy Laser Research**	**5096 High Energy Laser Research**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5096 High Energy Laser Research	0.000	41.498	45.333	48.316	51.699	52.143	53.053	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds DOD HEL applied research through the HEL JTO. HEL weapon systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DOD HEL Science and Technology program. In general, efforts funded under this program are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid-state lasers, beam control, optics, propagation, and free electron lasers.

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. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) For FY 2003, this activity was performed under PE 0602890D8Z, High Energy Laser Research, and the approximate funding for FY 2003 was $45.9 million.			
(U)			
(U) MAJOR THRUST: Explore solid state lasers that have potential for the quickest impact in future HEL weapons because of their inherent small size and the fact that they require only electrical energy in order to run, thereby greatly simplifying systems engineering and supportability.	0.000	11.000	11.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Continue to develop enabling solid state laser technologies through applied research necessary for the demonstration of solid state lasers at initial weapon grade power levels. Under the Joint High Power Solid State Laser program continue development of solid state laser technologies supporting the demonstration of 25 kilowatts in FY 2005 and follow-on 100 kilowatt solid state laser designs.			
(U) In FY 2005: Continue to mature enabling solid state laser technologies through applied research necessary for the demonstration of solid state lasers at initial weapon grade power levels. Support the Joint High Power Solid State Laser program demonstration of 25 kilowatts devices leading to follow-on 100 kilowatt solid state laser designs.			
(U)			
(U) MAJOR THRUST: Explore free electron lasers that have potential in future HEL weapons because they require only electrical energy in order to run and can be designed to operate at a the best wavelength for a specific application	0.000	8.400	8.400

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**	PROJECT NUMBER AND TITLE **5096 High Energy Laser Research**

	within a large range of wavelengths.			
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue to accelerate the scaling of free electron lasers toward weapon class power levels. The initial power scaling milestone will be 10 kilowatts for a laboratory demonstrator. Develop a photocathode model as a tool to design advanced robust long-life photocathodes. Design and begin fabrication of a high current radio frequency cavity at 700 megahertz for integration into 10 kilowatt demonstrator. Conduct a study and begin laboratory tests to determine if new optical coating finishing methods produce optical coatings with robustness required for free electron laser applications.			
(U)	In FY 2005: Continue to accelerate the scaling of free electron lasers toward weapon class power levels. Continue 10 kilowatt laboratory demonstration to define development path for scaling toward 100 kilowatt field test demonstrator and eventual megawatt class free electron laser.			
(U)				
(U)	MAJOR THRUST: Develop advanced solid state laser technologies that are applicable to future HEL weapon laser devices.	0.000	3.750	5.000
(U)	In FY 2003: Not Applicable.			
(U)	FY 2004: Develop solid state laser technologies such as laser materials with large fluorescence lifetime and cross-section and the ability to operate at high temperatures, laser gain media thermal management techniques, and modular and scalable architectures for laser power scaling including technologies for beam combining. Develop ceramic laser gain media materials. Optimize ceramic material manufacturing processes for laser applications, fully characterize materials, and set the stage for comparison of single crystal material to ceramic material laser performance. Develop and demonstrate a more efficient high brightness diode array and use it in a demonstration with a fiber laser system. Develop and demonstrate fiber laser beam combining through spectral and phase front sensing approaches. Develop and demonstrate a heat exchanger building block for phase change thermal management/storage system for solid state lasers.			
(U)	FY 2005: Continue to develop solid state laser technologies to provide laser materials with large fluorescence lifetime and cross-section and the ability to operate at high temperatures, laser gain media thermal management techniques, and modular and scalable architectures for laser power scaling including technologies for beam combining.			
(U)				
(U)	MAJOR THRUST: Develop beam-control technologies that are directly applicable to surface, air, and space mission areas. Results of these activities will be transitioned to near-term HEL systems and will also serve to enhance the HEL-related technology base and industrial capability. Develop atmospheric characterization technologies and techniques aimed at making precise absorption measurements in interesting atmospheric windows, measuring and assimilating information on turbulence at locations relevant to tactical HEL systems, and developing and testing real-time characterization tools to assist the HEL operator.	0.000	10.218	10.683

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**	PROJECT NUMBER AND TITLE **5096 High Energy Laser Research**

(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue to develop beam control technology to improve HEL system performance. Seek to provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles, and maritime platforms, thus enabling the advantages of HELs to be applied in a wide variety of military operations. Develop high mechanical strength, high hardness HEL windows with low optical path distortions for tactical HEL applications. Develop technology to fabricate conformal HEL windows for tactical air vehicles. Develop wavefront sensors that are insensitive to high scintillation environments and prepare to benchmark performance in a simulated high scintillation environment. Establish a government optical metrology capability to precisely measure adsorption and reflectivity of optical coatings. Develop methods for discrimination, pointing, and tracking in high clutter using three-dimensional imaging. Continue to develop characterizations that concentrate on understanding atmospheric limitations in low-altitude tactical scenarios in order to increase the lethal range.			
(U)	In FY 2005: Continue to develop beam control technology to improve HEL system performance. Seek to provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles, and maritime platforms, thus enabling the advantages of HELs to be applied in a wide variety of military operations. Provide developed beam component technologies for integration into laboratory test beds for performance comparison and enhancement. Continue to develop characterizations that concentrate on understanding atmospheric limitations in low-altitude tactical scenarios (such as turbulence, thermal blooming, and platform disturbances) in order to increase the lethal range. Begin to plan a thermal blooming experiment.			
(U)				
(U)	MAJOR THRUST: Develop chemical laser technologies that provide higher performance and better supportability. Results of these activities will result in chemical lasers that are lighter and more affordable.	0.000	2.750	3.650
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Continue to develop and demonstrate closed-cycle chemical lasers, especially chemical oxygen iodine laser-derived devices, appropriate for space-based and tactical applications. Develop chemical laser generators that are capable of operating in a gravity free environment and conduct proof-of-concept testing of these devices.			
(U)	In FY 2005: Continue to develop and demonstrate closed-cycle chemical lasers, especially chemical oxygen iodine laser-derived devices. Conduct technology development/experiments to allow selection of the most promising chemical laser generators and chemical regeneration techniques that can be scaled for tactical weapon system applications.			
(U)				
(U)	MAJOR THRUST: Develop lethality technologies that concentrate on providing a strong scientifically-based understanding of laser kill mechanisms to allow the design of future HEL systems with the maximum kill probability for the minimum system size and cost.	0.000	4.280	4.400
(U)	In FY 2003: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**	PROJECT NUMBER AND TITLE **5096 High Energy Laser Research**

(U) In FY 2004: Continue to develop a firm, physics-based understanding of the mechanisms involved in the interaction between HEL beams and the targets they strike. Continue to develop databases that will be accepted by the HEL community and validated models that will be available to systems designers. Develop a subset of target folders for tactical laser weapons like the Advanced Tactical Laser and Mobile Tactical High Energy Laser.

(U) In FY 2005: Continue to develop a firm, physics-based understanding of the mechanisms involved in the interaction between HEL beams and the targets they strike. Continue to develop databases that will be accepted by the HEL community and validated models that will be available to systems designers.

(U)

(U) MAJOR THRUST: Develop a fully realistic model of end-to-end HEL system performance, from birth of photons in the laser to their death at the target, thereby improving the design of HEL systems and reducing the need for expensive field testing.	0.000	1.100	2.200

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Continue to develop the infrastructure for integrating existing and emerging high-fidelity component models into an end-to-end engagement model, thereby improving the design of HEL systems and reducing the need for expensive field testing. Continue to develop widely accepted engagement model for non-expert users capable of supporting many HEL systems, targets, and scenarios. The model will include platform constraints, provide parametrically represented probability of kill for various target surfaces, and allow for constrained sensitivity analyses.

(U) In FY 2005: Begin validation of infrastructure for integrating existing and emerging high-fidelity component models into an end-to-end engagement model, thereby improving the design of HEL systems and reducing the need for expensive field testing. Begin to validate engagement model using Service specific scenarios.

(U) Total Cost	0.000	41.498	45.333

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) PE 0602500F, Multi-Disciplinary Space Technology.									
(U) PE 0601108F, High Energy Laser Research Initiatives.									
(U) PE 0603444F, Maui Space Surveillance System.									
(U) PE 0603500F,									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**	PROJECT NUMBER AND TITLE **5096 High Energy Laser Research**

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

Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) PE 0603924F, High Energy Laser Advanced Technology Program.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0602307A, Advanced Weapons Technology.

(U) PE 0602114N, Power Projection Applied Research.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0207423F Advanced Communications Systems

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	0.000	11.951	13.917	0.969	0.969	0.000	0.000	Continuing	TBD
5084	AJCN	0.000	11.951	13.917	0.969	0.969	0.000	0.000	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

The Adaptive Joint Command, Control, Communications and Computing, Intelligence, Surveillance and Reconnaissance (C4ISR) Node Advanced Concept Technology Demonstration (ACTD) is developing software programmable Radio Frequency (RF) payloads designed to support Information Superiority. AJCN is an open, Commercial-Off-The-Shelf (COTS) based system that can be remotely programmed on the fly to perform a variety of functions simultaneously: air-to-air assured interopreable communications, electronic warfare (EW), signals intelligence (SIGINT), and computer network operations (CNO). AJCN addresses numerous Mission Needs Statements (MNS), Operational Requirements Documents (ORD), and the Combatant Commanders Integrated Priority Lists (IPL) related to communications, intelligence and Information Operations (IO).

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies to enhance Air Force operational systems.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	12.053	13.917
(U)	Current PBR/President's Budget	0.000	11.951	13.917
(U)	Total Adjustments	0.000	-0.102	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.102	
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

None.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0207423F Advanced Communications Systems**	**5084 AJCN**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5084 AJCN	0.000	11.951	13.917	0.969	0.969	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

The Adaptive Joint Command, Control, Communications and Computing, Intelligence, Surveillance and Reconnaissance (C4ISR) Node Advanced Concept Technology Demonstration (ACTD) is developing software programmable Radio Frequency (RF) payloads designed to support Information Superiority. AJCN is an open, Commercial-Off-The-Shelf (COTS) based system that can be remotely programmed on the fly to perform a variety of functions simultaneously: air-to-air assured interopreable communications, electronic warfare (EW), signals intelligence (SIGINT), and computer network operations (CNO). AJCN addresses numerous Mission Needs Statements (MNS), Operational Requirements Documents (ORD), and the Combatant Commanders Integrated Priority Lists (IPL) related to communications, intelligence and Information Operations (IO).

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies to enhance Air Force operational systems.

(U)	**B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U)	System Engineering and Integration		11.272	12.500
(U)	Field Evaluation/Military Utitlity Assessment		0.586	0.844
(U)	Concept of Operations (CONOPS)/TTP Development and Test		0.093	0.573
(U)	Total Cost	0.000	11.951	13.917

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Army									
(U)	DARPA									

(U) **D. Acquisition Strategy**

All major contracts within this Program Element and programs were awarded after full and open competition.

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2004**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0401840F AMC COMMAND & CONTROL SYSTEM

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	5.995	6.038	0.000	0.000	0.000	0.000	0.000	0.000
5119 Agile Transportation 2001	0.000	5.995	6.038	0.000	0.000	0.000	0.000	0.000	0.000

In FY04, this is a new PE.

(U) A. Mission Description and Budget Item Justification

Agile Transportation for the 21st Century (AT21) Advanced Concept Technology Development (ACTD) provides for a suite of decision support tools capitalizing on emerging technology to enhance command and control of the Defense Transportation System (DTS). In concert with Joint Vision 2020, AT21 will focus on identifying, exploring, and fostering advanced synergistic technologies for transportation and sustainment processes with an 'end-to-end' systems perspective. AT21 will transition both COTS and GOTS maturing database, optimization and collaboration technologies into the Defense Transportation System (DTS) to improve peacetime and wartine transportation operations for all Combatant Commanders, Services, and governmental entities. Transportation mode determination and optimization for strategic lift will be based on objective, time-sensitive delivery criteria. The United States Transportation Command (USTRANSCOM) will have the ability to provide the supported CINC with modal alternatives to meet such deployment requirements as required delivery date in theater. Assignment to sealift of collaboratively selected, sealift-qualified, movement requirements will automatically increase availability of scarce airlift assets for assignment to true mission critical requirements. AT21 will produce a software toolsuite for synchronizing and optimizing all DTS operations through unit level execution. This effort will produce an immediate return on investment through better lift aggregation, cost avoidance by increased lift optimization and quality of life of the service members, due to better scheduling. Additionally, this effort will support the Combatant Commanders with improved, rapid, and collaborative transportation planning to support any force deployment.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates cost-effective technologies to improve the design, performance, and support of current and future weapon systems.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	6.046	6.054
(U)	Current PBR/President's Budget	0.000	5.995	6.038
(U)	Total Adjustments	0.000	-0.051	
(U)	Congressional Program Reductions		-0.051	
	Congressional Rescissions			
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

Reduction IAW PBD 604.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0401840F AMC COMMAND & CONTROL SYSTEM**	**5119 Agile Transportation 2001**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5119 Agile Transportation 2001	0.000	5.995	6.038	0.000	0.000	0.000	0.000	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

Agile Transportation for the 21st Century (AT21) Advanced Concept Technology Development (ACTD) provides for a suite of decision support tools capitalizing on emerging technology to enhance command and control of the Defense Transportation System (DTS). In concert with Joint Vision 2020, AT21 will focus on identifying, exploring, and fostering advanced synergistic technologies for transportation and sustainment processes with an 'end-to-end' systems perspective. AT21 will transition both COTS and GOTS maturing database, optimization and collaboration technologies into the Defense Transportation System (DTS) to improve peacetime and wartine transportation operations for all Combatant Commanders, Services, and governmental entities. Transportation mode determination and optimization for strategic lift will be based on objective, time-sensitive delivery criteria. The United States Transportation Command (USTRANSCOM) will have the ability to provide the supported CINC with modal alternatives to meet such deployment requirements as required delivery date in theater. Assignment to sealift of collaboratively selected, sealift-qualified, movement requirements will automatically increase availability of scarce airlift assets for assignment to true mission critical requirements. AT21 will produce a software toolsuite for synchronizing and optimizing all DTS operations through unit level execution. This effort will produce an immediate return on investment through better lift aggregation, cost avoidance by increased lift optimization and quality of life of the service members, due to better scheduling. Additionally, this effort will support the Combatant Commanders with improved, rapid, and collaborative transportation planning to support any force deployment.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates cost-effective technologies to improve the design, performance, and support of current and future weapon systems.

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U) Accomplishments/Planned Program			
(U) Continue development of Strategic Transportation Planner (STP) to support optimization, mode determination broker and schedular.		1.804	2.025
(U) Continue development of Aircrew Scheduler, Airbase Tactical Transportation Planner, and Aircraft Maintenance Schedular to support the tactical echelon for optimization of assets.		1.803	2.028
(U) Continue development of deep Collobration in phases with Air Mobility Command (AMC), Military Traffic Mobility Command (MTMC), Military Sealift Command (MSC), Joint Forces Command (JFCOM), Pacific Command (PACOM), and Central Command (CENTCOM).		0.902	0.980
(U) Continue development of AMC Operational Transportation Planner to support the operational echelon for optimization of assets, mode determination and schedular.		1.486	1.005
(U) Total Cost	0.000	5.995	6.038

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0401840F AMC COMMAND & CONTROL SYSTEM**	PROJECT NUMBER AND TITLE **5119 Agile Transportation 2001**

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

(U) **D. Acquisition Strategy**

SPO plans to use sprial development, using Indefinate Delivery and Indefinate Quantity contracts.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603112F Advanced Materials for Weapon Systems

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	39.746	61.948	34.284	39.814	46.517	41.390	42.056	Continuing	TBD
2100	Laser Hardened Materials	13.201	17.012	22.551	27.928	35.454	30.138	30.622	Continuing	TBD
3153	Non-Destructive Inspection Development	8.088	9.956	4.069	4.103	4.178	4.249	4.318	Continuing	TBD
3946	Materials Transition	14.739	23.876	5.298	5.397	4.456	4.533	4.606	Continuing	TBD
4918	Deployed Air Base Demonstrations	3.718	11.104	2.366	2.386	2.429	2.470	2.510	Continuing	TBD

Note: In FY 2003, the space unique tasks in Projects 2100 and 3946 were transferred to PE 0603500F, Project 5032, as a result of the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates materials technology for transition into Air Force systems. The program has four projects which develop: (1) laser hardened materials technologies for the broadband laser protection of aircrews and sensors; (2) non-destructive inspection and evaluation technologies; (3) transition data on structural and non-structural materials for aerospace applications; and (4) airbase operations technologies including deployable base infrastructure, force protection, and fire fighting capabilities. Note: In FY 2004, Congress added $2.1 million for Vapor Grown Carbon Fiber, $1.4 million for Polymer Technology for Agile Combat Support, $1.4 million for Materials Integrity Management Research (MIMR) for Air Force Systems, $3.6 million for Quantitative Inspection Techniques for Assessing Aging of Military Aircraft, $5.0 million for the Metals Affordability Initiative, $1.5 million for Molecular Marking of Explosives, $2.0 million for Hybrid Bearings, $1.7 million for Advanced Laser Program for Plasma Enhanced Chemical Vapor Deposition, $1.4 million for Advanced Composite Processes for Unmanned Air Vehicle (UAV) Components, $3.0 million for E-SMART Threat Agent Network, $3.4 million for Plasma Arc/Waste to Energy Production, $1.1 million to Educate 21st Century Information Operations (IO) Workforce, $1.8 million for Ceramic Matrix Composites for Engines, and $1.0 million for Transparent Conductive Polymer Technology. Additionally, Congress reduced $1.0 million related to the National Aerospace Initiative.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	41.159	33.079	34.374
(U)	Current PBR/President's Budget	39.746	61.948	34.284
(U)	Total Adjustments	-1.413	28.869	
(U)	Congressional Program Reductions		-1.000	
	Congressional Rescissions		-0.531	
	Congressional Increases		30.400	
	Reprogrammings	-0.386		
	SBIR/STTR Transfer	-1.027		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603112F Advanced Materials for Weapon Systems**	**2100 Laser Hardened Materials**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2100 Laser Hardened Materials	13.201	17.012	22.551	27.928	35.454	30.138	30.622	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops enabling materials and concepts for protecting Air Force assets such as aircrews, munitions, and aerospace sensors against laser and high-power microwave directed energy threats. Concepts are demonstrated to provide hardening options for transition to Air Force systems. The goal is to ensure mission capability before, during, and after threat exposure. Current protection schemes are activated by intensity or wavelength and are only capable of countering a specific portion of the laser threat. Recent laser technology developments have increased laser wavelength agility. To harden systems against all potential lasers, the development of a combination of approaches is required.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced materials technologies that enhance laser hardening for sensors, avionics, and components to increase survivability and mission effectiveness of aerospace systems. Note: Increase in FY 2005 is due to an increased emphasis on sensor protection.	5.823	4.237	12.769
(U) In FY 2003: Demonstrated complete hardening for an electro-optical sensor system. Developed hardening solutions for Charge Coupled Device (CCD) imaging systems.			
(U) In FY 2004: Develop hardening solutions for replacement sensors selected for the electro-optical sensor system. Demonstrate image intensifier tube hardening. Evaluate hardening solutions for CCD imaging systems.			
(U) In FY 2005: Demonstrate hardening solutions for replacement sensor selected for the electro-optical sensor system. Initiate hardening development for multispectral and hyperspectral sensor systems.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials technologies that enhance laser protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a laser threat environment. Note: This effort includes Congressional Adds of $1.7 million in FY 2003 and $1.7 million in FY 2004 for an Advanced Laser Program for Plasma Enhanced Chemical Vapor Deposition.	7.378	12.775	9.782
(U) In FY 2003: Transitioned flexible filter technology in the form of spectacles for human factors evaluations and design refinement. Transitioned first generation tristimulus filter technology for daytime missions to the Life Support Systems Program Office. Fabricated refined tristimulus filter eyewear based on results from human factors study. Transitioned fixed wavelength filter technology to the night vision goggle (NVG) program for flight tests. Advanced the development of tunable filter technology for NVGs and panoramic NVGs (PNVGs). Identified and evaluated hardening technologies for use in protecting eyes from agile laser threats.			
(U) In FY 2004: Identify next generation technology advancements to improve performance of tristimulus filter			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **2100 Laser Hardened Materials**

technology. Transition in-band interim agile protection for NVGs. Characterize tunable filter technology in a representative PNVG prototype system. Develop optical limiter devices to protect eyes from agile laser threats.

(U) In FY 2005: Transition candidate materials technology advancements to improve performance of tristimulus filter technology. Demonstrate night vision goggle (NVG) compatible peripheral protection eyewear. Characterize the performance of brassboard panoramic NVG (PNVG)/NVG systems utilizing tunable filter technology. Continue to develop optical limiter technologies for agile protection of PNVG/NVG systems.

(U)	Total Cost	13.201	17.012	22.551

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0602202F, Human Effectiveness Applied Research.									
(U)	PE 0603231F, Crew Systems and Personnel Protection Technology.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	PE 0604706F, Life Support Systems.									
(U)	This project has been coordinated through the Tri-Service Laser Hardened Materials and Structures Group and the Joint Service Agile Laser Eye Protection Program.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **2100 Laser Hardened Materials**

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

duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3153 Non-Destructive Inspection Development**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3153	Non-Destructive Inspection Development	8.088	9.956	4.069	4.103	4.178	4.249	4.318	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced Non-Destructive Inspection/Evaluation (NDI/E) technologies to monitor performance integrity and to detect failure causing conditions in weapon systems components and materials. NDI/E capabilities greatly influence and/or limit many design, manufacturing, and maintenance practices. Reduction in the number of fighter wings and the need for rapid sortie generation demand an ability to perform real-time NDI/E more rapidly than is currently possible. This project provides technology to satisfy Air Force requirements to extend the lifetime of current systems through increased reliability and cost-effectiveness at field and depot maintenance levels. Equally important is assuring manufacturing quality, integrity, and safety requirements.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced technologies for improved capabilities in materials corrosion, fatigue monitoring, and testing of aging aircraft to reduce operations and maintenance costs. These technologies will contribute to full operability and safety of the aircraft fleet. Note: This effort includes Congressional Adds of $1.4 million in FY 2003 for Assessing Aging of Military Aircraft and $3.6 million in FY 2004 for Quantitative Inspection Techniques for Assessing Aging of Military Aircraft.	2.420	5.276	1.170
(U) In FY 2003: Developed and demonstrated advanced technologies for improved capabilities in detection and characterization of corrosion of joints in aging aircraft. Developed and demonstrated advanced methods to detect cracks in multiple layers in order to meet aging aircraft life extension requirements.			
(U) In FY 2004: Demonstrate and validate pulsed eddy current automated scanner technology for improved capabilities in detection and characterization of corrosion of joints in aging aircraft. Validate low-frequency electromagnetic probe methods to detect cracks in multiple layers in order to meet aging aircraft life extension requirements.			
(U) In FY 2005: Transition advanced technologies for improved capabilities in detection and characterization of corrosion of joints in aging aircraft. Transition advanced methods to detect cracks in multiple layers to meet aging aircraft life extension requirements.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced technologies for improved capabilities to inspect for cracks and other damage to extend the total safe life of turbine engines. Note: This effort includes a Congressional Add of $2.5 million in FY 2003 for Quantitative Inspection Techniques for Assessing Aging of Military Aircraft.	3.726	2.003	1.595
(U) In FY 2003: Completed transition of non-destructive evaluation (NDE) benchmarks. Tested automated inspection			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3153 Non-Destructive Inspection Development**

		FY 2003	FY 2004	FY 2005
	capability of rotary components for planned life extension of engine rotors. Selected optimal NDE approaches to extend the life of fracture-critical gas turbine engine components and identified protocols for component inspections. Developed residual stress gradient measurement technologies to increase measurement on shot peened surfaces.			
(U)	In FY 2004: Characterize optimal non-destructive evaluation (NDE) approaches to extend the life of fracture-critical gas turbine engine components and establish protocols for component inspections.			
(U)	In FY 2005: Develop methods to detect and characterize damage in repaired (linear friction welded) turbine engine components. Demonstrate and begin transition of optimal NDE approaches to extend the life of fracture-critical gas turbine engine components.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced inspection technologies supporting low-observable (LO) systems to enhance affordability and ensure full performance and survivability. Note: This effort includes a Congressional Add of $1.1 million in FY 2003 for Handheld Holographic Radar Gun.	1.942	0.000	1.304
(U)	In FY 2003: Transitioned to the field an advanced multispectral LO NDE tool for assessing radio frequency signature (zone versus whole aircraft) that is real-time, small, lightweight, portable, user-friendly, and covers multiple frequency bands.			
(U)	In FY 2004: Not Applicable. Note: FY 2004 efforts were delayed until FY 2005 due to higher Air Force priorities.			
(U)	In FY 2005: Initiate the development of a portable diagnostic probe that is broadband and will provide complex electromagnetic material properties. Initiate development of a portable, multi-functional, multi-platform diagnostics tool for use in battle damage repair of LO materials and structures.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced systems status monitoring technologies to provide on-board and embedded sensing to gain continuous awareness of the state of key subsystems. Note: In FY 2004, this effort includes a Congressional Add of $1.4 million for Materials Integrity Management Research (MIMR) for Air Force Systems and a Congressional Reduction of $0.7 million related to the National Aerospace Initiative.	0.000	2.677	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop optimal approaches and methodologies to address the continuous monitoring of materials integrity and status for critical elements of structures/airframes, propulsion systems, high temperature protection, tankage, and wiring.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	8.088	9.956	4.069

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3153 Non-Destructive Inspection Development**

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602102F, Materials.									
This project has been coordinated through the									
(U) Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3946 Materials Transition**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3946 Materials Transition	14.739	23.876	5.298	5.397	4.456	4.533	4.606	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced materials and processing technologies for fielded and planned Air Force weapon, airframe, and engine applications. Advanced materials and processes that have matured beyond applied research are characterized, critical data are collected, and critical evaluations in the proposed operating environment are performed. This design and scale-up data enhances overall affordability of promising materials and processing technologies, providing needed initial incentives for their industrial development.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials and processing technologies for air vehicles and subsystems to enhance the lift, propulsion, low-observable (LO) performance, and overall affordability of air vehicles. Note: In FY 2003, this effort includes Congressional Adds of $4.0 million for Powdered Programmable Process, $3.5 million for Ceramic Matrix Composites for Engines, $1.2 million for Hybrid Bearing, and $1.1 million for Vapor Grown Carbon Fiber. In FY 2004, this effort includes Congressional Adds of $5.0 million for the Metals Affordability Initiative, $1.4 million for Advanced Composite Processes for Unmanned Air Vehicle (UAV) Components, $2.1 million for Vapor Grown Carbon Fiber, $1.8 million for Ceramic Matrix Composites for Engines, $2.0 million for Hybrid Bearings, and $1.0 million for Transparent Conductive Polymer Technology and a Congressional Reduction of $0.3 million related to the National Aerospace Initiative.	11.661	22.292	4.968
(U) In FY 2003: Fabricated and characterized integrated composite structure assemblies for aircraft with reduced part count and assembly costs. Completed the demonstration of advanced non-linear optical materials for aircraft infrared (IR) countermeasures against far-IR laser sources and then transitioned results. Conducted characterization of materials and processes for enhancing the reliability and maintainability of LO systems. Accelerated the development of advanced bearing materials for gas turbine engines.			
(U) In FY 2004: Develop an affordable high-temperature composite process that enables the fabrication of turbine engine components for future air vehicles to meet cost and performance criteria. Demonstrate fabrication processes and properties of ceramic composite materials for turbine engine exhaust components. Identify materials and their properties for a mid-infrared laser source enabling aircraft infrared countermeasures. Demonstrate improved materials and inspection tools/processes to enhance reliability and maintainability of low-observable platforms. Develop and evaluate advanced fluids, lubricants, and surface treatments for combined cycle engine components in high-speed vehicle applications. Develop and assess advanced metallic materials and processing technologies for weapon system development and sustainment, and for application to cryogenic structures and scramjet and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3946 Materials Transition**

		FY 2003	FY 2004	FY 2005
	combined-cycle engine components and structures. Accelerate the development of advanced bearing materials for gas turbine engines. Demonstrate the capability of injection molded aircraft transparencies loaded with various levels of carbon nanotubes to replace the conductivity currently provided by brittle exterior coatings.			
(U)	In FY 2005: Develop and demonstrate reliable life extension capabilities for turbine engine rotors. Demonstrate a high temperature composite for turbine engine components. Validate performance in a turbine engine environment of ceramic composite materials for exhaust components. Develop and characterize advanced materials and materials process capabilities for ultra-lightweight, ultra-high power generation for airborne directed energy weapons. Develop materials and demonstrate their properties for a mid-infrared laser source enabling aircraft infrared countermeasures. Validate and transition improved materials and inspection tools/processes for low-observable systems to enable higher mission capable rates.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials and processing technologies to enhance the sustainability of Air Force aerospace systems by lowering operations and maintenance costs and ensuring the full operability and safety of systems and personnel. Note: In FY 2003, this effort includes a Congressional Add of $1.0 million for Advanced Material Corrosion Research for Liquid Metal Alloys.	3.078	0.493	0.330
(U)	In FY 2003: Initiated efforts to develop and characterize corrosion resistant coatings and corrosion prevention compounds for aging aircraft structures applications.			
(U)	In FY 2004: Evaluate corrosion resistant coatings and corrosion prevention compounds for aging aircraft structures applications. Initiate effort to determine durability and failure mechanisms of hybrid structures in unmanned air vehicles (UAVs).			
(U)	In FY 2005: Transition corrosion resistant coatings and corrosion prevention compounds for aging aircraft structures applications. Develop test methodologies and evaluation techniques to determine durability and characterize failure mechanisms of hybrid structures in UAVs.			
(U)				
(U)	CONGRESSIONAL ADD: Educate 21st Century Information Operations (IO) Workforce.	0.000	1.091	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Establish an Information Operations curriculum at New Mexico State University to educate graduate and undergraduate students.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	14.739	23.876	5.298

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3946 Materials Transition**

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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603112F Advanced Materials for Weapon Systems**	**4918 Deployed Air Base Demonstrations**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4918 Deployed Air Base Demonstrations	3.718	11.104	2.366	2.386	2.429	2.470	2.510	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project supports the Aerospace Expeditionary Forces (AEF) through development and demonstration of advanced, rapidly deployable airbase technologies that reduce airlift and manpower requirements, setup times, and sustainment costs and improve protection and survivability of deployed AEF warfighters. Efficient and cost-effective technologies are developed and demonstrated to provide deployable infrastructure, advanced weapon system support, force protection, and fire fighting capability for deployed AEF warfighters.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Demonstrate and transition affordable, rapid deployment technologies that ensure military readiness, maintain aerospace missions, support advanced weapon systems, and enable peacetime training operations. Note: In FY 2004, remaining activities in this thrust will be integrated into the other major thrusts in this project.	0.101	0.000	0.000
(U) In FY 2003: Furthered the development of advanced waste reactor technologies to support emerging weapons. Demonstrated rapidly deployable full-scale mixed-base hydrogen peroxide production plant.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Demonstrate and transition advanced rapid deployment airbase technologies that reduce airlift and manpower requirements, setup times, and sustainment costs in support of AEF operations. Note: In FY 2003, this effort includes a Congressional Add of $1.8 million for Tyndall Air Force Research Laboratory. In FY 2004, this effort includes Congressional Adds of $3.4 million for Plasma Arc/Waste to Energy Production and $1.4 million for Polymer Technology for Agile Combat Support.	2.215	6.500	1.432
(U) In FY 2003: Enhanced the development of shelters, power, and rapid airfield assessment technologies that improve system performance and reduce airlift requirements in support of AEF operations. Developed advanced aircraft firefighting technologies such as firefighting agents and equipment. Transitioned a highly effective, deployable crash/rescue system based on three-dimensional foam technology to support AEF operations. Note: In FY 2003, the deployable firefighting technology activities in this major thrust were moved to the force protection major thrust in this project.			
(U) In FY 2004: Transition air-inflatable shelter technology to support logistics footprint reduction in AEF operations. Develop 10KW fuel cell power system that improves deployable power system performance and reduces airlift requirements for AEF operations. Demonstrate rapid airfield assessment and repair technologies that improve			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **4918 Deployed Air Base Demonstrations**

	performance and enhance AEF operations support.			
(U)	In FY 2005: Continue development of a 10KW fuel cell power system that improves deployable systems performance and reduces airlift requirements for support of Aerospace Expeditionary Forces (AEF) operations. Transition rapid airfield assessment and repair technologies that improve deployable systems performance and reduce airlift requirements for support of AEF operations.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Demonstrate and transition efficient and cost-effective technologies to provide force protection to deployed AEF warfighters and infrastructure. Note: In FY 2004, this effort includes Congressional Adds of $3.0 million for Environmental Sensing and Monitoring Systems (E-SMART) Threat Agent Network and $1.5 million for Molecular Marking of Explosives.	1.402	4.604	0.934
(U)	In FY 2003: Developed deployable protective and advanced blast suppression technologies to protect deployed warfighters.			
(U)	In FY 2004: Demonstrate deployable protective and advanced blast suppression technologies to protect deployed warfighters. Develop a reduced-size full-capability firefighting vehicle for deployed operations. Develop self-sterilizing coatings and laminates for expeditionary structures. Demonstrate system to integrate threat sensor data for airbase protection. Evaluate molecular tagging technology for explosive materials. Note: In FY 2003, the deployable firefighting technology activities were moved into this major thrust.			
(U)	In FY 2005: Transition deployable protective and advanced blast suppression technologies to protect deployed warfighters. Demonstrate a reduced-size full-capability firefighting vehicle for deployed operations. Demonstrate self-sterilizing coatings and laminates for expeditionary structures.			
(U)	Total Cost	3.718	11.104	2.366

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0604617F, Agile Combat Support.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **4918 Deployed Air Base Demonstrations**

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603203F Advanced Aerospace Sensors

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	50.988	41.124	30.634	34.010	42.947	39.603	39.426	Continuing	TBD
5019	Advanced RF Technology for ISR Sensors	4.414	4.904	3.577	4.386	4.587	5.449	5.536	Continuing	TBD
665A	Advanced Aerospace Sensors Technology	11.469	14.826	10.754	9.617	10.718	10.897	11.072	Continuing	TBD
69DF	Target Attack and Recognition Technology	35.105	21.394	16.303	20.007	27.642	23.257	22.818	Continuing	TBD

Note: In FY 2003, efforts in advanced radio frequency (RF) technologies for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this PE, Project 665A, transferred to Project 5019. Also in FY 2003, space unique tasks in this PE, Project 665A, transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

Divided into three broad project areas, this program develops technologies to enable the continued superiority of sensors from aerospace platforms. The first project develops and demonstrates advanced technologies for RF sensors for aerospace ISR systems. The second project develops and demonstrates advanced technologies for electro-optical (EO) sensors, radar sensors and electronic counter-countermeasures, and components and algorithms. The third project develops and demonstrates RF and EO sensors for detecting, locating, and targeting airborne, fixed, and time-critical mobile ground targets obscured by natural or man-made means. Together, the projects in this program develop the means to find, fix, target, track, and engage air and ground targets anytime, anywhere, and in any weather. Note: In FY 2004, Congress added $5.0 million for the National Operational Signature Production and Research Capability. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new sensor and electronic combat system developments that have military utility and address warfighter needs.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	52.482	36.550	30.714
(U)	Current PBR/President's Budget	50.988	41.124	30.634
(U)	Total Adjustments	-1.494	4.574	
(U)	Congressional Program Reductions		-0.074	
	Congressional Rescissions		-0.352	
	Congressional Increases		5.000	
	Reprogrammings	-0.110		
	SBIR/STTR Transfer	-1.384		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603203F Advanced Aerospace Sensors**	**5019 Advanced RF Technology for ISR Sensors**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5019	Advanced RF Technology for ISR Sensors	4.414	4.904	3.577	4.386	4.587	5.449	5.536	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in advanced radio frequency (RF) technologies for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this PE, Project 665A, transferred to this project.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates RF aerospace surveillance sensors and signal processing for ISR sensors capable of operating in adverse clutter and jamming environments. This project provides the warfighter with sensors capable of detecting and tracking both airborne (conventional and low radar cross section) and ground-based, high-value, time-critical targets. Work includes developing aerospace environmentally-qualified (vibration, shock, temperature, and radiation-hardened) sensor capabilities (including integrated electro-optical mixed signal), as well as advanced component and subsystem technologies.

(U)	**B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Develop techniques for advanced air moving target indication, ground moving target indication (GMTI), and foliage penetrating ground target indication.	0.882	1.081	1.642
(U)	In FY 2003: Configured data collection opportunities using existing assets for validation of techniques generated for advanced air moving target indication, GMTI, and foliage-penetrating ground target indication. Initiated an effort to design a flexible testbed using a manned test aircraft to demonstrate multi-intelligence surveillance.			
(U)	In FY 2004: Collect data for multi-intelligence air moving target indication, GMTI, and foliage-obscured ground target indication. Mature the design for a flexible testbed demonstrating multi-intelligence surveillance to the critical design review level.			
(U)	In FY 2005: Validate data collected for air moving target indication, ground moving target indication and foliage-obscured ground target indication through computer simulation and emulation techniques for discerning ground and air targets under multi-intelligence waveform, pulse repetition frequency, and signal processing scenarios. Initiate plans for an experiment that will validate techniques for multi-intelligence sensing.			
(U)				
(U)	MAJOR THRUST: Develop multi-intelligence sensor designs.	1.451	1.271	0.000
(U)	In FY 2003: Conducted in-house development of a multi-intelligence sensor design, utilizing technologies developed in aperture development, signal processing, and radar design. Developed techniques for discriminating ground from air targets under conditions of common pulse repetition frequencies, waveforms, and receiver systems.			
(U)	In FY 2004: Complete the design of a multi-intelligence surveillance system and model it in mission area simulations. Validate the system through computer simulation and emulation techniques for discerning ground and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **5019 Advanced RF Technology for ISR Sensors**

	air targets under multi-intelligence waveform, pulse repetition frequency, and signal processing scenarios. Plan an experiment that will validate electronic protection signal processing techniques for multi-intelligence data collection systems.			
(U)	In FY 2005: Not Applicable. Work completed.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate advanced radar signal processing techniques to mitigate clutter and jamming interference, and improve detection and tracking of difficult targets in hostile environments.	1.406	1.049	1.101
(U)	In FY 2003: Developed knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indication (GMTI) sensors. Implemented multi-dimensional adaptive processing techniques and knowledge-aided radar signal processing techniques on selected advanced computing architectures, and demonstrated these techniques for multi-mission aerospace radar applications.			
(U)	In FY 2004: Demonstrate and evaluate knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in GMTI sensors. Continue implementing adaptive processing techniques for multi-mission conformal arrays and wideband and polarization adaptive processing techniques for multi-function radar on selected advanced computing architectures, and continue demonstrating these techniques for multi-mission aerospace radar applications.			
(U)	In FY 2005: Demonstrate and evaluate knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in multi-intelligence sensors. Demonstrate and evaluate adaptive processing techniques for multi-mission conformal arrays and wideband and polarization adaptive processing techniques for multi-function radar on selected advanced computing architectures for multi-mission aerospace radar applications.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate photonic digital and analog mixed signal multi-gigahertz component architectures.	0.675	0.257	0.000
(U)	In FY 2003: Developed and integrated chip-scale photonic and hybrid mixed signal components for radio frequency (RF) signal generation, phased array antenna beam formation, and beam control. Developed and demonstrated high-resolution wide bandwidth photonic wavelength division multiplexing and signal processing technology. Provided performance modeling, verification, and analysis of photonic and hybrid mixed signal devices for military unique applications.			
(U)	In FY 2004: Continue providing impartial performance modeling, verification, and analyses of photonic and hybrid mixed signal devices for RF signal generation, phased array antenna beam formation, and beam control, in support of government-sponsored and independent research.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate techniques to surveil venues denied to standoff intelligence,	0.000	1.246	0.834

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **5019 Advanced RF Technology for ISR Sensors**

surveillance, and reconnaissance platforms.

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Initiate developing techniques to surveil venues denied to standoff intelligence, surveillance, and reconnaissance (ISR) platforms. The emphasis is on denied access areas, such as urban canyons, inner areas of buildings, and heavily concealed targets that use advanced camoflauge, concealment, and deception techniques. Specifically, the effort will concentrate on short-range, low-cost, expendable sensors that can exploit multiple radio frequency (RF) phenomenologies.

(U) In FY 2005: Continue developing techniques to surveil venues denied to standoff ISR platforms, concentrating on short-range, low-cost, expendable sensors that can exploit multiple RF phenomenologies.

(U)	Total Cost	4.414	4.904	3.577

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0603270F, Electronic Combat Technology.									
(U)	PE 0603500F, Multi-disciplinary Advanced Space Technology.									
(U)	PE 0604270F, Electronic Warfare (EW) Development.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603203F Advanced Aerospace Sensors**	**665A Advanced Aerospace Sensors Technology**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
665A	Advanced Aerospace Sensors Technology	11.469	14.826	10.754	9.617	10.718	10.897	11.072	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommedation to consolidate all space unique activities. Also in FY 2003, efforts in advanced radio frequency (RF) technologies for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this project transferred to this PE, Project 5019.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates aerospace sensor technologies for manned and unmanned platforms, including electro-optical (EO) sensors, targeting and attack radar sensors, and electronic counter-countermeasures for radars. It provides aerospace platforms with the capability to precisely detect, track, and target both airborne (conventional and low radar cross section) and ground-based, high-value, time-critical targets. Project activities include developing multi-function radar and electronic combat technology. Desired warfighting capabilities include the ability to detect concealed targets in difficult background conditions.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop integrated EO sensor technology to search, detect, locate, and identify air and ground targets at ranges significantly longer than currently achievable, including targets that are camouflaged, low-observable, or employ other means of deception.	3.166	3.316	2.104
(U) In FY 2003: Completed fabricating and testing a ground demonstration sensor and aircraft integration design. Assessed real-time data processing performance.			
(U) In FY 2004: Extend performance of ground demonstration sensor to flying test-bed configuration. Ground test aircraft integration components. Extend design to integrate key subsystems for modular testing.			
(U) In FY 2005: Demonstrate multi-spectral passive cueing in an airborne environment. Extend performance of ground demonstration sensor with integrated key systems for modular testing to flying test-bed configuration.			
(U)			
(U) MAJOR THRUST: Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace ISR applications.	3.260	3.682	4.732
(U) In FY 2003: Completed fabricating and testing a demonstration sensor for high altitude reconnaissance aircraft. Performed flight characterization. Assessed signature-based data processing performance.			
(U) In FY 2004: Extend performance of a demonstration sensor for high altitude reconnaissance aircraft to incorporate an emissive spectral sensing capability. Fabricate, laboratory integrate, and test emissive spectrometer components.			
(U) In FY 2005: Complete fabrication and testing of demonstration system for high-altitude aircraft with incorporation of emissive spectral sensing capability for day and night operations. Perform flight characterization and support			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **665A Advanced Aerospace Sensors Technology**

	transition to acquisition center.			
(U)				
(U)	MAJOR THRUST: Develop advanced electro-optical sensor technology for non-cooperative target identification.	0.809	0.941	0.000
(U)	In FY 2003: Completed design and initiated developing a multi-function laser for air and ground target identification.			
(U)	In FY 2004: Complete developing and demonstrate a multi-function laser for air and ground target identification based on target geometry and vibration.			
(U)	In FY 2005: Not Applicable. Work completed.			
(U)				
(U)	MAJOR THRUST: Develop technologies to maximize Global Positioning System (GPS) jam resistance, positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities.	1.210	1.215	0.911
(U)	In FY 2003: Developed advanced GPS M-Code technologies. Developed reference technologies to adaptively operate GPS in buildings, underground, and in air and space to provide precise time, position, and velocity for multiple platforms. Developed virtual flight test technology for improved assessment of GPS anti-jam technologies.			
(U)	In FY 2004: Demonstrate precise reference aerospace sensing technologies to adaptively operate underground and in buildings. Design geo-registration technologies to maximize navigation warfare exploitation techniques for enhanced offensive and defensive combat capabilities. Develop virtual flight test simulation technology to assess advanced GPS anti-jam techniques.			
(U)	In FY 2005: Design critical experiments for assured reference technologies to maximize positional accuracy, timing accuracy, and exploitation techniques for network centric engagement. Develop automatic multi-intelligence sensor data registration technology for improved geo-location performance. Expand virtual flight test simulation technology for improved assessment of precise reference sensing networks.			
(U)				
(U)	MAJOR THRUST: Develop, test, evaluate, and demonstrate the radio frequency (RF) sensor techniques required to detect, track, and target high-value, time-critical targets that are difficult to detect through either stealth or concealment.	1.828	0.393	2.617
(U)	In FY 2003: Evaluated "mini" unmanned aerial vehicle (UAV) concept of operation and RF sensor performance improvements in the detection, tracking, and targeting of high-value, time-critical targets.			
(U)	In FY 2004: Laboratory test "mini" UAV concept of operation and RF sensor performance improvements in the detection, tracking, and targeting of high-value, time-critical targets.			
(U)	In FY 2005: Demonstrate in the laboratory evolved multi-intelligence techniques. Demonstrate "mini" UAV concept of operation and RF sensor performance improvements in the detection, tracking and targeting of high-value, time-critical targets. Develop RF receiver technologies to detect, characterize, and encode difficult signals to assist in the detection, and location of high-value, time-critical targets.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **665A Advanced Aerospace Sensors Technology**

(U)	MAJOR THRUST: Develop weapons guidance quality track radar performace in advanced jamming environments.	0.233	0.406	0.390
(U)	In FY 2003: Developed a concept definition and a system analysis of a fire control radar system for airborne applications.			
(U)	In FY 2004: Develop advanced radar techniques, sub-systems, and methods to establish and maintain track radar performance of weapons-guidance quality in advanced jamming environments. Devise integrated high-fidelity fire control radar and weapon system simulation model to evaluate system and sub-system requirements and performance.			
(U)	In FY 2005: Evaluate advanced radar techniques, sub-systems and methods to establish and maintain weapons guidance quality track radar performance in advanced jamming environment. Validate and test high fidelity fire control radar and weapon system simulation model to evaluate system and sub-system requirements and performance.			
(U)				
(U)	MAJOR THRUST: Develop technology for aerospace sensors compatible with hypersonic flight parameters.	0.000	4.873	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Define a technically feasible, operationally effective sensor suite and concept of operations for use on the Hypersonic Reconnaissance/Attack Vehicle. Develop a feasibility analysis and sensor performance simulation tool. Recommend airframe configurations that will maximize the effectiveness of the vehicle as a reconnaissance platform in a hypersonic environment.			
(U)	In FY 2005: Not Applicable. Work completed.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Physical Vapor Transport.	0.963	0.000	0.000
(U)	In FY 2003: Demonstrated deposition techniques for high growth rate, high-quality silicon carbide semiconductor substrates to enable advanced physical vapor transport techniques.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	11.469	14.826	10.754

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0603205F, Flight Vehicle Technology.									
(U)	PE 0603707F, Weather Systems									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT NUMBER AND TITLE 665A Advanced Aerospace Sensors Technology

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

Advanced Development.

(U) PE 0603500F, Multi-disciplinary Advanced Development Space Technology.

(U) PE 0602111N, Weapons Technology.

(U) PE 0602232N, Space and Electronic Warfare (SEW) Technology.

(U) PE 0604249F, LANTIRN Night Precision Attack.

(U) PE 0603270F, Electronic Combat Technology.

(U) A Memorandum of Agreement has been established between Air Force Research Laboratory and Defense Advanced Research Projects Agency to jointly develop the technology required to detect high-value, time-critical targets in a variety of environments.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603203F Advanced Aerospace Sensors**	**69DF Target Attack and Recognition Technology**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
69DF	Target Attack and Recognition Technology	35.105	21.394	16.303	20.007	27.642	23.257	22.818	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, efforts in advanced radio frequency (RF) technologies for intelligence, surveillance, and reconnaissance previously performed in this project transferred to this PE, Project 5019.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced technologies for attack management, fire control, and target identification and recognition. This includes developing and demonstrating integrated and cooperative fire control techniques to provide for adverse-weather precision air strikes against multiple targets per pass and at maximum weapon launch ranges. Specific fire control technologies under development include attack management, sensor fusion, automated decision aids, advanced tracking for low radar cross section threats, and targeting using both on-board and off-board sensor information. This project also evaluates targeting techniques to support theater missile defense efforts in surveillance and attack. These fire control technologies will provide force multiplication and reduce warfighter exposure to hostile fire. This project also develops and demonstrates target identification and recognition technologies for positive, high confidence cueing, recognition, and identification of airborne and ground-based, high-value, time-critical targets at longer ranges than are currently possible. The goal is to apply these technologies to tactical air-to-air and air-to-surface weapon systems so they are able to operate in all weather conditions, during day or night, and in high-threat, multiple target environments. Model-based vision algorithms and target signature development techniques are the key to target identification and recognition. This project is maturing these technologies in partnership with the Defense Advanced Research Projects Agency, and evaluating the techniques to support theater missile defense efforts in surveillance and attack. Fire control and recognition technologies developed and demonstrated in this project are high leverage efforts, providing for significant advancements in operational capabilities largely through software improvements readily transitionable to new and existing weapon systems.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Develop modeling and simulation to show enhanced global awareness and precision engagement capability for warfighters, as enabled by automated targeting technologies for rapid detection, location, and prosecution of time-critical targets.	1.236	1.133	1.586
(U)	In FY 2003: Employed the modeling, simulation, and analysis testbed to analyze and demonstrate automatice target recognition (ATR) and information fusion algorithms for time-critical targeting, emphasizing the difficult targeting missions where weather, terrain, foliage, camouflage, and deception techniques obscure or conceal the targets of interest. Developed and employed air and ground target signature generation models to support automated target signature exploitation in automatic target recognizer and multi-sensor fusion algorithms. Generated synthetic target signatures for automated signature exploitation of RF and electro-optical sensor data.			
(U)	In FY 2004: Demonstrate the analysis testbed in operationally realistic environments, using operationally realistic data and processes. Continue developing and employing air and ground target signature generation models that			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **69DF Target Attack and Recognition Technology**

	support automated target signature exploitation in automatic target recognizer and multi-sensor fusion algorithms. Continue generating synthetic target signatures for automated signature exploitation of radio frequency (RF) and electro-optical (EO) sensor data.			
(U)	In FY 2005: Initiate an analysis of an enhanced capability to find and identify time-critical targets using automated target recognition processing in the Distributed Common Ground Station. Complete an analysis of an enhanced capability to find and track targets under trees and camouflage by employing Foliage Penetration Radar and automated sensor fusion technologies. Continue developing and employing air and ground target signature generation models to support automated target signature exploitation in automatic target recognizer and multi-sensor fusion algorithms. Continue generating synthetic target and scene signatures for automated signature exploitation of RF and EO sensor data. Analyze advanced ground target signature generation methods.			
(U)				
(U)	MAJOR THRUST: Develop common open system technology integration for real-time information in- and out-of-the-cockpit to improve aircrew combat and joint battlespace situational awareness, target nomination, and target engagement capabilities.	1.818	1.328	1.842
(U)	In FY 2003: Demonstrated initial capability to fuse all-source threat, imagery, target, and survivor location data using an airborne platform digitally linked to airborne combat search and rescue assets.			
(U)	In FY 2004: Incrementally upgrade common situational awareness open system technologies to integrate special below line-of-sight threat geo-location and threat awareness receiver system that provides aircrew with integrated air defense system threat intent data for enhancing in-flight threat response options and aircraft self-protection capabilities. Demonstrate a laboratory capability to fuse all-source threat, target, survivor location, and threat intent data for use across special operations and other tactical aviation platforms. Conduct limited flight evaluations of key system components to assess system performance capabilities in low-altitude, terrain-masked threat environments.			
(U)	In FY 2005: Integrate and flight-test common situational awareness technology equipment suite on representative special operations aircraft to assess integrated system performance capabilities, aircrew workload reduction, and product maturity levels. Initiate a laboratory incremental development technology product approach to match transition of common situational awareness system components with special operations user acquisition resources for both fixed-wing and vertical lift aircraft.			
(U)				
(U)	MAJOR THRUST: Develop and test an automatic target recognition (ATR) system for tracking and identifying moving and stationary ground targets for use in strike and reconnaissance platforms.	5.160	2.686	2.374
(U)	In FY 2003: Integrated advanced stationary target identification techniques and algorithms with synthetic aperture radar processing. Advanced the state-of-the-art for moving target identification techniques and algorithms by providing technology maturation and risk reduction. Continued analysis of requirements and affordable risk reduction for transition via planned sensor upgrades to strike and reconnaissance platforms.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **69DF Target Attack and Recognition Technology**

(U) In FY 2004: Demonstrate a stationary ground target classification and identification capability using advanced ATR techniques in real-time in a laboratory setting using operational computer hardware devices. Develop transition plans and perform transition risk reduction tasks for integrating this capability into operational strike and reconnaissance platforms. Develop advanced moving target classification and identification techniques and algorithms for integration with high range resolution radar and other moving target indication processing techniques.

(U) In FY 2005: Finalize transition plans for advanced stationary target identification techniques and algorithms developed in the laboratory with synthetic aperture radar processing. Continue analyzing requirements and affordable risk reduction for transition of advanced moving target classification and identification techniques and algorithms via planned sensor upgrades to strike and reconnaissance platforms. Continue developing advanced moving target classification and identification techniques and algorithms for integration with high range resolution radar and other moving target indication processing techniques.

(U)

(U) MAJOR THRUST: Develop multi-sensor automatic target recognition (ATR) for Air Force intelligence, surveillance, reconnaissance (ISR), strike, and weapon systems.	3.766	3.689	5.127

(U) In FY 2003: Tested and integrated Air Force and Defense Advanced Research Projects Agency (DARPA) multi-sensor ATR fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force ISR, strike, and weapon systems. Characterized single and multi-sensor contributions from radar and electro-optical (including hyperspectral imaging) sensors with automated exploitation. Continued demonstrating, to image analysts and Air Operation Centers decision makers, the impact of automated multi-sensor ATR and fusion capability on timeline reductions for time-critical targeting.

(U) In FY 2004: Assess the performance of Air Force and DARPA multi-sensor ATR fusion algorithms using the Air Force ATR evaluation test facility. Continue characterizing both single and multiple sensor contributions from radar and electro-optical (including hyperspectral imaging) sensors with automated exploitation. Initiate developing tools to automate data collection planning for transition of algorithms. Improve ATR research and development computer and networking infrastructure via software, hardware, and network integration enhancements. Improve processing capabilities and expand DoD-wide repository of research and development (R&D) sensor data. Develop an integrated computational and collaborative environment to accelerate the transition of ATR and sensor fusion technologies. Utilize synthetic data generation capability to augment and enhance existing R&D and operational data sets. Continue to show timeline reduction for time-critical targeting impact of automated multi-sensor ATR and fusion capability to image analysts and decision-makers in the experimental Air Operations Centers.

(U) In FY 2005: Continue to assess the performance of Air Force and DARPA multi-sensor automatic target recognition fusion algorithms using the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, reconnaissance, strike, and weapon systems. Continue characterizing both single and multiple sensor contributions from radar and EO (including hyperspectral imaging) sensors with automated exploitation. Automate

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **69DF Target Attack and Recognition Technology**

	data collection planning for transition (database development and upgrade) of algorithms. Continue improving ATR R&D computer and networking infrastructure via software, hardware, and network integration enhancements. Continue improving processing capabilities and the expansion of the DoD-wide repository for research and development (R&D) sensor data. Continue developing an integrated computational and collaborative environment to accelerate the transition of ATR and sensor fusion technologies. Continue developing synthetic data generation capability to augment and enhance existing R&D and operational data sets. Continue to show impact of automated multi-sensor automatic target recognition and fusion capability in terms of timeline reduction for time-critical targeting to image analysts and decision-makers in the experimental Air Operations Centers.			
(U)				
(U)	MAJOR THRUST: Develop technology to detect, identify, and engage targets under trees (TUT).	12.201	4.979	0.000
(U)	In FY 2003: Characterized performance of foliage penetration radar sensors and algorithms for robust target detection and tracking with low probability of false alarms. Developed TUT-specific intelligence preparation of the battlefield tools for improved tracking, detection, sensor management, and target identification and location. Developed tools for multi-intelligence georegistration. Performed end-to-end modeling for the TUT family of systems, providing measures of effectiveness that encompass the entire kill chain cycle. Performed virtual simulations to identify system integration issues, human decision functions, and system processes. Developed integration plans with warfighter-selected operational systems. Tested system functionality, including fusion and georegistration, and concepts of employment.			
(U)	In FY 2004: Demonstrate TUT-specific intelligence preparation of the battlefield tools for improved tracking, detection, sensor management, and target identification and location. Integrate tools for multi-intelligence georegistration with fusion architecture. Finish system functionality test, including fusion and georegistration tests, and perform study of possible trades in concepts of employment.			
(U)	In FY 2005: Not Applicable. Work completed.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate a moderate confidence automatic target recognition and advanced cueing (ATR/C) capability for stationary and moving targets.	8.900	0.000	2.087
(U)	In FY 2003: Continued developing a follow-on, high confidence combat identification capability under the Reliable Combat Identification for Surface Targeting effort. Characterized advanced stationary and moving target radar data to determine its utility for ATR/C and combat identification. Developed tools to support sensor system, sensor management, and system performance analyses. Characterized the performance of identification techniques for multiple moving targets. Performed advanced multi-sensor data collection on stationary and moving targets. Determined which combination of sensors, modes, and fusion processing techniques would provide combat identification of the highest confidence.			
(U)	In FY 2004: Not Applicable. Air Force realignment of projects due to higher priorities within the Science and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **69DF Target Attack and Recognition Technology**

	Technology program provided additional funding in FY 2003, but no additional funding in FY 2004. Beginning in FY 2005, this effort is supported by planned-for core funding.			
(U)	In FY 2005: Perform critical experiments based upon results from studies and analyses of which combination of sensors, modes, and fusion processing techniques would provide combat identification of the highest confidence. Perform engineering-level analyses and critical experiments to determine what sensor technologies and fusion techniques may provide a near-term combat identification capability of the highest confidence achievable. Initiate a technology demonstration effort of promising near-term sensor technologies and fusion processing techniques. Continue characterization studies of advanced stationary and moving target radar data to determine its utility for automatic target recognition and advanced cueing (ATR/C) and combat identification. Refine tool development to support sensor system, sensor management, and system performance analyses. Perform advanced multi-sensor data collections on stationary and moving targets.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate an automatic target recognition (ATR) capability integrated with advanced geo-registration techniques and innovative change detection algorithms.	0.000	2.579	3.287
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate a spiral development activity focused on time-critical targeting. Develop initial capability for an advanced real-time contingency cell in support of initial experiments for the Combined Air Operations Center. Perform mission-level and system-of-systems studies and analyses to determine which combination of sensors, modes, and fusion processing techniques would provide a high confidence combat identification capability for stationary and moving ground targets.			
(U)	In FY 2005: Integrate ATR with automatic target cueing, geo-registration, and Change Detection techniques. Demonstrate initial integrated time-critical targeting capability leveraging the Advanced Real-Time Contingency Cell, the Targets Under Trees program products and the technology developments associated with the Defense Advanced Research Projects Agency Dynamic Tactical Targeting program.			
(U)				
(U)	CONGRESSIONAL ADD: National Operational Signature Production and Research Capability.	2.024	5.000	0.000
(U)	In FY 2003: Continued expanding the database and began creating the signature modeling and simulation capability to consistently and expediently expand database production support for critical combat identification systems.			
(U)	In FY 2004: Mature the signature modeling and simulation capability to consistently and expediently expand database production support for critical combat identification systems. Expand and enhance the target and threat radar signature prediction codes and tools to support a deployed non-cooperative combat identification system.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	35.105	21.394	16.303

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT NUMBER AND TITLE **69DF Target Attack and Recognition Technology**

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

(U) **D. Acquisition Strategy**

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603205F Flight Vehicle Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	3.463	0.992	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
4398 Air Base Technology	3.463	0.992	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2003, remaining efforts transferred to PE 0603112, Project 4918. However, Congress added $3.5 million for environmental sensing and monitoring systems (E-SMART) Chemical and Biological Sensors in FY 2003. In FY 2004, Congress added $1.0 million for Air Force Research Laboratory (AFRL) Study of Legacy Tactical Aircraft.

(U) A. Mission Description and Budget Item Justification

Prior to FY 2003, this project developed technologies for fixed and bare base operations, including airfield pavements, energy systems, air base survivability, air base recovery, protective systems, airfield fire protection, and crash rescue.

This program is in the Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for exhibiting new systems development that have military utility and address warfighter needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	3.463	0.000	0.000
(U)	Current PBR/President's Budget	3.463	0.992	0.000
(U)	Total Adjustments	0.000	0.992	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.008	
	Congressional Increases		1.000	
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

In FY 2003, remaining efforts transferred to PE 0603112F, Project 4918. However, Congress has added funds for special interest projects since FY 2003.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603205F Flight Vehicle Technology**	**4398 Air Base Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4398 Air Base Technology	3.463	0.992	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

Prior to FY 2003, this project developed technologies for fixed and bare base operations, including airfield pavements, energy systems, air base survivability, air base recovery, protective systems, airfield fire protection, and crash rescue.

This program is in the Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for exhibiting new systems development that have military utility and address warfighter needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) CONGRESSIONAL ADD: Develop and integrate additional capabilities into the environmental sensing and monitoring system (E-SMART™) system.	3.463	0.000	0.000
(U) In FY 2003, Continued Congressionally-directed effort to develop and integrate additional chemical and biological sensor and monitoring technologies into the E-SMART™ system.			
(U) In FY 2004: Funds for this effort were approriated in PE 0603112F, Advanced Materials for Weapon Systems.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Conduct a study into service life extenstion potentials for legacy tactical aircraft.	0.000	0.992	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004, Initiate Congressionally-directed AFRL Study of Legacy Tactical Aircraft.			
(U) In FY 2005: Not Applicable.			
(U) Total Cost	3.463	0.992	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0603112F, Advanced Materials for Weapon Systems.									
(U) This project was coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603205F Flight Vehicle Technology**	PROJECT NUMBER AND TITLE **4398 Air Base Technology**

(U) **D. Acquisition Strategy**

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603211F Aerospace Technology Dev/Demo

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	27.767	47.610	29.145	27.199	26.019	29.009	30.500	Continuing	TBD
486U	Advanced Aerospace Structures	8.687	15.535	3.682	5.847	5.964	6.064	6.162	Continuing	TBD
4920	Flight Vehicle Tech Integration	19.080	32.075	25.463	21.352	20.055	22.945	24.338	Continuing	TBD
5099	National Aerospace Initiative	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program demonstrates advanced aerospace vehicle technologies. Advanced aerospace structures are demonstrated to sustain and enhance the capability of current and future aerospace vehicles, such as a next generation bomber. Flight vehicle technology integration is accomplished through system level integration of various technologies to include avionics, advanced propulsion, and weapon systems for demonstration in near-realistic operational environments. Note: In FY 2004, Congress added $6.2 million for advanced aluminum aerostructures, $2.4 million for bias woven preforms, $1.3 million for unmanned aerial vehicles (UAV) composites, $2.0 million for fly-by-light avionics for unmanned combat air vehicle (UCAV), $0.9 million for MEDLINK global response, and $3.4 million for sensorcraft unmanned aerial vehicle.

This program is in the Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing aerospace vehicle system upgrades and/or new system developments that have military utility and address warfighter needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	29.002	73.416	31.427
(U)	Current PBR/President's Budget	27.767	47.610	29.145
(U)	Total Adjustments	-1.235	-25.806	
(U)	Congressional Program Reductions		-42.298	
	Congressional Rescissions		-0.408	
	Congressional Increases		16.900	
	Reprogrammings	-0.408		
	SBIR/STTR Transfer	-0.827		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **486U Advanced Aerospace Structures**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
486U Advanced Aerospace Structures	8.687	15.535	3.682	5.847	5.964	6.064	6.162	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates affordable aerospace vehicle technologies to sustain the existing fleet, reduce the cost of aircraft ownership, and enhance the capability of current and future aerospace vehicles. Sustainment of the existing fleet through extended operational service life with innovative technology application will lead to reduced operations and support costs, and increased operational readiness. Analytical certification will reduce the cost associated with component replacement by allowing and certifying new designs under reduced test requirements. Development of capability enhancing technologies will expand the operational envelope and increase survivability in high threat environments. Demonstration of these technologies will restore structural integrity, extend structural life, enhance the capability, and reduce the life cycle costs of fielded aircraft.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop technologies to improve traditional sustainment methods of current and future aircraft.	1.949	2.917	0.000
(U) In FY 2003: Continued improvements in sustainment technologies for existing aging aircraft and future aerospace vehicle structures for reduced operations and support costs and to extend usable structural lives. Continued the development of technology required for full implementation of bonded composite repair of thick and complex structures. Continued development of new analytical methods and techniques to expand bonded composite repair capabilities to thick and complex geometry structures enabling repair in lieu of replacement of primary load carrying structural components.			
(U) In FY 2004: Develop improvements in sustainment technologies for existing aging aircraft and future air vehicle structures for reduced operations and support costs and to extend the usable structural lives. Continue the development of new analytical methods and techniques to extend bonded composite repair capability to thick and complex geometry structures enabling repairs in lieu of replacement of primary load carrying structural components.			
(U) In FY 2005: Not Applicable. Changes to this program are due to higher Air Force priorities.			
(U)			
(U) MAJOR THRUST: Develop non-traditional sustainment methods, and diagnostic/prognostic monitoring capabilities for future aircraft.	2.806	2.406	0.115
(U) In FY 2003: Developed improved non-traditional sustainment technologies that will extend aircraft life, increase aircraft availability, and reduce operations and support costs. Continued development of unitized composite structures to replace mechanically fastened built up components that are highly susceptible to damage from dynamic in-service usage in elimination of maintenance actions due to loose fasteners and fastener hole damage.			
(U) In FY 2004: Develop innovative non-traditional sustainment technologies that will extend aircraft life, increase			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **486U Advanced Aerospace Structures**

	aircraft availability, and reduce operations and support costs. Complete development of unitized composite structures concepts for repair or replacement of mechanically fastened built up components that are highly susceptible to loose fasteners and fastner hole damage from dynamic in-service usage, thereby providing a reduction in maintenance actions.			
(U)	In FY 2005: Develop innovative non-traditional sustainment technologies that will extend aircraft life, increase aircraft availability, and reduce operations and support costs. Develop real-time diagnostic and prognostics health monitoring tools of thermal protection systems, fuel tanks, structure, and subsystems to enable high temperature operations and allowing rapid turn around for high-speed vehicles.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate technologies related to improved munitions separation enhancement and acoustic reduction in current and future aircraft. Note: Prior to FY 2005, this effort was funded in project 4920, in the improved performance of unmanned platform thrust.	0.000	0.000	3.567
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Develop active flow control devices to significantly increase and expand the separation envelope for miniature munitions and reduce weapon bay acoustics to minimize damage at speeds in excess of Mach 1.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Aluminum Aerostructures Initiatives (A3I).	3.472	6.345	0.000
(U)	In FY 2003: Initiated Congressionally-directed effort for advanced aluminum aerostructures.			
(U)	In FY 2004: Continued Congressionally-directed effort for advanced aluminum aerostructures. Note: In FY 2004, two Congressional Adds were made for this effort; both are being managed as a single effort.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Composites.	0.460	1.388	0.000
(U)	In FY 2003: Initiated Congressionally-directed efforts for ultra-lightweight composites.			
(U)	In FY 2004: Continued Congressionally-directed effort for unmanned aerial vehicle (UAV) composites.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Three-Dimensional Bias Woven Preforms Development Program.	0.000	2.479	0.000
(U)	In FY 2003: Not Applicable. No FY 2003 funds.			
(U)	In FY 2004: Continue Congressionally-directed effort for Three-Dimensional Bias Woven Preforms Development Program begun with FY 2002 Congressional Add.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	8.687	15.535	3.682

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **486U Advanced Aerospace Structures**

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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603211F Aerospace Technology Dev/Demo**	**4920 Flight Vehicle Tech Integration**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4920 Flight Vehicle Tech Integration	19.080	32.075	25.463	21.352	20.055	22.945	24.338	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project integrates and demonstrates advanced flight vehicle technologies that will improve the performance and supportability of existing and future manned and unmanned aerospace vehicles. System level integration brings together the aerospace vehicle technologies along with avionics, propulsion, and weapon systems for demonstration in a near-realistic operational environment. Integration and technology demonstrations reduce the risk and time required to transition technologies into operational aircraft. This program provides proven aerospace vehicle technologies for all-weather, day/night operations with improved performance and affordability.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop of autonomous flight controls for safe flight operations between manned and unmanned air platforms.	4.484	13.490	9.482
(U) In FY 2003: Developed and demonstrated key control automation techniques and algorithms to enable the safe and interoperable application of unmanned and manned vehicle systems. Continued development of hardware and algorithms for automated air collision avoidance. Flight demonstrated intelligent-agent based algorithms and modular software system architecture for cooperative control of unmanned vehicles. Continued demonstration of hardware and algorithms for automatic air collision avoidance.			
(U) In FY 2004: Develop and demonstrate key control automation techniques and algorithms to enable the safe and interoperable application of unmanned vehicle systems. Continue development of an integrated control technology suite combining compact, low-cost hardware with adaptive, fault tolerant inner-loop control and autonomous, trajectory-generating outer-loop control to provide significantly increased reliability and mission effectiveness for unmanned vehicle systems. Develop and demonstrate control component technologies for systems integration. Develop automated aerial refueling algorithms and system design concepts for unmanned and manned systems to eliminate need for forward staging areas, extend range, shorten response time, and enable in-theater force projection with fewer assets.			
(U) In FY 2005: Continue development and demonstration of control automation techniques, components, and algorithms to enable the safe and interoperable application of unmanned vehicle systems. Complete the integration and test of key autonomous control component technologies. Demonstrate fully integrated, adaptive, fault tolerant, autonomous control system suite to provide significantly increased reliability and mission effectiveness for unmanned vehicle systems. Demonstrate key photonic sensing and control elements for flight critical control.			
(U)			
(U) MAJOR THRUST: Develop an Automated Aerial Refueling capability for unmanned and manned air platforms.	0.000	0.000	5.167

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **4920 Flight Vehicle Tech Integration**

Note: In FY 2004, Automated Aerial Refueling efforts described in the above thrust area were broken out to allow for increased visibility for this effort.

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Complete development of automated aerial refueling sensing, communication, and control algorithm components. Complete integration, simulation, and analysis verifying safe autonomous operation in proximity of manned tankers. Begin flight demonstrations of initial automated aerial refueling capability for unmanned aerial vehicles using existing fleet tankers, operational procedures, and unmanned combat air vehicles.

(U)

(U) MAJOR THRUST: Develop and demonstrate integrated technologies to improve the performance of unmanned platforms.	3.716	2.863	3.464

(U) In FY 2003: Developed an integrated control technology suite to provide increased reliability and mission effectiveness for unmanned vehicle systems. Completed baseline systems architecture combining compact, low-cost hardware with adaptive, fault tolerant inner-loop control and autonomous, trajectory-generating outer-loop control. Developed, tested, and verified component technologies for systems integration.

(U) In FY 2004: Develop advanced aerodynamic/structural integration concepts to enable increased system performance at reduced cost. Continue development and producibility demonstration of system hardware for an actively controlled conformal inlet system enabling increased installed propulsion system performance at reduced weight and size. Develop and demonstrate active flow control devices to increase and enhance the separation envelope for miniature munitions and reduce weapon bay acoustics to minimize damage susceptibility of sensitive commercial subsystem electronics.

(U) In FY 2005: Develop advanced aerodynamic/structural integration concepts to enable increased system performance at reduced cost. Demonstrate an actively controlled conformal inlet system for increased propulsion system performance for unmanned air vehicles.

(U)

(U) MAJOR THRUST: Develop analytical certification methods and capability to reduce the need for physical testing in the certification of structural components resulting in reduced acquisition cost for new systems and reduced support costs for future and legacy systems.	0.409	1.735	0.577

(U) In FY 2003: Demonstrated and validated advanced control mechanization technologies to provide highly reliable operation for manned and unmanned systems at significantly reduced size, weight, and cost. Completed advanced development and demonstration of direct optical control and interfacing of vehicle management and more-electric subsystems. Transfered technology to unmanned air vehicle control integration efforts.

(U) In FY 2004: Develop advanced structural concepts and design methods for future aerospace vehicle airframes for enhanced affordability and higher performance. Complete demonstration of advanced of low-cost bonded composite

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **4920 Flight Vehicle Tech Integration**

	structures concepts enabled by new analysis, manufacturing and assembly processes, which will reduce life cycle costs of current and future aerospace vehicles by maximizing the use of composite structures. Develop approaches to reliably use virtual and analytical methods to substantially reduce the need for physical testing in the certification of structural components resulting in reduced acquisition cost for new systems and reduced support costs for legacy systems.			
(U)	In FY 2005: Develop improved sustainment technologies for existing aging aircraft and future aerospace vehicle structures to reduce operations and support costs and extend usable structural lives. Develop real-time diagnostic and prognostics health monitoring tools of thermal protection systems, tanks, structures, and subsystems to enable rapid turn around and high temperature operations. Complete the demonstration of approaches to reliably use virtual and analytical methods to substantially reduce the need for physical testing in the certification of structural components resulting in reduced acquisition cost for new systems and reduced support costs for legacy systems.			
(U)				
(U)	MAJOR THRUST: Develop aircraft structures that have embedded components, which have previously been separate components that were attached to the air platforms.	1.909	4.174	4.175
(U)	In FY 2003: Developed multi-functional integrated structures to reduce acquisition costs, support costs, weight, and volume, while increasing the performance of air vehicles. Continued development of concepts with embedded high frequency multi-element antenna arrays in load bearing structure to enable increased antenna performance and new capabilities at reduced cost, weight, and volume. Developed highly efficient and durable multi-function structures with embedded electrical conductors and data cabling, health monitoring networks, fuel handling and sensing, and thermal management to minimize vehicle weight, volume, and acquisition and support costs.			
(U)	In FY 2004: Develop multi-functional integrated structures to reduce acquisition cost, support costs, weight, and volume and increase performance of air vehicles. Continue development of concepts with embedded high and low frequency multi-element antenna arrays in load bearing structure for antenna performance improvement and reduced vehicle weight and volume. Develop highly efficient and durable structures with embedded electrical conductors and data cabling, health monitoring networks, fuel handling and sensing, and thermal management to minimize vehicle weight, volume, and acquisition and support costs.			
(U)	In FY 2005: Continue development of multi-functional integrated structures to reduce acquisition and support costs, weight, and volume and increase performance of air vehicles. Complete demonstration of concepts with high multi-element antenna arrays embedded in load-bearing structure to increase antenna performance improvement and reduced vehicle weight, cost, and volume. Continue development of concepts of very large, low frequency antenna arrays embedded in load-bearing structure to enable new antenna capabilities and increased performance, while reducing vehicle weight, cost, and volume.			
(U)				
(U)	MAJOR THRUST: Develop aircraft designs and technologies that improve the overall performance of propulsion	1.806	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **4920 Flight Vehicle Tech Integration**

	systems, which are embedded inside current and future aircraft.			
(U)	In FY 2003: Developed integral airframe technologies to enable increased propulsion system performance. Successfully completed demonstration of inlet duct concepts with advanced aerodynamic technologies that enable structural integration, enhanced performance, survivability, and increased propulsion system performance. Developed conformal inlet concepts with advanced aerodynamic technologies that enable higher efficiency of propulsion systems.			
(U)	In FY 2004: Not Applicable. Changes to this program are due to higher Air Force priorities.			
(U)	In FY 2005: Not Applicable. Changes to this program are due to higher Air Force priorities.			
(U)				
(U)	MAJOR THRUST: Develop advanced structural concept designs.	1.717	0.000	0.000
(U)	In FY 2003: Developed advanced structural concepts and design methods to enhance affordability and increase the performance of current and future aerospace vehicles. Continued development of new analysis methods, design concepts, and design criteria to enable low-cost unitized composite structures. Continued development of demonstration articles for test verification of analyses methods, design concepts, and design criteria.			
(U)	In FY 2004: Not Applicable. Changes to this program are due to higher Air Force priorities.			
(U)	In FY 2005: Not Applicable. Changes to this program are due to higher Air Force priorities.			
(U)				
(U)	MAJOR THRUST: Develop adaptive structures to provide in-flight modifications offering improved performance over a wide range of flight conditions and mission profiles.	2.155	3.269	2.598
(U)	In FY 2003: Developed affordable advanced aero-structural concepts and design methods to enable new performance capabilities for future aerospace vehicles. Continued flight test demonstration of the increased high-speed control authority of an active aeroelastic wing. Developed concepts for applying continuous moldline technologies to reduce aerodynamic drag and electromagnetic signature for reconfigurable structures to enable maximum warfighting capability and versatility in a single platform. Developed highly efficient wing concepts integrating active aeroelastic design concepts, adaptive structures, and aerodynamic flow control technologies to enable new capabilities for long-range air vehicles and long-endurance vehicles.			
(U)	In FY 2004: Develop advanced aero-structural concepts and design methods for enhanced affordability, higher performance, and survivability for future aerospace vehicles. Complete flight test demonstrating increased high-speed control authority enable by an active aeroelastic wing. Complete demonstration of reconfigurable continuous moldline structure concepts to reduce aerodynamic drag and electromagnetic signature to enable platform adaptation as mission requirements change and thus maximize its versatility. Continue development of highly efficient wing concepts integrating active aeroelastic design concepts, adaptive structures, and aerodynamic flow control technologies to enable viable long-range and long-endurance air vehicle concepts			
(U)	In FY 2005: Develop integrated thermal airframe structures, including thermal protection systems, attachments, seals,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **4920 Flight Vehicle Tech Integration**

	joining technologies, hot primary structure, and structural health monitoring for high speed vehicle applications.			
(U)				
(U)	CONGRESSIONAL ADD: Sensorcraft.	2.884	3.470	0.000
(U)	In FY 2003: Initiated Congressionally-directed effort for sensorcraft unmanned aerial vehicle.			
(U)	In FY 2004: Continued Congressionally-directed effort for sensorcraft unmanned aerial vehicle.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Fly-by-light Avionics for Unmanned Combat Air Vehicle (UCAV).	0.000	2.082	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate Congressionally-directed effort for fly-by-light Avionics for Unmanned Combat Air Vehicle (UCAV).			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	Congressional Add: Medlink Global Response.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate Congressionally-directed effort for establishing round the clock in-flight telemedicine access to emergency physicians for assistance in managing in-flight medical emergencies.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	19.080	32.075	25.463

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602201F, Aerospace Vehicle Technologies.									
(U)	PE 0603333F, Unmanned Air Vehicle Dev/Demo.									
(U)	PE 0604731F, Unmanned Combat Air Vehicle.									
(U)	PE 0604105F, Next Generation Bomber.									
(U)	This project has been coordinated through the									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603211F Aerospace Technology Dev/Demo**	PROJECT NUMBER AND TITLE **4920 Flight Vehicle Tech Integration**

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

Reliance process to harmonize
efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603216F Aerospace Propulsion and Power Technology

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	84.067	93.425	79.914	68.626	74.950	92.472	93.006	Continuing	TBD
2480	Aerospace Fuels and Atmospheric Propulsion	11.498	3.101	0.374	0.338	3.163	5.359	5.445	Continuing	TBD
3035	Aerospace Power Technology	5.728	4.185	4.297	4.332	4.412	4.487	4.560	Continuing	TBD
4921	Aircraft Propulsion Subsystems Int	33.809	28.600	16.719	19.647	15.036	26.533	26.920	Continuing	TBD
4922	Space & Missile Rocket Propulsion	1.344	12.739	6.039	7.065	5.038	5.123	5.204	Continuing	TBD
5098	Advanced Aerospace Propulsion	0.000	15.750	26.300	10.819	20.387	23.605	23.074	Continuing	TBD
681B	Advanced Turbine Engine Gas Generator	31.688	29.050	26.185	26.425	26.914	27.365	27.803	Continuing	TBD

Note: In FY 2003, space unique tasks in Project 4922 were transferred to PE 0603500F, Project 5033, in conjunction with the Space Commission recommendation to consolidate all space unique activities. In Project 4922, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles. In FY 2004, Project 5098 is a new project, but not a New Start.

(U) **A. Mission Description and Budget Item Justification**

This program develops and demonstrates technologies to achieve enabling and revolutionary advances in turbine, advanced cycle, and rocket propulsion, as well as power generation and storage, and fuels. The program has six projects, each focusing on technologies with a high potential to enhance the performance of existing and future Air Force weapons systems. The Aerospace Fuels and Atmospheric Propulsion project develops and demonstrates improved hydrocarbon fuels and advanced propulsion systems for high-speed/hypersonic flight. The Aerospace Power Technologies project develops and demonstrates power technologies for weapons and aircraft. The Advanced Turbine Engine Gas Generator (ATEGG) project develops and demonstrates core turbine engine technologies for current and future aircraft propulsion systems. The Aerospace Propulsion Subsystem Integration project integrates the engine cores demonstrated in the ATEGG project with low-pressure components into demonstrator engines. Turbine engine propulsion projects within this program are part of the Integrated High Performance Turbine Engine Technology and the Versatile Affordable Advanced Turbine Engine programs. The Advanced Aerospace Propulsion project develops the scramjet propulsion cycle to a technology readiness level appropriate for in-flight demonstration and for full integration with other engine cycles (including turbine and rocket based). Finally, the Space and Missile Rocket Technology project develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques. Rocket propulsion projects within this program are part of the Integrated High Payoff Rocket Propulsion Technology program, which includes the area of Technology for the Sustainment of Strategic Systems. In FY 2004, Congress added $2.5 million for the Advanced Turbine Engine Gas Generator and Aircraft Propulsion Subsystems Integration, and removed $23.0 million from the Space and Missile Rocket Propulsion efforts.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	88.236	114.726	62.578
(U)	Current PBR/President's Budget	84.067	93.425	79.914
(U)	Total Adjustments	-4.169	-21.301	
(U)	Congressional Program Reductions		-23.000	
	Congressional Rescissions		-0.801	
	Congressional Increases		2.500	
	Reprogrammings	-1.565		
	SBIR/STTR Transfer	-2.604		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to decreased funding for technologies supporting the National Aerospace Initiative.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**2480 Aerospace Fuels and Atmospheric Propulsion**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2480	Aerospace Fuels and Atmospheric Propulsion	11.498	3.101	0.374	0.338	3.163	5.359	5.445	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates improved hydrocarbon fuels and advanced, novel aerospace propulsion systems, including systems for high-speed/hypersonic flight. The advanced fuel emphasis is on developing and demonstrating new thermally stable, high-heat sink, and controlled chemically reacting fuels for a conventional turbine engine, turbine-based combined cycle engines, and other advanced propulsion systems. The project also develops and demonstrates fuel system components that minimize cost, reduce maintenance, and improve performance of future aerospace systems. The advanced propulsion emphasis is on demonstrating concepts for combined cycle, ramjet, and scramjet engines. This project is integrated into the Versatile Affordable Advanced Turbine Engine program.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Evaluate and develop advanced (ramjet/scramjet) and combined cycle engine options for next generation aerospace vehicles and their weapons for long-range strike and low-observables. Note: In FY 2004, these activities will be moved to PE 06032163F, Project 5098.	4.473	0.000	0.000
(U) In FY 2003: Completed development of high fidelity analytical tools to evaluate combined cycle engine options, such as gas turbine and ramjet/scramjet combinations, for next generation aerospace vehicles and their weapons for long-range strike. Completed evaluation of advanced (ramjet/scramjet) and combined cycle engine options for next generation aerospace vehicles and their weapons for long-range strike. Developed key engine technologies to maximize the use of vehicle speed in force miniaturization and platform survivability for a capability beyond low-observables. Conducted analyses and experiments to optimize component technologies for transition between gas turbine engine and ramjet/scramjet engine cycles, and to optimize the cruise speed of ramjet/scramjet engines. Conducted a pre-design study to evaluate force-multiplier and bomber survivability as a function of a flight Mach number achievable for next generation aerospace vehicles and their weapons.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Demonstrate thermally stable fuels and fuel system hardware concepts to enhance cooling capacity (performance), minimize fuel coking, and reduce fuel system maintenance. Note: Due to FY 2005-2007 funding shifts, the FY 2004-2005 high heat sink fuel technologies demonstration efforts were slipped for completion in post FY 2007.	0.672	0.802	0.060
(U) In FY 2003: Studied, tested, and demonstrated specific advanced high-heat sink fuels that can increase fuel delivery			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **2480 Aerospace Fuels and Atmospheric Propulsion**

system durability at high temperatures and reduce maintenance due to fuel degradation in a sub-scale integrated fuel/air heat exchanger. Demonstrated long-term JP-8+225 performance in a fuel system simulator.

(U) In FY 2004: Continue to study, test, and demonstrate, at a pilot-light level, advanced high-heat sink fuels and hardware concepts that can increase fuel delivery system durability and performance at high temperatures and can reduce maintenance due to fuel degradation in aircraft fuel systems and engine control hardware. Develop bread-board, on-engine fuel additive injection hardware. Continue demonstrating long-term JP-8+225 performance in bench and full-scale fuel systems. Initiate demonstration of the performance of fuel developed from alternative (non-petroleum) sources in reduced scale fuel system simulators.

(U) In FY 2005: Continue to study, test, and demonstrate, at a pilot-light level, advanced high heat sink fuels and hardware concepts that can increase fuel delivery system durability and performance at high temperatures and reduce maintenance due to fuel degradation in an aircraft fuel system and engine control hardware.

(U)

(U) MAJOR THRUST: Determine fuel cooling requirements and specifications for advanced aircraft sensors and directed energy weapons that will meet the needs of evolving manned systems and unmanned aerial vehicle (UAVs). Note: Due to FY 2005-2007 funding shifts, the FY 2004-2005 UAV fuel additive efforts were revised for a restart in post FY 2007.	0.384	0.415	0.150

(U) In FY 2003: Developed requirements for low temperature additives to prevent fuel from freezing to allow advanced manned and unmanned systems sustain high altitude loiter for extended periods. Commenced refining the design and building an UAV fuel system/tank simulator to study high and low temperature fuel behavior.

(U) In FY 2004: Demonstrate, at a pilot-light level, low temperature additives for use in jet fuel to allow advanced manned and unmanned systems to sustain high altitude loiter for extended periods. Continue refining the design and building an UAV fuel system/tank simulator to study low temperature fuel behavior. Demonstrate additive performance in aircraft like fuel system simulator.

(U) In FY 2005: Continue pilot-light level demonstrations of low temperature additives for use in jet fuel to allow advanced manned and unmanned systems to sustain high altitude loiter for extended periods with focus on combustion performance of additized fuels.

(U)

(U) MAJOR THRUST: Develop and demonstrate efficacy of low-cost, environmentally friendly fuel additives to reduce soot particulate emissions from gas turbine engines using advanced research combustors and small turbine engines. Note: Due to FY 2005-2007 funding shifts, the FY 2005 combined cycle engine fuel additive efforts were revised for a restart in post FY 2007.	0.769	0.802	0.060

(U) In FY 2003: Expanded demonstration testing with low-cost fuel additives to reduce particulate emissions from gas turbine engines by 50 percent and to improve ignition characteristics and combustion in current and advanced propulsion concepts, including combined cycle engines. Demonstrated effectiveness of particulate mitigation

additives in a full-scale engine test.			
(U) In FY 2004: Continue pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent. Continue developing additives to improve ignition and combustion characteristics in current and advanced propulsion concepts, including combined cycle engines. Qualify additives through material compatibility, toxicology, and hot section tests, and demonstrate additive effectiveness in engine component tests.			
(U) In FY 2005: Continue pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate enhancements to fuel system technology. Note: Due to FY 2005-2007 funding shifts, the FY 2005 combined cycle engine candidate/hardware efforts were revised for a restart in post FY 2007.	0.384	0.682	0.057
(U) In FY 2003: Designed and developed concept hardware and fuel system simulators to evaluate key high temperature components of reusable aerospace vehicles, focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling. Characterized hydrocarbon fuel candidates for combined cycle engines. Completed investigating fuel concepts that will maximize the performance of advanced or combined cycle engines and minimize logistic costs.			
(U) In FY 2004: Continue to design and develop concept hardware and fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles, focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling. Continue characterization of hydrocarbon fuel candidates and enhanced hardware concepts for combined cycle engines.			
(U) In FY 2005: Continue pilot-light level design and development of hardware and fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling.			
(U)			
(U) MAJOR THRUST: Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Expeditionary Air Force. Note: Due to FY 2005-2007 funding shifts, the FY 2005 novel nozzle efforts were revised for a restart in post FY 2007.	0.841	0.400	0.047
(U) In FY 2003: Determined the benefits of advanced additive packages to improve any commercially available jet fuel that can meet military standards. Developed novel methods to inject additives packages to improve fuels and advanced field diagnostic techniques, such as smart nozzles, to assess fuel quality, additive injection requirements, and aid in mission planning by monitoring mission limiting fuel properties. Demonstrated a field-capable concept for fuel identification and characterization.			
(U) In FY 2004: Continue pilot-light development of novel methods for fuel analysis and additization in order to extend the usable temperature range of commercially available aviation fuel through application of novel technologies, including biologically related approaches. Demonstrate applicability of rapid fuel screening and identification using			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **2480 Aerospace Fuels and Atmospheric Propulsion**

	chromatography-based statistical analysis methods and commercially available fuel analyzers.			
(U)	In FY 2005: Continue pilot-light development of novel methods including bio- and nano-technology for fuel analysis.			
(U)				
(U)	CONGRESSIONAL ADD: Variable Flow Ducted Rocket (VFDR) Propulsion System.	3.975	0.000	0.000
(U)	In FY 2003: Develop a preliminary design for an integrated tactical missile technology demonstrator using a VFDR. Developed conceptual designs for VFDR tactical missiles that are compatible with the internal carriage in the F/A-22. Defined a preliminary flight test plan. Developed high-fidelity models and simulations for engineering, engagement, and mission analysis. Performed critical experiments to reduce the risk of key component technologies.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	11.498	3.101	0.374

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602102F, Materials.									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0603112F, Advanced Materials for Weapons Systems.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**3035 Aerospace Power Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3035 Aerospace Power Technology	5.728	4.185	4.297	4.332	4.412	4.487	4.560	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates electrical power generation, energy storage, thermal management, and distribution systems for aerospace applications. This technology enhances reliability and survivability, and reduces vulnerability, weight, and life cycle costs for manned and unmanned aerospace vehicles. The electrical power system components developed are projected to provide a two- to five-fold improvement in aircraft reliability and maintainability, and a 20 percent reduction in power system weight. This project also develops and demonstrates high power generation, energy storage, and thermal management technologies to enable high power density sources for directed energy weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate high-density secondary power systems and advanced weapons power technologies for a next generation aerospace vehicle.	1.921	0.000	0.000
(U) In FY 2003: Completed trade studies, detailed design, and critical technology development to optimize secondary power system size, weight, and efficiency. Completed evaluating electric power technology options for advanced weapon systems.			
(U) In FY 2004: Not Applicable. Note: In FY 2004, funding for this effort was shifted to higher Air Force priorities.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop power generation and conditioning, high rate batteries, and energy storage component and subsystem technologies for integration of high power subsystems with directed energy weapons (DEW). These technologies will enable the delivery of high power for operation of DEW.	0.815	1.190	1.560
(U) In FY 2003: Developed a high power, low duty cycle generator for pulsed DEWs. Completed fabricating lengths of Yttrium Barium Copper Oxide sufficient to fabricate coated conductors for cryogenic generators.			
(U) In FY 2004: Fabricate and test high power, low duty cycle generator critical components for pulsed DEWs.			
(U) In FY 2005: Fabricate high power low duty cycle generator system for pulsed DEWs.			
(U)			
(U) MAJOR THRUST: Develop power generation/conditioning/distribution component, energy storage, and thermal management components and subsystem technologies for manned and unmanned aircraft systems. These technologies will improve aircraft self-sufficiency, reliability, maintainability, and supportability, while reducing life cycle costs and enabling new capabilities.	1.009	2.043	1.974
(U) In FY 2003: Developed a power electrical generator system that is closely coupled with the propulsion system.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **3035 Aerospace Power Technology**

(U)	In FY 2004: Initiate design of the demonstration electrical generator for integration into mid-thrust class engines. Fabricate and test large amp-hour (200) cells and batteries.			
(U)	In FY 2005: Complete detailed design of demonstration electrical generator for integration into mid-thrust class engines.			
(U)				
(U)	MAJOR THRUST: Develop power generation/conditioning/distribution, energy storage, and thermal management components and subsystem technologies that are synergistic with air, space, and weapons platforms.	1.983	0.952	0.763
(U)	In FY 2003: Demonstrated advanced power conditioning technologies with motor drives and lithium-ion batteries to provide reductions in both volume and weight.			
(U)	In FY 2004: Fabricate low volume/low weight high temperature motor drive.			
(U)	In FY 2005: Test low volume/low weight high temperature motor drive.			
(U)	Total Cost	5.728	4.185	4.297

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**		PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **4921 Aircraft Propulsion Subsystems Int**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4921	Aircraft Propulsion Subsystems Int	33.809	28.600	16.719	19.647	15.036	26.533	26.920	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates gas turbine propulsion system technologies applicable to aircraft. The Aerospace Propulsion Subsystems Integration (APSI) project includes demonstrator engines such as the Joint Technology Demonstrator Engine for manned systems and the Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. The demonstrator engines integrate the core (high-pressure spool) technology developed under the Advanced Turbine Engine Gas Generator project with the engine (low-pressure spool) technology such as fans, turbines, engine controls, and exhaust nozzles. Additionally, these efforts include activities under the national High Cycle Fatigue program. This project also focuses on system integration of inlets, nozzles, engine/airframe compatibility, power and thermal management subsystems, and low-observable technologies. APSI provides aircraft with potential for longer range and higher cruise speeds with lower specific fuel consumption, surge power for successful engagements, high sortie rates with reduced maintenance, reduced life cycle cost, and improved survivability, resulting in increased mission effectiveness. Technologies developed are applicable to sustained high-speed vehicles and responsive space launch. The APSI supports the goals of the national Integrated High Performance Turbine Engine Technology (IHPTET) program, which is focused on doubling turbine engine propulsion capabilities while reducing cost of ownership. Anticipated technology advances include turbine engine improvements providing an approximate 30 percent reduction in tactical fighter aircraft takeoff gross weight and 100 percent increase in aircraft range/loiter. APSI is also fully integrated into the Versatile Affordable Advanced Turbine Engine program (VAATE). The IHPTET and VAATE programs provide continuous technology transition for military turbine engine upgrades and derivatives, and have the added dual-use benefit of enhancing the United States turbine engine industry's international competitiveness.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Design, fabricate, and demonstrate durability and integration technologies for turbofan/turbojet engines. These technologies will improve durability, supportability, and affordability of current and future Air Force aircraft.	6.056	7.359	2.577

(U) In FY 2003: Completed analysis, fabrication, instrumentation, and assembly of an engine for structural/durability testing. Completed refurbishment of the Advanced Turbine Engine Gas Generator, fabrication, and instrumentation in preparation for final assembly of the Joint Technology Demonstrator Engine with fixed inlet guide vanes and Moderate Aspect Ratio rotor, Integrally Bladed Rotor repair, fan rim damper, High Cycle Fatigue mistuning and damping technologies, vaneless counter-rotating high/low pressure turbine, probabilistic rotor system design, gamma titanium aluminide low pressure turbine coverplate, sprayform cast hardware, and Ceramic Matrix Composite technologies.

(U) In FY 2004: Complete structural durability testing on an engine and performance testing of the Joint Technology Demonstrator Engine containing fixed inlet guide vanes and a Moderate Aspect Ratio rotor, fan rim damper, High Cycle Fatigue mistuning and damping technologies, vaneless counter-rotating high/low pressure turbine, probabilistic

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **4921 Aircraft Propulsion Subsystems Int**

rotor system design, sprayform cast turbine case, and a high fuel/air ratio Impingement Film Floatwall Combustor. Initiate advanced engine designs for a sustained supersonic engine with advanced aero, mistuned fan with ice phobic coatings, a Low Pressure Turbine with advanced thermal barrier coatings and microcircuit cooling scheme, thermoplastic externals and health monitoring.

(U) In FY 2005: Validate the High Cycle Fatigue Test Protocol by completing structural durability testing of advanced engine components and instrumentation. Enhance advanced engine designs for a sustained supersonic engine with advanced aero, mistuned fan with ice phobic coatings, a Low Pressure Turbine with advanced thermal barrier coatings and microcircuit cooling scheme, thermoplastic externals, and health monitoring.

(U)

(U) MAJOR THRUST: Design, fabricate, and test advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, sustained supersonic and hypersonic cruise vehicles, and transports. Each of these component technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engineers.	17.521	14.762	12.072

(U) In FY 2003: Completed advanced engine designs and initiated fabrication of a High Cycle Fatigue robust front frame, an affordable Organic Matrix Composite (OMC) fan frame, a two-stage forward swept fan, a tiled low pressure turbine (LPT) blade, an uncooled Ceramic Matrix Composite LPT blade, a Metal Matrix Composite shaft, and model-based flexible control with diagnostics. Initiated advanced engine designs for tandem fan with (OMC) tip shroud, carbon counter-rotating intershaft seal, and active augmenter screech control.

(U) In FY 2004: Complete fabrication, instrumentation, assembly, and test of a High Cycle Fatigue robust front frame, an affordable OMC fan frame, a two-stage forward swept fan, a tiled LPT blade, an uncooled Ceramic Matrix Composite LPT blade, a Titanium Matrix Composite shaft, and model-based flexible control with diagnostics in an advanced demonstrator engine. Enhance advanced engine designs for a tandem fan with OMC tip shroud, carbon counter-rotating intershaft seal, and active augmentor screech control.

(U) In FY 2005: Complete fabrication and initiate testing of a High Cycle Fatigue robust front frame, an affordable OMC fan frame, a two-stage forward swept fan, a tiled LPT blade, an uncooled Ceramic Matrix Composite LPT blade, a Titanium Matrix Composite shaft, and model-based flexible control with diagnostics. Complete advanced engine designs for tandem fan with OMC tip shroud, carbon counter-rotating intershaft seal, and active augmentor screech control.

(U)

(U) MAJOR THRUST: Design, fabricate, and test advanced component technologies for limited life engines. These technologies improve the performance, durability, and affordability of engines for missile and unmanned air vehicle, and hypersonic weapon applications.	7.561	4.000	2.070

(U) In FY 2003: Completed fabrication and commenced testing on an Organic Matrix Composite fan, uncooled ceramic high-pressure turbine, and slinger combustor. Completed fabrication of a low volume combustor. Prepared for

	engine structural durability testing of a high stage loading splittered fan and uncooled ceramic low-pressure turbine. Completed study effort to identify critical technologies for a supersonic turbine engine powered missile.			
(U)	In FY 2004: Complete engine structural durability testing of a high stage loading splittered fan and uncooled ceramic low-pressure turbine. Complete testing of an Organic Matrix Composite fan, an uncooled ceramic high-pressure turbine, and slinger combustor. Complete testing of low volume combustor. Complete fabrication and conduct durability testing on an uncooled Ceramic Matrix Composite turbine blisk/nozzle, and a Carbon/Carbon exhaust nozzle. Initiate designs of advanced component technologies for intelligent and durability engine testing.			
(U)	In FY 2005: Initiate designs of advanced component technologies for intelligent and durability engine testing to include an advanced fan, a ceramic turbine, turbine with new advanced cooling approach, and oil less bearings.			
(U)				
(U)	MAJOR THRUST: Develop high-speed turbine engine technology for next generation air and space vehicles.	1.710	0.000	0.000
(U)	In FY 2003: Completed study to evaluate gas turbine technologies for long-range strike vehicles (e.g., gas turbine and ramjet/scramjet combined/combination cycle engines).			
(U)	In FY 2004: Not Applicable. Note: In FY 2004, funding for this effort was shifted to higher Air Force priorities.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Joint Expendable Turbine Engine Concept (JETEC) Phase III.	0.961	0.000	0.000
(U)	In FY 2003: Designed and fabricated a fixed composite nozzle and added instrumentation to the combustor for the JETEC Phase III demonstrator engine test. The JETEC goal is to develop turbine engines that reduce fuel consumption, increase thrust/airflow ratio, and reduce production costs for supersonic expendable and limited life unmanned vehicle turbine engines. These efforts will contribute to the continued detailed design, fabrication, assembly, and test of materials and high pressure ratio technologies. Technologies include single crystal Lamilloy blades and advanced thermal barrier coated cast cool vanes.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Turbine Engine Gas Generator And Aircraft Propulsion Subsystem Integration.	0.000	2.479	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Design and fabricate advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Refurbish, fabricate, instrument and assemble hardware from the advanced turbine engine gas generator. This gas generator will be used in engine testing of the following components: two-stage forward swept fan, uncooled Ceramic Matrix Composite low pressure turbine vane, Titanium Matrix Composite shaft and model-based flexible control with diagnostics. Each of these component technology innovations can be applied to the Air Force's engine inventory and offer potentially significant			

Exhibit R-2a, RDT&E Project Justification

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE	DATE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**4921 Aircraft Propulsion Subsystems Int**	**February 2004**

performance enhancements to future aircraft engines.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	33.809	28.600	16.719

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities									
(U)	PE 0602201F, Aerospace Flight Dynamics.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0603003A, Aviation Advanced Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**4922 Space & Missile Rocket Propulsion**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4922 Space & Missile Rocket Propulsion	1.344	12.739	6.039	7.065	5.038	5.123	5.204	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique technology efforts in this project were transferred to PE 0603500F, Project 5033, in conjunction with the Space Commission recommendation to consolidate all space unique activities. In this project, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technologies for the sustainment of strategic systems (including solid boost/missile propulsion, Post Boost Control, and aging and surveillance efforts) and tactical rockets. Characteristics such as environmental acceptability, affordability, reliability, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program will improve the performance of expendable systems' payload capabilities by approximately 20 percent and reduce hardware and operation costs by approximately 30 percent. The projects in this program are part of the Technologies for the Sustainment of Strategic Systems program and support the Integrated High Payoff Rocket Propulsion Technology program.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	1.344	0.000	0.000
(U) In FY 2003: This project previously included space unique funding, which was transferred to PE 0603500F, Project 5033. These funds represent the civilian salaries for the work effort transferred.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate missile propulsion and Post Boost Control Systems (PBCS) technologies for Intercontinental Ballistic Missile (ICBM). Note: Efforts support work being conducted in 0603500F, Project 5033, for the Technology for the Sustainment of Strategic Systems-Phase I.	0.000	6.501	1.721
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Demonstrate component technologies with readily available materials to reduce hardware costs with increased performance for the PBCS. Continue hardware development integrating case, nozzle, insulation, and propellant for the Missile Propulsion Demonstration-Phase I.			
(U) In FY 2005: Complete Phase I full-scale risk reduction component developments for the advanced PBCS demonstration. Complete demonstration of component technologies with readily available materials to reduce hardware costs with increased performance for the PBCS. Enhance hardware development integrating case, nozzle,			

Exhibit R-2a, RDT&E Project Justification | DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**4922 Space & Missile Rocket Propulsion**

	insulation, and propellant for the Missile Propulsion Demonstration-Phase I.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate missile propulsion, Post Boost Control Systems (PBCS), aging, and surveillance technologies for strategic systems. Efforts support the Technology for Sustainment of Strategic Systems-Phase II.	0.000	6.238	4.318
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Begin development of advanced modeling and simulation tools (Phase II) applying them to actual missile components for verification, design, and modification. Begin development of advanced aging and surveillance models and tools to further improve capability to analyze and predict motor life and system health.			
(U)	In FY 2005: Continue modeling and simulation tools (Phase II) development for analyzing and developing missile components. Begin to develop subcomponents to test the accuracy of the tools and update the models with the resulting data. Continue development of aging and surveillance tools for predicting the health of solid rocket motors. Develop methods to apply these tools on a motor-by-motor basis vice a fleet wide basis.			
(U)	Total Cost	1.344	12.739	6.039

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0602601F, Spacecraft Technology.									
(U)	PE 0603401F, Advanced Spacecraft Technology.									
(U)	PE 0603853F, Evolved Expendable Launch Vehicle Program.									
(U)	PE 0603114N, Power Projection Advanced Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **4922 Space & Missile Rocket Propulsion**

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**5098 Advanced Aerospace Propulsion**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5098 Advanced Aerospace Propulsion	0.000	15.750	26.300	10.819	20.387	23.605	23.074	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2004, this Project is a new project, but not a New Start. In FY 2005-2007, funding was shifted Projects 2480 and 4921 in this PE to this Project.

(U) A. Mission Description and Budget Item Justification

This project develops the scramjet propulsion cycle to a technology readiness level appropriate for in-flight demonstration and for full integration with other engine cycles (including turbine and rocket based) to provide revolutionary propulsion options for the Air Force. The primary focus is on the hydrocarbon-fueled, scramjet engine. Multi-cycle engines will provide the propulsion systems necessary to support aircraft and weapon platforms operating over the range of Mach 0 to 8+. Efforts include scramjet flow-path optimization to enable operation over the widest possible range of Mach numbers, active combustion control to assure continuous positive thrust (even during mode transition), robust flame-holding to maintain stability through flow distortions, and maximized volume-to-surface area to minimize the thermal load imposed by the high-speed engine. Thermal management plays a vital role in scramjet and combined cycle engines, including considerations for protecting potential low speed propulsion systems during hypersonic flight.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation over a range of Mach 4 to 8.	0.000	15.750	26.300
(U) In FY 2003: Not Applicable. Note: Activities were previously part of other projects in this PE.			
(U) In FY 2004: Design and fabricate a fixed geometry flow-path for a hydrocarbon-fueled scramjet with robust operations over a range of Mach 4.5 to 7+ to include optimization of the flow-path cross-section and the flame-holding/fuel-mixing geometry. Develop a robust engine start system to achieve full engine light after boost to Mach 4.5. Initiate design of an active engine sense-control system to manage start transient and engine mode changes during acceleration. Initiate vehicle design capable of rocket-boost to Mach 4, full integration with scramjet engine and hydrocarbon fuel system, and acceleration from Mach 4.5 to 7+. Initiate selection of rocket boosters.			
(U) In FY 2005: Initiate ground test of the hydrocarbon-fueled, fixed geometry flow path. Continue detailed design of the scramjet engine demonstrator air vehicle. Conduct wind tunnel testing of the air vehicle models. Conduct various design trade studies to ready the overall demonstrator design (includes air vehicle structures, avionics, instrumentations, scramjet propulsion systems, and boosters) for a critical design review.			
(U) Total Cost	0.000	15.750	26.300

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **5098 Advanced Aerospace Propulsion**

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

(U) **D. Acquisition Strategy**

Not Applicable

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **681B Advanced Turbine Engine Gas Generator**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
681B	Advanced Turbine Engine Gas Generator	31.688	29.050	26.185	26.425	26.914	27.365	27.803	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops turbine engine gas generator technologies for current and future aircraft propulsion systems. The objective is to provide the continued evolution of technologies into an advanced gas generator in which the performance, cost, durability, reparability, and maintainability can be assessed in a real engine environment. The gas generator, or core, is the basic building block of the engine and it consists of a compressor, a combustor, and a high-pressure turbine. Experimental core engine testing enhances early, low-risk transition of key engine technologies into engineering development, where they can be applied to derivative and/or new systems. These technologies are applicable to a wide range of military and commercial systems including aircraft, missiles, land combat vehicles, ships, and responsive space launch. Component technologies are demonstrated in a core (sub-engine) test. The core performances of this project are proven in demonstrator engines in Project 4921 of this PE. Efforts are part of the Integrated High Performance Turbine Engine Technology and the Versatile Affordable Advanced Turbine Engine programs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Design, fabricate, and test performance demonstration core engines, using advanced materials including Titanium Matrix Composites, to provide improved performance and fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, sustained supersonic and hypersonic cruise vehicles, and large transports. Each of these technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines.	26.579	24.390	21.866

(U) In FY 2003: Completed design and continued hardware fabrication of a core engine test article with an advanced compressor aerodynamics, a trapped vortex combustor with a ceramic matrix composite combustor liner, a ceramic matrix composite vane, magnetic bearings, and an advanced high-pressure turbine blisk. Completed core engine testing of a high-pressure ratio four stage compressor with an integrated lightweight combustor that has microcircuit cooled turbine blade outer airseals, revolutionary hot section material, advanced Thermal Barrier Coating, and thinwall supercooled turbine blades. Preliminarily designed a core engine test article with a 6-stage compressor, an Integrated Lightweight Combustor with integrated vane pack, a cooled-cooling air system, and micro-circuit cooled high pressure turbine blades with advanced thermal barrier coating.

(U) In FY 2004: Continue hardware fabrication of a core engine test article with advanced compressor aerodynamics, a trapped vortex combustor with ceramic matrix composite combustor liners, magnetic bearings, and advanced turbine blisk and vane materials. Continue design of hardware for core engine testing of a high-pressure ratio six-stage compressor with an integrated lightweight combustor with integrated vane pack, a cooled cooling air system, and micro-circuit cooled high pressure turbine blades with advanced thermal barrier coating.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **681B Advanced Turbine Engine Gas Generator**

(U)	In FY 2005: Continue hardware fabrication of a core engine test article with advanced compressor aerodynamics, a trapped vortex combustor with ceramic matrix composite combustor liners, magnetic bearings, advanced turbine blisk and advanced turbine vane materials. Complete design and initiate fabrication of hardware for core engine testing of a cooled-cooling air system, and micro-circuit cooled high pressure turbine blades with advanced thermal barrier coating.			
(U)				
(U)	MAJOR THRUST: Design, fabricate, and durability test demonstration core engines to provide increased durability and affordability for turbofan/turbojet engines for fighters, attack aircraft, bombers, sustained supersonic and hypersonic cruise vehicles, and large transports.	1.826	1.506	1.500
(U)	In FY 2003: Designed and initiated fabrication of long lead hardware for turbine engine advanced hardware for core engine evaluations in the national durability programs.			
(U)	In FY 2004: Enhance the design and continue fabrication of long lead hardware for turbine engine advanced core evaluations in the national durability programs.			
(U)	In FY 2005: Complete the design and continue fabrication of long lead hardware for turbine engine advanced hardware for core engine evaluation in the national durability programs.			
(U)				
(U)	MAJOR THRUST: Design, fabricate, and evaluate technology demonstration core engines to provide improved performance and fuel consumption for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, theater transports, and large unmanned air vehicles.	3.283	3.154	2.819
(U)	In FY 2003: Advanced core engine testing of a forward swept splittered compressor rotor, a high temperature rise combustor, a counter- rotating vaneless turbine, and ceramic matrix composite turbine blades and vanes.			
(U)	In FY 2004: Continue core engine testing of a forward swept splittered compressor rotor, a high temperature rise combustor, a counter-rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings.			
(U)	In FY 2005: Complete core engine testing of a forward swept splittered compressor rotor, a high temperature rise combustor, a counter- rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings. Initiate design of small versatile affordable core engine technologies.			
(U)	Total Cost	31.688	29.050	26.185

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602201F, Aerospace Flight									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **681B Advanced Turbine Engine Gas Generator**

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

Dynamics.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0603003A, Aviation Advanced Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603231F Crew Systems and Personnel Protection Technology

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	37.959	42.822	32.794	32.525	33.129	33.685	34.224	Continuing	TBD
2830	Decision Support and Cognitive Systems	8.128	8.865	6.369	6.236	6.187	6.291	6.393	Continuing	TBD
3257	Helmet-Mounted Sensory Technologies	7.304	7.636	4.788	5.327	5.421	5.511	5.599	Continuing	TBD
4923	Logistics Readiness and Sustainment	7.076	12.463	10.532	10.847	11.204	11.393	11.575	Continuing	TBD
4924	Distributed Mission Training Technology	6.535	6.475	7.220	7.160	7.161	7.281	7.397	Continuing	TBD
5020	Directed Energy Protective Systems	8.916	7.383	3.885	2.955	3.156	3.209	3.260	Continuing	TBD

Note: In FY 2003, the Directed Energy Protective Systems program at Brooks City-Base, Texas, moved from Project 3257 to Project 5020 to align resources with the Air Force Research Laboratory organization.

(U) **A. Mission Description and Budget Item Justification**

This program develops and demonstrates technologies to enhance human performance and effectiveness and to enable the aerospace force. State-of-the-art advances are made to train personnel, protect and sustain warfighters, and improve human interfaces with weapon systems. The Decision Support and Cognitive Systems project develops and demonstrates crew system interface technologies and information operations technologies that promote effective decision-making, control, and execution in operational environments. The Helmet-Mounted Sensory Technologies project develops and demonstrates advanced operator interface technologies for multi-functional helmet-mounted displays and night vision devices, and laser eye protection. The Logistics Readiness and Sustainment project develops and demonstrates technologies that will protect the force, enhance logistics, and improve the design, deployability, performance, and support of current and future weapon systems. The Distributed Mission Training Technology project develops and demonstrates advanced training, simulation, and mission rehearsal technologies. The Directed Energy Protective Systems project develops and demonstrates advanced technologies for laser eye protection and for assuring the safety of personnel involved with test, deployment, and operation of high-energy laser weapons and systems. Note: In FY 2004, Congress added $1.4 million for Laser Eye Protection Research, $1.4 million for Virtual Warriors, $1.8 million for Crew Systems Personnel Protection, $1.7 million for Helmet Cueing System, $1.0 million for The Logistics Institute, and $1.4 million for Total Atmospheric Liquefaction for Oxygen and Nitrogen (TALON).

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies to protect and enhance the performance of Air Force personnel in operational environments.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603231F Crew Systems and Personnel Protection Technology

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	39.235	34.487	32.881
(U)	Current PBR/President's Budget	37.959	42.822	32.794
(U)	Total Adjustments	-1.276	8.335	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.365	
	Congressional Increases		8.700	
	Reprogrammings	-0.542		
	SBIR/STTR Transfer	-0.734		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603231F Crew Systems and Personnel Protection Technology**	**2830 Decision Support and Cognitive Systems**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2830	Decision Support and Cognitive Systems	8.128	8.865	6.369	6.236	6.187	6.291	6.393	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project provides technology to improve human combat performance, combat support performance, and aerospace safety through better information delivery and crew station integration, which are achievable through effective decision support and cognitive systems engineering. Crew stations represent the fundamental interface between the warfighter and equipment across the gamut of aerospace operations. To cope with the recognized data overload in command centers and weapon platforms, this project develops technologies to quantify requirements, develop information interfaces, and evaluate crew performance in selected operational environments. This project includes bioacoustic technologies to complement decision support and visual information technologies as part of an integrated solution to negate information overload in the Air Expeditionary Force environment, while improving sound cueing, voice communications, and hearing protection for weapon systems operators, command centers, and security forces.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate user-tailored information management and portrayal technologies that enhance battlespace situational awareness for global- and MAJCOM-level information warfare and air operations centers to reduce decision-making bottlenecks.	2.708	3.222	1.500

(U) In FY 2003: Transitioned and integrated initial version of combat assessment tools into joint and/or Air Force weapon systems. Developed decision-making process and model to characterize different types of adversary systems and assess alternative ways they may be favorably influenced by allied force actions. Developed speech recognition front-end and advanced visualization for operations centers' information management tool. Improved flow of time-critical targeting information into strike aircraft to enhance pilot situational awareness, exploiting capabilities inherent with helmet-mounted display technology.

(U) In FY 2004: Develop a decision-making modeling, simulation, and analysis tool to evaluate different types of adversary systems and to assess alternative ways they may be favorably influenced by allied force actions. Integrate this tool into next-generation planning and combat assessment tools to demonstrate enhanced information warfare planning. Develop dynamic user tailoring for operation centers' information management tool.

(U) In FY 2005: Integrate a decision-making modeling, simulation, and analysis tool into final version of previously demonstrated combat assessment tool and transition into joint and/or Air Force weapon systems. Develop collaborative information sharing for operation centers' information management tool. Complete and integrate final version information management tool into joint and/or Air Force weapon systems.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **2830 Decision Support and Cognitive Systems**

(U)	MAJOR THRUST: Develop advanced high-performance bioacoustic hearing protection technologies to achieve 40-45 dB noise attenuation for personnel working in and around fighter aircraft.	0.893	0.000	0.000
(U)	In FY 2003: Demonstrated communication capability in 150 dB noise fields. Integrated deep insert earplug technology with active noise reduction to achieve 45 dB field attenuation. Demonstrated improved attenuation and user acceptability in laboratory and field environments.			
(U)	In FY 2004: Not Applicable. Note: Major thrust completed in FY 2003.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate advanced audio technologies to enhance security force situational awareness and threat response time using acoustic sensors.	1.459	0.947	0.000
(U)	In FY 2003: Demonstrated to deployed security forces an improved situational awareness capability by using intelligent algorithms, three-dimensional (3-D) audio, and audio symbology to code the detected threats and assist in threat intervention. Demonstrated at a military exercise the operational payoff from using 3-D audio radios and helmets in a mobile patrol squadron. Developed an automated threat assessment system to evaluate the severity and importance of detected noise.			
(U)	In FY 2004: Demonstrate a user-centered interface to improve threat level and location awareness for security force command, as well as automated acoustic threat detection, localization and classification of foot traffic, land vehicles, air vehicles, and munitions firing. Demonstrate during a military exercise the operational payoff from using the combination of acoustic sensors, multimedia displays at the command center, and three-dimensional audio radios to assist mobile patrol squads.			
(U)	In FY 2005: Not Applicable. Note: Technology will transition to Special Operations Forces in FY 2004 for testing.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate human-centered science and technology for the Air Force Information Warfare (IW) community. This technology will provide the IW warrior with tailored decision support systems, guidelines for effective selection of information warriors, information operations simulators and training systems, improved operational shift schedules to increase personnel efficiency and effectiveness, enhanced decision-making tools, and automated tools to reduce operator task load.	1.320	1.970	2.069
(U)	In FY 2003: Performed initial operating capability (IOC) baseline review and process study to develop tools to influence human senses. Technologies will enable perception management and deception, model and simulate human behavior, develop adversary cultural and decision models, enhance predictive battlespace awareness, and improve interaction and monitoring capability by determining effectiveness of automated tools in support of intelligence and information warfare units.			
(U)	In FY 2004: Develop technologies to provide human-centered alternatives to current IW architectures, systems, processes, and operations. Technologies will focus on predictive battlespace awareness and tailored decision support			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **2830 Decision Support and Cognitive Systems**

		FY 2003	FY 2004	FY 2005
	systems and tools to augment human operators' performance. Finalize IOC process study and develop a modernization plan for IW as well as a detailed plan to support future demonstrations of IW tools, training, and requirements.			
(U)	In FY 2005: Develop and demonstrate tools, methods, and technology to gain, exploit, defend, and attack information. Identify and prioritize Information Warfare (IW) capabilities for enhancement by exemplar technologies and methods. Develop, demonstrate, and evaluate IW support tools and technologies to assess operational impact.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate human effectiveness technology to improve combat effectiveness reporting, situation assessment updates, and decision support for Combined Air Operations Centers (CAOC). Note: New application of technology in FY 2004 from first major thrust.	0.000	1.338	2.800
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Perform cognitive task analysis of key CAOC positions and develop measures of performance and effectiveness. Begin to develop visualizations promoting battlespace situational awareness.			
(U)	In FY 2005: Develop user-tailorable visualizations to optimize human perception of battlespace situational awareness. Demonstrate enhanced collaborative capability for effective, time-critical information exchange operations between CAOC and other operational units.			
(U)				
(U)	CONGRESSIONAL ADD: Virtual Warriors. Note: Formerly known as Combat Automation Requirement Testbed in FY 2003.	1.748	1.388	0.000
(U)	In FY 2003: Extended human modeling and simulation technologies to make effective trade-offs between crew system concepts and mission effectiveness. Analyzed and developed integrated crew system concepts to reduce manning within air operations centers, showing contribution of human modeling to substantiate time-critical targeting effectiveness and affordability. Developed extensions to the simulation testbed that will provide the capability to objectively and systematically assess the overall sensor-to-shooter process for time-critical targets.			
(U)	In FY 2004: Integrate human modeling and simulation technologies into distributed simulation exercises to reduce manning within air operations centers and to shorten time-critical targeting cycle times.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	8.128	8.865	6.369

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602202F, Human									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **2830 Decision Support and Cognitive Systems**

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

Effectiveness Applied Research.

(U) PE 0604706F, Life Support Systems.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **3257 Helmet-Mounted Sensory Technologies**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3257	Helmet-Mounted Sensory Technologies	7.304	7.636	4.788	5.327	5.421	5.511	5.599	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, the Directed Energy Protective Systems program at Brooks City-Base, Texas, moved from Project 3257 to Project 5020 to align resources with the Air Force Research Laboratory organization.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced technologies for ejection-safe, multi-functional Helmet-Mounted Displays and night vision devices. Development of helmet-mounted tracker and display (HMT/D) technologies will enable pilots to detect, identify, target, and launch weapons faster and more accurately. Development of improved aircrew Night Vision Goggle (NVG) technologies will enhance aerial combat capabilities at night.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced Helmet-Mounted Tracker and Display (HMT/D) and subsystem technologies to improve mission effectiveness and pilot situational awareness during day and night missions in all-weather conditions. These technologies help pilots to detect, identify, target, and engage with weapons faster and more accurately.	3.893	2.313	1.845
(U) In FY 2003: Investigated and developed advanced symbology sets for tactical HMT/Ds to improve targeting, increase situational awareness, and reduce spatial disorientation. Integrated ultrasonic transducers with inertial head tracker to improve tracker accuracy. Investigated utility of advanced daytime HMT/D incorporating miniature color display for future simulations and flight evaluations.			
(U) In FY 2004: Demonstrate advanced symbology sets for tactical HMT/Ds in an operational environment to assess improvements to targeting, to increase situational awareness, and to reduce spatial disorientation. Demonstrate and assess utility of advanced head tracker that improves tracker accuracy, reduces system latency, and reduces mobility footprint.			
(U) In FY 2005: Assess capability of integrated technology application of advanced symbology sets and advanced head tracker at night to reduce target acquisition and engagement timelines. Demonstrate real-time target information on HMT/D to destroy time-critical ground targets. Demonstrate space-stabilized head-up displays on HMT/D in laboratory.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate technologies for improved aircrew night vision goggles to increase mission effectiveness and enhance air operations by allowing the pilot to perform daytime tactics at night.	1.504	0.000	0.000
(U) In FY 2003: Incorporated and evaluated laser-hardening technologies for image intensifier tube. Integrated a HMT/D			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **3257 Helmet-Mounted Sensory Technologies**

	with the Integrated Panoramic Night Vision Goggle.			
(U)	In FY 2004: Not Applicable. Note: Technology transitioned to Joint Helmet Mounted Cueing System Program Office in FY 2003.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate advanced visual display technologies to provide integrated day/night capability for reducing pilot workload and enhancing mission performance. Note: New application of technology in FY 2004 from previous major thrust.	0.000	2.910	2.943
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Assess capabilities of emerging night vision devices and investigate head-mounted, multi-channel displays. Develop technologies to reduce bulk and head-supported weight required by existing cathode ray tube-based designs to improve aircrew safety and comfort.			
(U)	In FY 2005: Develop and integrate miniature digital night vision devices and with head-mounted multi-channel displays to optimize display of information to aircrew. Investigate the utility of new displays for providing imagery and video to the aircrew to reduce time looking at head-down displays in the cockpit. Assess leading edge display technologies to support fielding of laser eye protection and laser hardening technologies with advanced Helmet-Mounted Tracker and Displays and night vision goggles.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate subsystems to protect the aircrew member wearing Helmet-Mounted Displays (HMDs) during emergency ejection in current and future high-performance fighter aircraft. Aerodynamic lift-reducing helmet concepts will provide a decrease in head and neck injuries for crewmembers wearing HMDs during high-speed emergency ejections.	0.937	0.727	0.000
(U)	In FY 2003: Conducted tests to verify head, neck, and eye protection are provided to 600 Knots Equivalent Air Speed (KEAS) threshold, 700 KEAS objective.			
(U)	In FY 2004: Identify candidate lift-reducing concepts and integrate helmet design with emerging HMD designs. Conduct impact, windblast, and ejection sled tests to verify performance under high-speed ejection conditions.			
(U)	In FY 2005: Not Applicable. Note: Major thrust will be completed in FY 2004.			
(U)				
(U)	CONGRESSIONAL ADD: Helmet Cueing System Technology.	0.970	1.686	0.000
(U)	In FY 2003: Developed and demonstrated advanced head tracker technologies to improve helmet cueing capabilities for onboard weapons and sensors.			
(U)	In FY 2004: Transition the advanced head tracker and related helmet cueing technologies from the laboratory environment to the operational environment. Develop and package the advanced head tracker including integration with an operational aircraft's sensors and weapons, in preparation for a flight demonstration of the new helmet cueing			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **3257 Helmet-Mounted Sensory Technologies**

capability.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	7.304	7.636	4.788

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602202F, Human Effectiveness Applied Research.									
(U)	PE 0602102F, Materials.									
(U)	PE 0603112F, Advanced Materials for Weapon Systems.									
(U)	PE 0603319F, Airborne Laser Program.									
(U)	PE 0604706F, Life Support Systems.									
(U)	PE 0604201F, Integrated Avionics Planning and Development.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603231F Crew Systems and Personnel Protection Technology**	**4923 Logistics Readiness and Sustainment**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4923 Logistics Readiness and Sustainment	7.076	12.463	10.532	10.847	11.204	11.393	11.575	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technologies that will enhance logistics support functions; improve the effectiveness of logistics information systems and command and control systems; enhance the fidelity and accuracy of large-scale military simulations; and improve the protection of personnel in deployed environments. This includes technologies to model and simulate intelligent behavior; to better integrate the human with computer-based information systems; to provide near real-time status of logistics resources and aircraft status; and to perform earlier prediction of the effects of exposure to hazardous chemicals. The resulting efforts will improve warfighter decision-making in the areas of logistics management, command and control, and force protection.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate intelligent software agents and realistic human and organizational behavior models. These computer agents and models will add realism and fidelity to large-scale synthetic environments and war games, provide intelligence analysts a way to model collected data, and improve the user interaction with logistics information systems.	2.200	2.777	2.123
(U) In FY 2003: Demonstrated intelligent software agents that emulate potential enemy integrated air defense command and control echelons. These agent-based models incorporated cultural behavioral differences observed in the real world.			
(U) In FY 2004: Demonstrate software architecture for behavior modeling that can be readily tuned to different personality types. The models being developed will simulate potential enemy command and control decision-making at the air component commander level of control.			
(U) In FY 2005: Develop human behavior based computer models that enable the study of information operations on command and control echelons and that better represent logistics functions in synthetic exercises.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate logistics technologies for improved deployment operations and improved system supportability. These technologies will maximize the efficiency and effectiveness of Air Force deployments and mobility operations in support of Agile Combat Support initiatives and Air Expeditionary Force concepts.	2.540	4.489	3.072
(U) In FY 2003: Developed initial software tool set to provide wing commanders and senior logisticians with advanced logistics information and management capabilities, including rapid access to real-time resources status information, proactive problem identification, decision support, and process tracking.			
(U) In FY 2004: Complete development of software tool set to provide wing commanders and senior logisticians with			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4923 Logistics Readiness and Sustainment**

		FY 2003	FY 2004	FY 2005
	advanced logistics information and management capabilities, including rapid access to real-time resources status information, proactive problem identification, decision support, and process tracking. Begin to assess and develop technology to automatically collect and update critical information required to effectively manage logistics resources in support of combat operations.			
(U)	In FY 2005: Continue to develop and apply technology to automatically collect and update critical information required to effectively manage logistics resources in support of combat operations. Begin to design and develop very fast, easy-to-use simulation capabilities for Air Force units to optimally apply limited logistics resources during operation.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate advanced job performance aiding technologies to enhance the utility of global air mobility command and control systems. These technologies will provide command and control operators with automated access to a manageable amount of critical information from multiple sources to avoid operator overload and thus support faster, more accurate decision-making and problem resolution during mobility operations.	1.366	1.471	2.613
(U)	In FY 2003: Developed and demonstrated software to provide advanced user interfaces by combining intelligent agents and artificial intelligence software with automated, work-centered collaborative planning and decision support technologies to automatically identify weather impacts on air mobility missions.			
(U)	In FY 2004: Develop artificial intelligence software, work-centered collaborative planning tools, and advanced decision support technologies to augment global air mobility command and control systems.			
(U)	In FY 2005: Continue to develop artificial intelligence software that can automatically draw conclusions, develop work-centered collaborative planning tools, and develop advanced decision support technologies. Demonstrate these technologies in an operational environment within the Tanker Airlift Control Center.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate technologies that will enhance and streamline aircraft maintenance processes to improve the Air Force's ability to meet Air Expeditionary Force requirements by providing faster and more accurate methods of diagnosing and predicting component failures.	0.000	2.734	2.724
(U)	In FY 2003: Not Applicable. Note: Funds redirected to higher Air Force priorities.			
(U)	In FY 2004: Begin to develop cognitive decision technologies, new information fusion techniques, and algorithms to determine failure trends for improved maintenance troubleshooting. Develop revolutionary formats for presenting technical information and software tools that support collaborative problem-solving during aircraft maintenance.		-	
(U)	In FY 2005: Continue to develop cognitive decision technologies, new information fusion techniques, and algorithms to determine failure trends for improved maintenance troubleshooting. Continue to develop revolutionary formats for presenting technical information and software tools that support collaborative problem solving during aircraft maintenance.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4923 Logistics Readiness and Sustainment**

(U)	CONGRESSIONAL ADD: The Logistics Institute. Note: FY 2004 add is a continuation of the FY 2003 add titled Battlespace Logistics Readiness and Sustainment.	0.970	0.992	0.000
(U)	In FY 2003: Developed and demonstrated technologies that will enhance Air Force maintenance and supply processes and improve the design, deployability, performance, and logistics support of current and future weapon systems.			
(U)	In FY 2004: Continue to develop and demonstrate technologies that will enhance Air Force maintenance and supply processes and improve the design, deployability, performance, and logistics support of current and future weapon systems.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	7.076	12.463	10.532

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602201F, Aerospace Flight Dynamics.									
(U)	PE 0602202F, Human Effectiveness Applied Research.									
(U)	PE 0603721N, Environmental Protection.									
(U)	PE 0604708F, Civil, Fire, Environmental, Shelter.									
(U)	PE 0604740F, Integrated Command and Control Applications.									
(U)	PE 0605801A, Programwide Activities.									
(U)	PE 0708011F, Industrial Preparedness.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4923 Logistics Readiness and Sustainment**

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

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603231F Crew Systems and Personnel Protection Technology**	**4924 Distributed Mission Training Technology**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4924	Distributed Mission Training Technology	6.535	6.475	7.220	7.160	7.161	7.281	7.397	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced training, simulation, and mission rehearsal technologies that will improve warfighter capabilities and mission readiness by enhancing operator and team performance skills. This effort includes the development of technologies that enable integration of computer models, live weapon systems, and weapon system simulators to portray the global battlespace, including all-weather, day/night flight operations, command and control, force protection, and aerospace operations. This project develops and demonstrates advanced training and simulation technologies that will improve warfighter readiness by enhancing mission training and mission rehearsal capabilities. Development and effective use of this global battlespace requires advances in training systems, interconnection, information, visual, and representation technologies. The resulting mission training and rehearsal capabilities will enhance the mission essential competencies of the combat and combat support individuals and teams that comprise the aerospace force.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Advance warfighter integrated training and rehearsal for aerospace operations, command and control, force protection, and air base defense warfighters. Technologies will increase training effectiveness and efficiency, and decrease time to mission qualification.	2.422	1.680	1.063
(U) In FY 2003: Developed and validated training technologies and methods to enable deployed personnel to maintain mission essential skills. Implemented and evaluated the next generation threat system in Distributed Mission Training (DMT) testbed.			
(U) In FY 2004: Develop mission essential competency analysis toolset for air superiority that identifies those critical knowledge, skills, and experiences that are important enablers of mission performance for individuals and teams. Develop specifications for virtual and live training performance assessment and measurement to enable deployed personnel to maintain mission essential skills, and develop training and simulation technologies that will enable integrated command and control training within the DMT environment. Demonstrate competency-based design of a simulator performance measurement and tracking system, and develop a stand-alone performance monitoring and tracking capability for live-fly instrumented range data.			
(U) In FY 2005: Develop and validate capability to conduct integrated command and control and combat employment training and rehearsal. Develop specifications for a deployable Distributed Mission Operations (DMO) training and rehearsal technology suite for full combat tactical weapons employment mission planning, training, and rehearsal. Complete collaborative toolset for mission analysis and tracking. Demonstrate an integrated live-fly and virtual simulation performance measurement capability and evaluate its operational utility. Complete first DMO skills			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4924 Distributed Mission Training Technology**

	development, assessment, and decay study for combat air forces.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate the application of information and communications technologies for realistic mission training and mission rehearsal in a distributed simulation environment. These technologies will increase readiness training by enabling more realistic employment of weapon systems within a horizontally and vertically integrated system of sensors, command and control, and weapons platforms.	0.679	1.288	0.000
(U)	In FY 2003: Demonstrated the capability to establish a High-Level Architecture (HLA) federation that provides aircrew and command and control training to geographically separated audiences. Demonstrated an HLA federation to enable distributed mission training to operate at multiple security levels.			
(U)	In FY 2004: Demonstrate a near-real-time HLA based training environment enabling aircrew and command and control training for geographically separated training audiences. Validate performance of an HLA network guard federation operating at multiple security levels and produce documentation to support certification and accreditation.			
(U)	In FY 2005: Not Applicable. Note: Technology will transition to the Distributed Mission Operations Center in FY 2004.			
(U)				
(U)	MAJOR THRUST: Demonstrate advances in simulator visual system technologies through the development of ultrahigh resolution projection systems, low-cost high-fidelity image generator, and thin-film holographic collimating display technologies. Technologies will create high-definition immersive virtual environment for aircrew readiness training and mission rehearsal, increasing mission rehearsal capability for the warfighter.	1.568	1.785	3.280
(U)	In FY 2003: Developed and demonstrated less expensive, thin-film holographic collimating display components for the simulator. Developed and demonstrated a proof-of-concept ultrahigh resolution, color laser projector. Integrated and evaluated high-bandwidth PC-based image generator with high-resolution laser projector.			
(U)	In FY 2004: Fabricate and evaluate efficient, full-size, thin-film holographic collimating screen materials. Develop a 5120 x 4096 pixel low-cost PC-based image generator.			
(U)	In FY 2005: Design and fabricate the frame and display structure for the next generation, full field-of-view 20/20 visual display system. Integrate proof-of-concept ultrahigh-resolution laser projectors with open-standard external interfaces, capable of displaying over ten times the resolution currently displayed by commercial High-Definition Television (HDTV) projectors. Design and develop high-performance, low-cost image generator based on commodity graphics along with a high-resolution terrain database to provide visual and sensor imagery at 60 HZ. Integrate advanced visual technologies to create the 20/20 Immersive Visual Display.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate training technologies and techniques to optimize night vision device-aided night operations. These technologies will reduce the cost of Night Vision Goggle (NVG) qualification and increase combat capability.	1.866	0.843	1.400

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4924 Distributed Mission Training Technology**

		FY 2003	FY 2004	FY 2005
(U)	In FY 2003: Completed generic NVG simulation and generic Forward Looking Infrared simulation using the same tools used for NVG functionality, allowing for high-fidelity, completely correlated visible and sensor simulation imagery. Developed proof-of-concept for dual mode, covert and overt, external aircraft lighting for fighter aircraft. Completed digital conversion of introductory and instructor courseware. Developed simulator-based training scenarios for initial qualification, spatial orientation, and advanced combat night operations.			
(U)	In FY 2004: Develop guidelines to introduce NVG training during pilot training. Transition and implement high fidelity NVG simulation into Distributed Mission Training and Formal Training Unit facilities. Develop performance metrics for NVG scan, crosscheck and spatial orientation. Develop and evaluate two-ship simulator scenarios for NVG initial and continuation training. Develop an annual NVG refresher course suitable for use in deployed status.			
(U)	In FY 2005: Develop the functional specification for a desktop Night Vision Goggle (NVG) visualization trainer suitable for initial NVG familiarization training, mission planning/preview, and mishap investigation. Develop and evaluate simulator based spatial orientation scenarios for NVG use. Determine the training value of high-fidelity NVG visual simulation on mission qualification time.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate a high-fidelity Distributed Mission Operations (DMO) training and rehearsal capability for operators in an Air Operations Center (AOC). Link AOC operational mission requirements and principles of instruction to enable effective and efficient training at both the AOC Formal Training Unit and the operational units.	0.000	0.879	1.477
(U)	In FY 2003: Not Applicable. Note: New application of research in FY 2004 from first major thrust.			
(U)	In FY 2004: Develop specifications, strategies, and methods for individual-, team-, and division-level training and rehearsal within an AOC. Develop preliminary guidelines and metrics for assessing mission readiness levels for AOC members. Explore individual-level simulation-based training capabilities.			
(U)	In FY 2005: Develop preliminary competency-based requirements for use at the operational units and evaluate alternative content development and delivery methods. Develop tools and authoring shells for courseware development. Evaluate alternative local and DMO training and rehearsal technologies in operational exercises and experiments.			
(U)	Total Cost	6.535	6.475	7.220

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602202F, Human Effectiveness Applied Research.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4924 Distributed Mission Training Technology**

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

(U) PE 0604227F, Distributed Mission Training.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603231F Crew Systems and Personnel Protection Technology**	**5020 Directed Energy Protective Systems**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5020 Directed Energy Protective Systems	8.916	7.383	3.885	2.955	3.156	3.209	3.260	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, the Directed Energy Protective Systems program at Brooks City-Base, Texas, moved from Project 3257 to Project 5020 to align resources with the Air Force Research Laboratory organization.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced technologies for Laser Eye Protection (LEP) and for assuring safety of personnel involved with test, deployment, and operation of high-energy laser weapons and systems. The project develops technologies to provide protection against laser threats and hazards, without compromising performance, vigilance, and mission effectiveness. It also develops tools and guidelines for testing and deploying high-energy laser systems and technologies to enhance personnel safety and effectiveness in aerospace operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate multi-wavelength Laser Eye Protection (LEP) technologies for aircrew and ground personnel to provide protection against any laser hazard or threat in a single device.	1.305	1.586	1.600
(U) In FY 2003: Evaluated LEP/laser-hardened night vision goggle compatibility and integration issues. Evaluated performance of mini-band clip-on device to provide selected, multi-wavelength LEP and received safe-to-fly certification. Demonstrated first phase of a Laser Detector and Warning system toward integration into aircraft cockpits and with multi-wavelength LEP.			
(U) In FY 2004: Begin evaluating and integrating optical limiters, tunable liquid crystals, photochromic and electrochromic materials, reflective technologies, and advanced dyes toward demonstration of agile LEP. Continue development, integration, and evaluation of LEP spectacles with laser-hardened NVGs. Continue supporting development and evaluation of a Laser Detector and Warning system toward integration into aircraft cockpits and agile LEP. Evaluate human performance of second mini-band clip-on device to provide selected, multi-wavelength LEP.			
(U) In FY 2005: Evaluate human performance of third mini-band clip-on device to provide selected, multi-wavelength LEP. Complete support for development and evaluation of a Laser Detector and Warning system for integration into aircraft cockpits and agile LEP. Complete aircrew evaluations of peripheral LEP protection for wear with laser hardened Night Vision Goggles.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate technologies that permit safe testing, deployment, and use of high-energy laser weapons and systems.	0.707	0.869	1.435
(U) In FY 2003: Completed laboratory experiments and field measurements to support initial Validation, Verification,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **5020 Directed Energy Protective Systems**

	and Accreditation of Version 1, Laser Range Safety Tool for Test Range Commanders and Safety Officials employing High Energy Laser Systems. Completed several key bioeffects studies to anchor the damage threshold on sub-microsecond high-energy laser pulses. Integrated a biological dose-response curve, required for probabilistic risk assessment of laser hazards, into the Laser Range Management Software for use in Advance Tactical Laser collateral hazard analyses.			
(U)	In FY 2004: Release version 2.0 of Laser Range Safety Tool (LRST) and complete integration with laser test range personnel to permit rapid analysis of high energy laser test operations. Integrate laser bioeffects data to refine laser safety parameters for computer code supporting LRST. Refine software damage models for high-energy laser weapons based on bioeffects studies and field test measurements.			
(U)	In FY 2005: Begin development effort for real-time LRST permitting commanders and range personnel immediate response on laser safety predictions arising from use of the Airborne Laser. Demonstrate Probabilistic Risk Assessment as an approach to high energy laser range safety. Complete revisions to national consensus standards for near infrared wavelengths. Begin development of Phase II of the LRST.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate biomolecular sensors to support testing of counterforce technologies and neutralization of biological weapons. Note: Technology from PE 0602202F will transition to this new major thrust in FY 2005.	0.000	0.000	0.494
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Develop and demonstrate spore, bacterial, viral, and toxin simulants with internal tracking markers, and develop the critical microbiology required for simulant testing of counterforce and neutralization concepts. Conduct sub- to full-scale testing of tracking and tracing capabilities of simulants in conjunction with breadboard agent defeat weapons tests for counterproliferation.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate Laser Eye Protection (LEP) technologies in the form of spectacles and visors for aircrew and ground personnel to provide protection from lasers while minimizing negative impacts on vision. Note: This effort includes $0.9 million in FY 2003 Congressional Add funding and $1.4 million in FY 2004 Congressional Add funding for Laser Eye Protection Research.	1.465	1.755	0.356
(U)	In FY 2003: Completed evaluation of protective performance, visual acuity impacts, life support equipment compatibility, and aircrew acceptability of next-generation LEP, designed to provide acceptable visual performance while protecting against a second laser in the visible spectrum. Developed and demonstrated LEP for air-based laser platforms and for special operations teams. Demonstrated and evaluated LEP with vision corrective prescriptions. Accelerated operational utility evaluations of prescription-capable LEP and included first response capability to 'pop-up' laser threats.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **5020 Directed Energy Protective Systems**

(U)	In FY 2004: Begin design and development of a laser protective visor compatible with night vision goggles. Continue demonstration and evaluation of LEP for air-based laser platforms. Evaluate protective performance, visual acuity impacts, equipment compatibility, and user acceptability of LEP for special operations teams. Transition technology for vision corrective prescription Laser Eye Protection (LEP), and for wide-band, near-infrared, and two visible laser line protection. Accelerate development of LEP for Air Force Special Operations Command ground forces; finish LEP spectacles for the Airborne Laser and the Advanced Tactical Laser wavelengths and vision corrective spectacles ahead of baseline schedule.			
(U)	In FY 2005: Continue development and integration of LEP with night vision goggles. Develop hypervision technologies towards integrating with LEP. Begin development of standardized methods for evaluating effects on human visual performance of potential component technologies for future LEP devices. Begin development of an LEP visor for the Advanced Tactical Laser.			
(U)				
(U)	CONGRESSIONAL ADD: Total Atmospheric Liquefaction for Oxygen and Nitrogen (TALON).	3.399	1.388	0.000
(U)	In FY 2003: Designed, fabricated, and tested a palletized advanced technology demonstrator for on-board production of oxygen and nitrogen for airlift aircraft. Technology could increase the availability of high-purity nitrogen gas for fuel tank inerting; provide high-purity oxygen for aircrew, paratrooper, and patient life support; and reduce aircraft dependency on the costly and extensive deployment footprint of liquid oxygen. Fabricated and tested a cryocooler for liquefaction of nitrogen and oxygen from compressed air, and produced a detailed aircraft integration plan for the palletized system.			
(U)	In FY 2004: Continue development of component technologies for the palletized TALON technology demonstrator. Technology will increase the availability of high-purity nitrogen gas for fuel tank inerting; provide high-purity oxygen for aircrew, paratrooper, and patient life support; and reduce aircraft dependency on the costly and extensive deployment footprint of liquid oxygen. Fabricate full-scale oxygen and nitrogen distillation columns and integrate columns with cryocooling technologies. Continue to refine aircraft integration plans for flight-testing the palletized technology demonstrator on-board a heavy aircraft.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Special Operations Crew Research at Brooks Air Force Base.	2.040	0.000	0.000
(U)	In FY 2003: Developed technologies to counter warfighter fatigue, identify and neutralize biological agents, and reduce casualties and attrition in special operations training and operations.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Crew Systems Personnel Protection.	0.000	1.785	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **5020 Directed Energy Protective Systems**

(U) In FY 2003: Not Applicable.
(U) In FY 2004: Develop and demonstrate technologies and tailor guidelines to improve warfighter performance for Special Operations Forces.
(U) In FY 2005: Not Applicable.

(U) Total Cost	8.916	7.383	3.885

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) PE 0602102F, Materials.									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0603112F, Advanced Materials for Weapon Systems.									
(U) PE 0603319F, Airborne Laser Program.									
(U) PE 0604706F, Life Support Systems.									

(U) D. Acquisition Strategy

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2004**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603270F Electronic Combat Technology

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	24.000	34.597	28.282	26.555	26.318	26.759	27.189	Continuing	Continuing
2432	Defensive System Fusion Technology	7.766	8.017	7.657	5.872	5.357	5.447	5.534	Continuing	Continuing
431G	RF Warning & Countermeasures Tech	5.727	11.846	8.265	8.636	8.709	8.856	8.998	Continuing	Continuing
691X	EO/IR Warning & Countermeasures Tech	10.507	14.734	12.360	12.047	12.252	12.456	12.657	Continuing	Continuing

Note: In FY 2003, space unique tasks in this PE, Projects 431G and 691X, transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to support Air Force electronic combat (EC) requirements. The program focuses on developing components, subsystems, and technologies with potential aerospace combat, special operations, and airlift EC applications in three project areas. The first project develops and demonstrates techniques and technologies for integrating EC sensors and systems into a fused and seamless whole. The second project develops and demonstrates advanced technologies for radio frequency EC suites. The third project develops and demonstrates advanced warning and countermeasure technologies to defeat electro-optical, infrared, and laser threats to aerospace platforms. Note: In FY 2004, Congress added $0.5 million for that Receiver and Processing Concepts Evaluation Program and $2.5 million for Detect and Avoid for UAV. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new sensor and EC system developments that have military utility and address warfighter needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	23.828	28.496	28.356
(U)	Current PBR/President's Budget	24.000	34.597	28.282
(U)	Total Adjustments	0.172	6.101	
(U)	Congressional Program Reductions		-0.003	
	Congressional Rescissions		-0.296	
	Congressional Increases		6.400	
	Reprogrammings	0.673		
	SBIR/STTR Transfer	-0.501		

(U) Significant Program Changes:
Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **2432 Defensive System Fusion Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2432 Defensive System Fusion Technology	7.766	8.017	7.657	5.872	5.357	5.447	5.534	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates technologies for integrating electronic combat (EC) sensors and EC system fusion. It develops advanced algorithms and assessment techniques needed to evaluate and enable combat aircraft operations in multi-spectral threat and countermeasure environments. It also matures technologies required for command and control (C2) warfare, standoff jamming, and electronic support measures for the denial, disruption, and suppression of adversary air defense operations. Technologies included are: advanced components and techniques needed to jam enemy radars; advanced standoff jammer technologies; and electronic collection methods to inform field commanders of changes in the electronic environment.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and investigate offensive counter information warfare technologies to disrupt and deny hostile command and control nodes and networks.	3.236	3.394	2.975
(U) In FY 2003: Completed hardware and software system integration, and conducted extensive ground tests to evaluate electronic attack and electronic support measures techniques to counter adversarial communication and navigation systems. Continued detailed planning for the flight tests. Investigated and analyzed various computer networks for selection of the most viable threat. Designed effective countermeasure techniques against selected high-speed, wideband data link targets.			
(U) In FY 2004: Finalize the detailed flight test plan, based on the results of the exhaustive ground tests. Flight test the Electronic Attack/Electronic Support (EA/ES) countermeasures system to counter adversary communication and navigation systems. Document system design and ground/flight test results in a final report. Design hardware and software for the EA/ES system to counter high-speed, wideband data/communication links utilized by multiple ground-based and airborne platforms. Fabricate hardware to process and attack the threat network.			
(U) In FY 2005: Integrate and demonstrate flyable hardware and software for the EA/ES support system to counter high-speed, wideband data and communication links utilized by multiple ground based and airborne platforms.			
(U)			
(U) MAJOR THRUST: Develop and integrate advanced sensor receiver and processing technologies.	2.232	1.805	2.045
(U) In FY 2003: Conducted risk reduction evaluations and demonstrations in the Integrated Demonstrations and Applications Laboratory (IDAL) that focused these technologies on mission applications. Conducted IDAL risk reduction evaluations and demonstrations to evolve advanced sensor threat identification and location algorithms for real-time threat situational awareness.			
(U) In FY 2004: Conduct evaluations and risk reduction demonstrations of defensive sensors and the fusion of multiple			

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603270F Electronic Combat Technology**	**2432 Defensive System Fusion Technology**

	information sources for situational awareness in the IDAL. Continue conducting IDAL laboratory risk reduction evaluations and demonstrations that evolve and optimize sensor fusion algorithms.			
(U)	In FY 2005: Continue conducting evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness in the Integrated Demonstrations and Applications Laboratory (IDAL). Continue conducting IDAL laboratory risk reduction evaluations and demonstrations that evolve and optimize sensor fusion algorithms for utilization on tactical platforms that provide real-time threat situational awareness. Conduct IDAL laboratory risk reduction evaluations and demonstrations for advanced digital receiver and processor technologies that provide the warfighter with multispectral warning, identification, and threat response for current and next generation aerospace platforms.			
(U)				
(U)	MAJOR THRUST: Develop affordable radio frequency (RF) and electro-optical (EO) emitter warning concepts and techniques.	2.298	2.818	2.637
(U)	In FY 2003: Developed affordable threat alert and jamming techniques generator technologies for combat aircraft to increase survivability against advanced, integrated RF, EO, and infrared air defense systems, including trade study analyses for techniques to defeat future threat radar-guided missile systems. Continued hardware and software development through subsystem tests and early system integration for an advanced digital threat warning and response capability.			
(U)	In FY 2004: Continue developing affordable threat alert and jamming techniques generator technologies for combat aircraft to increase survivability against advanced, integrated RF, EO, and infrared air defense systems, including trade study analyses for techniques to defeat future threat radar guided missile systems. Complete system integration, tests, and laboratory demonstrations for an advanced digital threat warning and response capability.			
(U)	In FY 2005: Demonstrate affordable threat alert and jamming techniques generator technologies for combat aircraft to increase survivability against advanced, integrated RF, EO, and infrared air defense systems, including implementation of techniques to defeat future threat radar guided missile systems. Incorporate advanced jamming techniques into plans for flight demonstrations of a significantly improved digital threat warning and response capability. Develop advanced processing and encoding methods for complex emitter signals.			
(U)	Total Cost	7.766	8.017	7.657

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602204F, Aerospace Sensors.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **2432 Defensive System Fusion Technology**

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

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603500F, Multi-disciplinary Advanced Space Technology.

(U) PE 0604270F, Electronic Warfare (EW) Development.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603270F Electronic Combat Technology**	**431G RF Warning & Countermeasures Tech**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
431G RF Warning & Countermeasures Tech	5.727	11.846	8.265	8.636	8.709	8.856	8.998	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced technologies for radio frequency (RF) electronic combat (EC) suites to enhance the survivability of aerospace vehicles and to provide crew situational awareness. One major area addresses technologies for missile/threat warning, RF receivers, EC preprocessors, advanced sorting/preprocessing algorithms, and expert software for applications on existing and future EC systems. Another major technology area focuses on the development and demonstration of subsystems and components for generating on-board/off-board RF countermeasure techniques. This includes the development of electronic countermeasures (ECM) techniques as well as advanced ECM technologies such as antennas, power amplifiers, preamplifiers, etc.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop wideband, multi-mode, multi-function apertures for electronic warfare applications (i.e., threat detection, threat avoidance, suppression of enemy air defenses, surveillance, and reconnaissance).	1.828	2.040	3.315
(U) In FY 2003: Demonstrated proof-of-concept for cost and weight reduction for adaptive, wideband conformal phased arrays that are integrated into potential unmanned aerospace platforms. These subarrays will have multiple polarization elements and perform over an extremely wide frequency range with an instantaneous bandwidth of between 4:1 to 10:1.			
(U) In FY 2004: Fully characterize adaptive, wideband, conformal phased arrays that have been structurally integrated into future unmanned aerial vehicle aperture and receiver concepts to assess technology readiness levels.			
(U) In FY 2005: Develop low-cost wideband and conformal, multiple polarization arrays through the use of RF-on-Flex techniques.			
(U)			
(U) MAJOR THRUST: Develop aerospace platform self-protection and support jamming technologies and techniques to counter advanced RF threats associated with current and future aerospace weapon systems.	3.899	5.906	4.950
(U) In FY 2003: Completed study of and continued developing and demonstrating aerospace platform self-protection and support jamming technologies and techniques to counter advanced RF threats associated with current and future aerospace weapon systems. Initiated developing next generation monopulse countermeasure systems. Continued developing and evaluating innovative RF countermeasure techniques for aerospace platforms against future RF threat systems. Continued developing and performing laboratory and field tests of advanced electronic protection techniques and technology to protect aerospace radar systems.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **431G RF Warning & Countermeasures Tech**

(U) In FY 2004: Continue developing, and initiate testing of, next generation monopulse countermeasure systems for Air Force aerospace platforms. Perform laboratory testing of innovative RF countermeasure techniques for aerospace platforms against future radio frequency (RF) threat systems. Continue developing innovative electronic protection techniques in advanced radar systems. Laboratory and field test these techniques.
(U) In FY 2005: Develop self-protection countermeasures effective against for fourth generation surface to air missile systems. Conduct laboratory evaluations of countermeasures to defeat an advanced integrated air defense system. Continue laboratory and field-testing of innovative, networked RF countermeasure techniques against advanced target engagement radars. Develop anti-jam technologies for advanced RF sensor systems.
(U)

		FY 2003	FY 2004	FY 2005
(U)	CONGRESSIONAL ADD: Advanced Threat Alert Response/Lightweight Modular Support Jammer (ATAR/LMSJ).	0.000	3.400	0.000

(U) In FY 2003: Not Applicable.
(U) In FY 2004: Design, fabricate, and test technologies to support an end-to-end support jammer system with software-reconfigurable digital receivers and processors, countermeasures techniques, a waveform generator, jammer controller, and integrated RF transmitters and arrayed antenna apertures.
(U) In FY 2005: Not Applicable.
(U)

		FY 2003	FY 2004	FY 2005
(U)	CONGRESSIONAL ADD: Receiver and Processing Concepts Evaluation Program.	0.000	0.500	0.000

(U) In FY 2003: Not Applicable.
(U) In FY 2004: Expand research in advanced RF receiver and processing algorithms using state-of-the art concepts and modern technologies.
(U) In FY 2005: Not Applicable.

		FY 2003	FY 2004	FY 2005
(U)	Total Cost	5.727	11.846	8.265

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0604270F, Electronic Warfare (EW) Development.									
(U)	PE 0603500F, Multi-disciplinary Advanced Space Technology.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **431G RF Warning & Countermeasures Tech**

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

(U) PE 0604270N, EW Development.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603270F Electronic Combat Technology**	**691X EO/IR Warning & Countermeasures Tech**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
691X	EO/IR Warning & Countermeasures Tech	10.507	14.734	12.360	12.047	12.252	12.456	12.657	Continuing	Continuing
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique tasks.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates the advanced warning and countermeasure technologies required to negate electro-optical (EO), infrared (IR), and laser threats to aerospace platforms. Off-board (decoys and expendables) and on-board countermeasure technologies developed for aircraft self-protection will provide robust, affordable solutions for protection against IR missiles with autonomous seekers, multi-spectral threats, laser-guided weapons, and EO and IR tracking systems used to direct EO, IR, and radar-guided missiles.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop on-board, closed-loop, laser infrared countermeasures (IRCM) for large aircraft to defeat current and future IR-guided missiles in multiple scenarios.	0.320	0.000	0.000
(U) In FY 2003: Completed flight tests of closed-loop IRCM technology on large aircraft.			
(U) In FY 2004: Not Applicable. Work completed.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Analyze the vulnerabilities of current IR missile systems and future imaging IR sensors.	1.822	2.282	2.386
(U) In FY 2003: Conducted in-house analyses of the vulnerabilities of current IR missile systems and future imaging IR sensors. Fabricated an expendable decoy technology suitable for peacekeeping operations that can be safely deployed at low altitudes over urban areas. Acquired and assessed capabilities and vulnerabilities of imaging IR sensors used for target acquisition.			
(U) In FY 2004: Continue conducting in-house analyses on vulnerabilities of current and future IR imaging sensors and missiles. Demonstrate and evaluate countermeasure techniques for countering multiple types of imaging IR sensors used for target acquisition. Initiate developing low-cost, cooperative techniques to counter imaging IR sensors.			
(U) In FY 2005: Continue conducting in-house analyses on current IR-guided missile susceptibilities and future imaging IR sensors. Continue evaluation of countermeasure techniques for countering multiple types of imaging IR sensors used for target acquisition. Initiate developing low-cost, cooperative techniques to counter imaging IR sensors. Continue designing and begin developing expendable decoy technology with modified spatial and kinematic properties that can be used to deceive imaging IR missiles.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **691X EO/IR Warning & Countermeasures Tech**

(U)			
(U) MAJOR THRUST: Develop aerospace laser warning sensor technologies for timely alert to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser-guided ordnance) signals.	3.166	4.219	4.036
(U) In FY 2003: Initiated design of an airborne laser warning sensor which can cue agile filter protection for aircrew or sensor protection.			
(U) In FY 2004: Complete design of an airborne laser warning sensor that can cue agile filter protection for aircrew or sensor protection. Conduct laboratory demonstration of cueing capabilities. Test and demonstrate a multi-platform sensor capable of identifying and classifying battlefield lasers that are dangerous to eyes and sensors.			
(U) In FY 2005: Initiate risk reduction research and development for continuous wave and femto-second lasers from remote vehicles and sensors. Initiate development of advanced eye and sensor protection cueing concepts tailored for specific operational deficiencies.			
(U)			
(U) MAJOR THRUST: Develop a countermeasure technology to defeat passive electro-optical (EO) and infrared (IR) aircraft tracking sensors and ordnance guidance.	4.257	4.623	4.709
(U) In FY 2003: Initiated an advanced technology demonstration program to detect and counter passive EO and IR tracking sensors. Completed preliminary design for a method to counter sensors beyond kinematic launch capability.			
(U) In FY 2004: Complete designing a system that can locate and counter passive threats beyond kinematic launch boundaries. Complete assessment of multiple threats and threat surrogates. Initiate developing a laboratory testbed.			
(U) In FY 2005: Demonstrate laboratory capability to locate and counter passive threats before threats can develop a fire control solution. Initiate fabricating a testbed for field demonstrations over extended ranges.			
(U)			
(U) MAJOR THRUST: Develop EO/IR missile warning technologies to alert aircrews and aircraft self-protection systems to the approach of advanced, low-signature threats.	0.000	1.110	1.229
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Establish spatial, spectral, and temporal trade space for advanced missile warning sensors optimized for detecting low contrast missile threats in high clutter backgrounds. Perform airborne experiments to quantify expected performance.			
(U) In FY 2005: Perform a concept evaluation of a visible band passive warning sensor that can provide timely countermeasure initiation with high declaration probability and low false alarm rate.			
(U)			
(U) CONGRESSIONAL ADD: Detect and Avoid for UAV. Note: In FY 2003, this Add was titled Test Detect and Avoid Technology for FAA.	0.942	2.500	0.000
(U) In FY 2003: Developed and demonstrated an interim "see and avoid" system for unmanned aerial vehicles that meets			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **691X EO/IR Warning & Countermeasures Tech**

with Federal Aviation Administration approval to do limited flying in national airspace without a chase aircraft.

(U) In FY 2004: Implement an interim "see and avoid" system for unmanned aerial vehicles that meets with Federal Aviation Administration approval to do limited flying in national airspace without a chase aircraft.

(U) In FY 2005: Not Applicable.

(U) Total Cost 10.507 14.734 12.360

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0604270F, Electronic Warfare (EW) Development.									
(U)	PE 0603500F, Multi-disciplinary Advanced Development Space Technology.									
(U)	PE 0604270N, EW Development.									
(U)	PE 0603203F, Advanced Aerospace Sensors.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE **February 2004**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603311F Ballistic Missile Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	12.795	11.402	0.000	0.000	0.000	0.000	0.000	0.000	TBD
4091 Missile Electronics	12.795	11.402	0.000	0.000	0.000	0.000	0.000	0.000	TBD

Note: In FY 1997, the Air Force eliminated this program. However, Congress has added funds for special interest projects since FY 1997.

(U) A. Mission Description and Budget Item Justification

This program develops, integrates, and demonstrates advanced guidance, navigation, and control technologies for ballistic missiles, including upgrades of instrumentation for range safety instrumentation. Note: In FY 2004, Congress added $8.5 million for Ballistic Missiles Technology and $3.0 million for Common Aerospace Vehicle (CAV), Small Launch Vehicle (SLV), Minuteman III (MMIII) Critical Technology Development.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

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

	FY 2003	FY 2004	FY 2005
(U) Previous President's Budget	13.159	0.000	0.000
(U) Current PBR/President's Budget	12.795	11.402	0.000
(U) Total Adjustments	-0.364	11.402	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.098	
Congressional Increases		11.500	
Reprogrammings			
SBIR/STTR Transfer	-0.364		

(U) Significant Program Changes:

In FY 1997, the Air Force eliminated this program. However, Congress has added funds for special interest projects since FY 1997.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603311F Ballistic Missile Technology**	**4091 Missile Electronics**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4091 Missile Electronics	12.795	11.402	0.000	0.000	0.000	0.000	0.000	0.000	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This program develops, integrates, and demonstrates advanced guidance, navigation, and control technologies for ballistic missiles, including upgrades of instrumentation for range safety instrumentation. Note: In FY 2004, Congress added $8.5 million for Ballistic Missiles Technology and $3.0 million for Common Aerospace Vehicle (CAV), Small Launch Vehicle (SLV), Minuteman III (MMIII) Critical Technology Development.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) CONGRESSIONAL ADD: Ballistic Missile Technology, Advanced Guidance Technologies for Ballistic Missiles and Range Safety Instrumentation.	11.351	0.000	0.000
(U) In FY 2003: Developed, integrated, and demonstrated advanced guidance technologies applied to emerging designs that sustain current strategic missile systems. Developed new accelerometer technologies with the associated radiation hardenable electronics and flight computers required for future strategic missile applications. Developed, validated, and certified advanced, mobile range safety instrumentation extending prompt missile launch capabilities to existing and future range sensors. Developed advanced vehicle structures and designs for improved ballistic missile guidance and control. Developed and demonstrated sustainable technologies and material sources capable of reducing vehicle cost while increasing robustness, maintainability, and controllability to meet the unique requirements of the advanced ballistic missile mission.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Ballistic Missile Technology, Common Guidance Development Program of Sensor Technologies.	1.444	0.000	0.000
(U) In FY 2003: Developed advanced sensor technologies that are accurate and robust enough to provide the next generation of guidance instrumentation required for a broad range of future ballistic missiles. Identified the critical technical elements and component technologies needed to meet accuracy requirements, to extend range, to reduce maintenance costs, and to lengthen mean time between failures.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603311F Ballistic Missile Technology**	PROJECT NUMBER AND TITLE **4091 Missile Electronics**

(U)				
(U)	CONGRESSIONAL ADD: Ballistic Missile Technology.	0.000	8.428	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop, integrate, and demonstrate ballistic missile technologies related to advanced guidance, range safety instrumentation and guidance sensors. Extend testing of innovative accelerometer, gyroscope, and flight computer instrumentation to strategic radiation levels. Integrate the instruments with guidance architectures that provide a robust system applicable in the most demanding missile applications. Demonstrate existing and future integrated sensors in highly flexible and mobile range safety instrumentation.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Common Aerospace Vehicle (CAV), Small Launch Vehicle (SLV), Minuteman III (MMIII) Critical Technology Development.	0.000	2.974	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate ground testing of critical advanced vehicle preliminary hardware designs and structures required for CAV control. Initiate ground testing of accurate and robust guidance hardware designed for future small launch vehicles and MMIII critical technology development. Verify that critical elements and components are capable of meeting accuracy requirements over extended ranges while reducing maintenance costs and increasing mean time between failures.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	12.795	11.402	0.000

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602204F, Aerospace Sensors.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603311F Ballistic Missile Technology**	PROJECT NUMBER AND TITLE **4091 Missile Electronics**

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification										DATE February 2004
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)					PE NUMBER AND TITLE 0603333F Unmanned Air Vehicle Dev/Demo					
	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	16.719	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5067	Unmanned Combat Air Vehicle Tech Demo	16.719	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program will develop and demonstrate advanced unarmed, unmanned aerial vehicle (UAV) and unmanned combat air vehicle (UCAV) technologies. Flight testing to demonstrate integration of critical technologies, such as autonomous operations, inter-vehicle communications, and multi-vehicle flight operations, will improve the performance and supportability of UAVs and UCAVs.

This program is in Budget Activity 3, Advanced Development, since it develops and demonstrates technologies for new unarmed, unmanned aerial vehicles and UCAVs that have command, control, communications, computers, and intelligence capabilities and address warfighter needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	17.608	0.000	0.000
(U)	Current PBR/President's Budget	16.719	0.000	0.000
(U)	Total Adjustments	-0.889	0.000	
(U)	Congressional Program Reductions			
	Congressional Rescissions			
	Congressional Increases			
	Reprogrammings	-0.329		
	SBIR/STTR Transfer	-0.560		

(U) Significant Program Changes:

In FY 2004, this effort transfers into PE 0604731F, Unmanned Combat Air Vehicle.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603333F Unmanned Air Vehicle Dev/Demo**	PROJECT NUMBER AND TITLE **5067 Unmanned Combat Air Vehicle Tech Demo**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5067	Unmanned Combat Air Vehicle Tech Demo	16.719	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		

(U) A. Mission Description and Budget Item Justification

This program will develop and demonstrate advanced unarmed, unmanned aerial vehicle (UAV) and unmanned combat air vehicle (UCAV) technologies. Flight testing to demonstrate integration of critical technologies, such as autonomous operations, inter-vehicle communications, and multi-vehicle flight operations, will improve the performance and supportability of UAVs and UCAVs.

This program is in Budget Activity 3, Advanced Development, since it develops and demonstrates technologies for new unarmed, unmanned aerial vehicles and UCAVs that have command, control, communications, computers, and intelligence capabilities and address warfighter needs.

(U)	**B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U)	Completed development and integration of critical technologies that provide for autonomous operations, inter-vehicle communications, and multi-vehicle flight operation. Completed an end-to-end demonstration of the mission utility of UCAV.	9.980	0.000	0.000
(U)	Completed the development and demonstration of technologies to support an affordable UCAV unit recurring flyaway goal in a Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated Command, Control, and Communications network. Demonstrated multi-vehicle flight operations, including escort formations, collision avoidance, auto routing, and dynamic re-tasking among others. Demonstrated multiple re-planned weapons drops.	2.699	0.000	0.000
(U)	Completed development and demonstration of both electro-optical and radio frequency technologies on the UCAV.	1.897	0.000	0.000
(U)	Completed human systems technology support by demonstrating remote operator control/interface that can extend the capability to effectively and affordably perform the 21st century missions of defense suppression and tactical attack.	1.095	0.000	0.000
(U)	Completed integration of miniature munition concepts with UCAV and complete UCAV flight test with miniature munition concepts.	1.048	0.000	0.000
(U)	Total Cost	16.719	0.000	0.000

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602202F, Human Effectiveness.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603333F Unmanned Air Vehicle Dev/Demo**	PROJECT NUMBER AND TITLE **5067 Unmanned Combat Air Vehicle Tech Demo**

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

(U) PE 0602201F, Aerospace Vehicle Technologies.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603601F, Conventional Weapons.

(U) PE 0603789F, C3I Advanced Development.

(U) PE 0604731F, Unmanned Combat Air Vehicle.

(U) PE 0602702E, Tactical Technology.

(U) PE 0603285E, Advanced Aerospace Systems.

(U) PE 0603762E, Sensor and Guidance Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603401F Advanced Spacecraft Technology

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	52.424	96.912	60.124	65.892	72.085	88.248	90.947	Continuing	TBD
2181	Spacecraft Payloads	14.633	22.477	18.013	18.326	19.780	36.219	36.223	Continuing	TBD
3834	Integrated Space Technology Demonstrations	13.243	28.693	18.584	25.057	27.460	26.531	26.716	Continuing	TBD
4400	Space Systems Protection	2.688	9.432	3.473	3.505	3.570	3.630	3.688	Continuing	TBD
4938	Space Developmental Planning	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	TBD
5021	Space Systems Survivability	3.878	4.136	4.775	4.854	4.982	5.066	5.147	Continuing	TBD
5083	Ballistic Missiles Technology	0.000	6.802	6.859	5.815	4.069	4.137	4.204	Continuing	TBD
682J	Spacecraft Vehicles	17.982	25.372	8.420	8.335	12.224	12.665	14.969	Continuing	TBD

Note: In FY 2003, selected efforts in Project 4400 were transferred within this PE into Project 5021 in order to focus on improving survivability of space systems in natural environments.

(U) A. Mission Description and Budget Item Justification

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, spacecraft protection, spacecraft and launch vehicles, ballistic missiles, space systems survivability, and development of advanced laser communications technologies to support next generation satellite communication systems. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: In FY 2004, Congress added $1.2 million for Capacitively Coupled Interconnect, $1.5 million for Magnetoresistive Random Access Memory (MRAM) Innovative Communications Materials, $1.7 million for Integrated Spacecraft Engineering Tool, $4.7 million for Radially Segmented Launch Vehicle Risk Reduction, $2.1 million for AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch Vehicle Technology, $3.5 million for Hardening Technologies for Spacecraft Protection (HTSP), $4.7 million for Thin Amorphous Solar Arrays, $2.8 million for Robust Aerospace Composite Materials/Structures, and $3.5 million for Boron Energy Cell Development.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing space system upgrades and/or new space system developments that have military utility and address warfighter needs.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	54.884	72.114	60.282
(U)	Current PBR/President's Budget	52.424	96.912	60.124
(U)	Total Adjustments	-2.460	24.798	
(U)	Congressional Program Reductions		-0.072	
	Congressional Rescissions		-0.830	
	Congressional Increases		25.700	
	Reprogrammings	-1.223		
	SBIR/STTR Transfer	-1.237		

(U) Significant Program Changes:

Changes to this PE since the previous President's Budget are due to higher Air Force priorities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603401F Advanced Spacecraft Technology**	**2181 Spacecraft Payloads**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2181 Spacecraft Payloads	14.633	22.477	18.013	18.326	19.780	36.219	36.223	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, satellite control hardware and software for advanced satellite surveillance operations, and development of advanced laser communications technologies to support next generation satellite communications systems. Improved space-qualifiable electronics and software for data and signal processing will be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., radiation-hardening) commercial data and signal processor technologies for use in Air Force space systems. For mid-term applications, the Improved Space Computer Program will merge advanced, radiation-hardened space processor, memory, and interconnect technologies with commercially-derived, open system architectures to develop and demonstrate robust, on-board processing capabilities for 21st century Department of Defense satellites. In the long-term, this project area focuses on developing low-cost, easily modifiable software and hardware architectures for fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop spacecraft microelectronic devices, including radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications.	8.117	8.373	8.554
(U) In FY 2003: Performed simulations and validated designs of a general purpose embedded processor at 500 million instructions per second and digital signal processors at 1 billion operations per second. Fabricated and characterized high density, low power chips comprised of innovative chalcogenide programmable memory elements. Integrated chalcogenide into components such as field programmable logic and analog microelectronics. Developed macrocell libraries for application specific integrated circuit technology for up to eight million gate devices. Developed and demonstrated a micro-electro-mechanical based switch box multi-chip module and associated heuristics for multi-switch box applications to smart-wiring manifolds.			
(U) In FY 2004: Demonstrate functional elements for general-purpose processor at 500 million instructions per second and digital signal processors at 1 billion operations per second. Develop architectures and design electronics circuits in support of adaptable, self-repairing processors and memories. Demonstrate functional elements of chalcogenide-based field programmable logic and analog microelectronics. Develop hardened-by-design primitive cell libraries enabling the use of state-of-the-art commercial manufacturing plants for high performance, low-cost electronics. Build MEMS and chalcogenide-based switches supporting multi-switch box applications to smart-wiring manifolds.			
(U) In FY 2005: Fabricate a general-purpose processor at 500 million instructions per second and digital signal			

Exhibit R-2a, RDT&E Project Justification | DATE **February 2004**

BUDGET ACTIVITY **03 Advanced Technology Development (ATD)** | PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology** | PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

	processors at one billion operations per second. Demonstrate electronics circuits in support of adaptable, self-repairing processors and memories enabling spacecraft capable of autonomously adapting to new missions. Build functional elements of chalcogenide-based field programmable logic and analog microelectronics. Develop hardened by design macrocell libraries enabling the use of state-of-the-art commercial manufacturing plants for high performance, low-cost electronics. Demonstrate elements for hieratical smart-wiring manifolds capable of reconfiguring entire space asset subsystems. Implement the hardened-by-design mixed signal library and the design for analog-to-digital converter demonstration; fabricate devices in the Silicon Germanium process.			
(U)				
(U)	MAJOR THRUST: Develop intelligent satellite system technologies for responsive spacecraft operations and for satellite control, precision navigation, formation flying, and proximity operations technologies for spacecraft constellations.	1.721	2.803	1.808
(U)	In FY 2003: Completed initial development of microsatellite cluster management software. Developed command, control, and navigational capability for high fidelity spacecraft proximity operations. Developed automated planning and scheduling software for multiple satellites and the spacecraft and simulation data archiving and storage system. Developed initial guidance, navigation, and control algorithms for proximity operations and large deployable systems. Developed initial autonomous software technologies for responsive space systems.			
(U)	In FY 2004: Expand the development of command, control, and navigational capability for high fidelity spacecraft proximity operations with application to counterspace operations. Complete development of automated planning and scheduling software for multiple satellites and the spacecraft and simulation data archiving and storage system. Expand development of guidance, navigation, and control algorithms for proximity operations and large deployable systems. Develop initial command and telemetry simulation for mission operations center testing. Further develop autonomous software technologies for responsive space systems.			
(U)	In FY 2005: Advance development of command, control, and navigational capability for high fidelity spacecraft proximity operations with application to space capability protection. Complete development of guidance, navigation, and control algorithms for proximity operations and large deployable systems. Further command and telemetry simulation development for mission ops center testing. Integrate hardware-in-the-loop engineering development unit into testbed, interface with spacecraft command and telemetry simulations, and begin mission ops center testing.			
(U)				
(U)	MAJOR THRUST: Develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems, space capability protection technologies, access/mobility technologies, and flight experiments.	0.890	0.965	1.298
(U)	In FY 2003: Developed models for sparse, distributed aperture radio frequency (RF) system simulation to support technology trades and systems engineering. Expanded models of sparse aperture RF distributed signal processing for systems analysis. Explored models of space-based surveillance systems for technology investment decision support			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

with emphasis on military utility analysis.

(U) In FY 2004: Refine models for sparse, distributed aperture radio frequency (RF) system simulation to support systems engineering. Further develop models of sparse aperture RF distributed signal processing. Refine simulation models of space-based surveillance systems for military utility analysis. Develop initial modeling, simulation, and analysis tools for technical assessment of space capability protection and access/mobility technologies. Develop physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis applicable to potential flight experiments.

(U) In FY 2005: Complete development of models for sparse, distributed aperture RF system simulation. Complete development of sparse aperture RF distributed signal processing models. Expand development of simulations of space-based surveillance systems for military utility analysis. Refine development of modeling, simulation, and analysis tools for technical assessment of space capability protection and access/mobility technologies. Continue to develop physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis applicable to potential flight experiments.

(U)

(U) MAJOR THRUST: Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as "cold body" targets such as decoys, satellites, and midcourse warheads.	0.473	3.257	2.317

(U) In FY 2003: Demonstrated and characterized low temperature multi-color and low background detectors and focal plane arrays, and higher temperature arrays with improved radiation hardness. Fabricated and delivered longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperature mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing space backgrounds. Transitioned multi-color quantum well photodetector designs and other promising infrared technologies to large focal plane arrays.

(U) In FY 2004: Characterize higher operating temperature, mid-wave infrared focal plane arrays (FPA). Complete fabrication and characterize higher operating temperature, mid-wave infrared FPAs. Complete fabrication and characterize first-ever dual band (mid-wave, long-wave) FPAs having an extended long-wave infrared response. Investigate radiation hardened-by-design development for long wavelength infrared FPAs for space-based passive surveillance applications. Explore detector interfacing concepts for larger-format, higher capability space hyperspectral imaging systems.

(U) In FY 2005: Complete pathfinder, dual-band ("mid-wave, long-wave") FPA performance characterization and transition plans, and insert technology into a potential hyperspectral demonstration. Characterize and assess performance of long wavelength infrared FPAs developed with "radiation hardened-by-design." Investigate detector array and cryogenic detector multiplexer interfacing concepts that lead to improved, larger-format, space hyperspectral imaging capabilities. Extend performance of dualband vapor phase growth FPAs from moderate

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

	background levels to more stressing lower background levels endemic to space-based passive surveillance.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate satellite antenna technologies that exploit advanced electronic integration, high-density interconnects/packaging and advanced phased array component technologies to create large, lightweight space antennas.	2.271	1.430	1.903
(U)	In FY 2003: Tested and integrated selected embedded-structural transmit-receive electronics antenna modules for future multi-microsatellite constellation space flight experiment. Tested, integrated, and evaluated multi-beam, wide-bandwidth transmit-receive electronics antenna modules with payloads for possible airborne, multi-mode flight experiment. Fabricated and tested antenna modules that address requirements for minimizing mass and power by embedding lightweight electronics in the structure.			
(U)	In FY 2004: Deliver flight-ready multi-beam, wide-bandwidth antenna modules for airborne multi-mode flight experiment. Redesign baseline antenna module tiles using advanced substrate material to reduce antenna module weight by 25%. Develop and demonstrate ten milliwatt advanced low power, octave-wide bandwidth, low noise amplifier. Apply Application Specific Integrated Circuit technology to achieve a higher level of integration for the transmit-receive cells, reducing discrete components by 25%. Redesign antenna tile architecture to incorporate next generation miniaturized phased array components to support eight simultaneous beams. Design multi-decade-bandwidth antenna architecture.			
(U)	In FY 2005: Achieve an additional 25% reduction in discrete component requirements for the antenna modules by developing wide-bandwidth radio frequency manifold techniques for implementation in baseline antenna module tiles architecture. Complete redesign of tile architecture to incorporate new miniaturized phased array components to support eight simultaneous beams. Demonstration of multi-decade-bandwidth antenna architecture. Investigate design and development of sparse membrane array architectures for next generation agile beam control and smart antenna that extends the transmit/receive technology to autonomous beam control.			
(U)				
(U)	MAJOR THRUST: Develop technologies for multi-access laser communications space terminals with reduced weight, power, and cost for transformational communications.	0.000	0.990	1.946
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Investigate component integration issues and identify technical challenges for potential space experiments of multi-access laser communications systems. Develop initial ground breadboard testbed. Complete space-based laser communications architecture studies.			
(U)	In FY 2005: Explore component integration issues of multi-access laser communications systems. Complete ground breadboard testbed. Test breadboard terminal designs in approved compatibility testbed. Develop initial multi-access laser communications terminal brassboard development.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

(U)	MAJOR THRUST: Develop satellite payload subsystem technologies to exhibit revolutionary capabilities in operability, responsiveness, and cost-effectiveness.	0.000	1.982	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop enabling responsive spacecraft technologies, which include on-the-fly programmable, configurable, logic, and modular, reusable, self-initiating software, as well as technologies that enable rapid satellite integration and minimum time on-orbit satellite checkout.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop spectral sensing and data exploitation capabilities for military imaging and remote sensing applications. Note: Reflects increased emphasis on spectral sensing technology.	0.000	0.000	0.187
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Demonstrate spectral sensing and data exploitation capabilities for military imaging and remote sensing applications. Analyze technology and modeling results to advance the understanding of electro-optical/infrared polarimetric phenomology and initiate investigations into new instrumentation for space applications. Apply polarimetric signature modeling capability to assess space-based surveillance applications.			
(U)				
(U)	CONGRESSIONAL ADD: Capacitively Coupled Interconnect.	1.161	1.190	0.000
(U)	In FY 2003: Developed integrated circuit interconnection technology based on non-conductive approaches that provides denser, more powerful computation capabilities, increased bandwidth within and between electronic systems, and improved flexibility and increased reliability. Investigated theoretical basis of capacitively coupled interconnects and assessed their performance against traditional approaches. Formulated and conducted feasibility proof of principle based on findings.			
(U)	In FY 2004: Using previously established and proven principles, provide a system level demonstration of a non-conductive interconnection technology, in a form suitable for transfer to industry. Build an electronic system that demonstrates all the advantages of non-conductive interconnection technology in a realistic environment for one form of packaging.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Magnetoresistive Random Access Memory (MRAM) Innovative Communications Materials.	0.000	1.487	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop and characterize a magnetic tunneling junction magnetic memory element 1 by 0.25 micron in size, along with supporting circuitry and architecture models, leading to distributed, radiation-hard, non-volatile			

Exhibit R-2a, RDT&E Project Justification		DATE **February 2004**
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

memory for embedded and reconfigurable spacecraft computing systems.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	14.633	22.477	18.013

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0303601F, MILSTAR Satellite Communications System.									
(U)	PE 0305160F, Defense Meteorological Satellite Program (DMSP).									
(U)	PE 0602601F, Spacecraft Technology.									
(U)	PE 0603311F, Ballistic Missile Technology.									
(U)	PE 0603215C, Limited Defense System.									
(U)	PE 0603218C, Research and Support.									
(U)	PE 0603226E, Experimental Evaluation of Major Innovative Technologies.									
(U)	PE 0604609F, Reliability and Maintainability Technology Insertion Program (RAMTIP).									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

(U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **3834 Integrated Space Technology Demonstrations**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3834	Integrated Space Technology Demonstrations	13.243	28.693	18.584	25.057	27.460	26.531	26.716	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an relevant environment.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop autonomous microsatellite (10-100kg) technologies for an integrated, robust, flexible, modular microsatellite technology concept.	10.342	20.265	18.584
(U) In FY 2003: Performed mission operations concept trades using hardware-/software-in-the-loop simulations and mission planning tools for non-cooperative proximity operations. Completed component development and began system level integration, functional, and environmental test activities in preparation for launch and operations. Performed final launch vehicle safety analysis and ground test and evaluation. Used microsatellite hardware-in-the-loop and software simulations to perform comprehensive ground testing of the autonomous microsatellite around a non-cooperative resident space object.			
(U) In FY 2004: Develop and test a laser range finder subsystem. Develop and test the ground control system for real-time planning and flight operations of proximity operations microsatellite. Test autonomous operations software against simulated faults and anomalies. Complete system level integration of microsatellite and complete functional and environmental tests. Integrate microsatellite with launch system and perform functional and environmental tests. Begin integration with launch vehicle. Integrate ground control system and satellite software simulations. Perform simulated proximity operations missions for mission operations training and for determination of the simulated spacecraft performance and interaction with ground controllers.			
(U) In FY 2005: Complete development of autonomous proximity operations microsatellites ground control interface system. Perform real time simulated mission experiments beyond spacecraft envelop. Complete satellite/launch vehicle integration and launch. Perform mission operations around one or more non-cooperative resident space objects. Evaluate options for potential follow-on space situational awareness technology demonstration, using operational concept trades. Perform preliminary design concept trades and initial satellite design(s.) Downselect to best payload option. Initiate satellite bus design. Complete preliminary bus and payload design.			
(U)			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **3834 Integrated Space Technology Demonstrations**

(U) CONGRESSIONAL ADD: Next Generation Hybrid Orbital Maneuver Vehicle.	0.967	0.000	0.000
(U) In FY 2003: Explored technologies for a small, hybrid propulsion module capable of transferring selected Space Shuttle payloads to higher operational orbits after deployment. Integrated and ground test fired a propulsion module. Test information was used to assess whether the hybrid technology meets the relevant orbital transfer and Space Shuttle safety requirements.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Streaker Small Launch Vehicle.	0.967	0.000	0.000
(U) In FY 2003: Developed technologies for small launch vehicles for rapid and affordable deployment of small satellite and Common Aero Vehicle payloads. Conducted trade studies to define a responsive, simple, cost-effective small launch vehicle. Defined preliminary system design requirements and developed a mission model, a system concept, and mission and life cycle cost estimates for a small launch vehicle to place military payloads (200 - 2000 lb.) into Low Earth Orbit.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET).	0.967	1.686	0.000
(U) In FY 2003: Developed an integrated engineering, modeling, simulation, and design tool to support rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. This tool enables quick turnaround, advanced space mission analyses that incorporate future military space requirements to determine the impact on system performance and capabilities. Integrated government and commercial design, analysis, and optimization software into a combined systems analysis and design tool set that advances the capability to predict performance benefits and impacts for new technologies on space and launch vehicle systems.			
(U) In FY 2004: Expand the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Radially Segmented Launch Vehicle (RSLV) Risk Reduction.	0.000	4.660	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Validate the cost and performance of a rocket engine module used in the RSLV main propulsion system. Validate cost, mass properties, and structural performance of the RSLV segmented tanks through hardware			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **3834 Integrated Space Technology Demonstrations**

	fabrication and destructive testing. Demonstrate integrated operation of a segment pair through ground hot fire testing.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch Vehicle Technology.	0.000	2.082	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Fabricate and test 30,000 lb. thrust (30K) LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30K, pump-fed, regeneratively cooled chamber propulsion system and a two-stage-to-orbit vehicle system concept; effort could also lead to a reusable, configurable-plume propulsion system and target vehicle design. The target vehicle will be a relatively simple pressure-fed design to support plume detection and discrimination test objectives.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	13.243	28.693	18.584

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602601F, Spacecraft Technology.									
(U)	PE 0603605F, Advanced Weapons Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603401F Advanced Spacecraft Technology**	**4400 Space Systems Protection**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4400	Space Systems Protection	2.688	9.432	3.473	3.505	3.570	3.630	3.688	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, selected efforts were transferred within this PE from this project into Project 5021 in order to focus on improving survivability of space systems in natural environments.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in potentially hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to radio frequency and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Use multi-threat assessment tools to assess space-based electro-optical, communication, and other responses to various candidate radio frequency and laser countermeasures and directed energy threats.	0.415	1.861	1.010
(U)	In FY 2003: Verified and accredited initial weapons effects satellite assessment tools, completed documentation for users, and developed additional tools for satellite subsystems, such as processor assemblies, optical trains, and satellite buses.			
(U)	In FY 2004: Use existing satellite subsystem response data to continue verification of single satellite models of weapons effects for processor assemblies, optical trains, and satellite buses. Integrate single satellite models into satellite constellation analysis tool. Assess electro-optical designs of planned space systems for radio frequency and laser susceptibility and potential mitigation techniques. Assess directed energy threat susceptibility and potential for mitigation techniques for key satellite subsystems, such as communications.			
(U)	In FY 2005: Investigate models for radio frequency and laser response in communications and power subsystems and integration into single satellite communications and power subsystem models into satellite constellation analysis tool. Apply constellation analysis tool to wargaming exercises and assess efficacy.			
(U)				
(U)	MAJOR THRUST: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites.	1.524	2.732	2.022
(U)	In FY 2003: Designed plasma shield to selectively filter the radio frequencies reaching the satellite communications antennas; prepared for conceptual space demonstration. Conducted design and trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Explored technologies to support automatic wartime deployment of protection technologies for satellites whose			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **4400 Space Systems Protection**

		FY 2003	FY 2004	FY 2005
	peacetime mission would be compromised by on-board protection systems. Explored electronic protection techniques for optical sensors and systems.			
(U)	In FY 2004: Complete plasma shield design and define potential system applications. Refine selected design trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Investigate mitigation technologies such as deployable shields and triggered automatic gain control for radio frequency threats.			
(U)	In FY 2005: Investigate and identify candidate threat mitigation technologies for principle satellite subsystems, such as shielding and terminal protection techniques for multi-chip modules, reconfigurable processors/architectures, and anti-jam modems for uplink subsystems.			
(U)				
(U)	MAJOR THRUST: Develop visible and near-infrared laser protection technologies.	0.749	1.369	0.441
(U)	In FY 2003: Completed initial evaluations and ground-based demonstrations of visible and near-infrared laser protection techniques in preparation for space demonstrations.			
(U)	In FY 2004: Develop adaptive signal processing techniques to mitigate laser interference effects on readout electronics and focal plane array sensor subsystem components. Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Develop optical sensor subsystem threat mitigation techniques using solutions such as acousto-optical switches to deflect incoming laser energy from the focal plane array.			
(U)	In FY 2005: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating selective mitigation approaches. Develop selected protection techniques and evaluate effectiveness as a laser mitigation technique of optical sensor subsystems.			
(U)				
(U)	CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection (HTSP).	0.000	3.470	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Examine, evaluate, and summarize potential protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Establish relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Develop and test prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Expand ability to accurately predict the nuclear environment associated with a High Altitude Nuclear Event, enhancing the ability of designers to accurately determine their system vulnerability. Complete Version 1 of the Satellite Survivability Module code to include ability to analyze both radio frequency and laser effects within the Satellite Toolkit framework.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	2.688	9.432	3.473

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **4400 Space Systems Protection**

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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603401F Advanced Spacecraft Technology**	**5021 Space Systems Survivability**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5021 Space Systems Survivability	3.878	4.136	4.775	4.854	4.982	5.066	5.147	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, selected efforts from Project 4400 were transferred into this project in order to focus on improving survivability of space systems in natural environments.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technologies to improve space system survivability and reliability of current and future Department of Defense space systems that must continue operation despite natural space hazards. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop sensors to specify and forecast conditions in the space environment that degrade the operation of satellite, communication, navigation, and surveillance systems. Support integration, launch, validation, and operation of instrumentation to provide improved space radiation and ionospheric hazard specification and forecasting.	0.948	1.034	1.432
(U) In FY 2003: Launched, completed initial on-orbit checkout, and commenced validation of solar disturbances forecasting algorithms using space-based all-sky camera. Performed joint agency collaboration to fly relativistic electron and proton detector and demonstrated ability to perform on-orbit mapping of the dynamic radiation belts to quantify hazards to space systems. Developed initial conceptual design of advanced all-sky, white light camera for operational space weather forecasting system.			
(U) In FY 2004: Validate solar disturbance forecast algorithms derived from all-sky heliospheric imager. Develop instrument and data plan for joint-agency mission to map the high-intensity region of the radiation belt that limits choices for spacecraft orbits. Expand space weather forecasting system conceptual design to include interplanetary in situ plasma and magnetic field sensors in addition to miniaturized white-light camera. Develop initial micro- and nano-technology based concepts to miniaturize energetic particle, neutral density, and low energy plasma sensors needed to characterize space weather hazards.			
(U) In FY 2005: Complete all-sky image based solar disturbance forecast algorithms and transition to military/civilian operational forecasters. Integrate relativistic particle sensor onto joint-agency radiation belt mapping satellite. Investigate development of miniaturized plasma, magnetic field, and all-sky white light cameras for inclusion on interplanetary microsatellites. Determine optimal micro- and nano-technology path to achieve maximum deployable, highest capability energetic particle, neutral density, and low-energy plasma sensors for space weather characterization.			
(U)			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5021 Space Systems Survivability**

(U)	MAJOR THRUST: Conduct collaborative space and laboratory experiments and develop hardware and software tools to improve the survivability of spacecraft power, communications, navigation, and surveillance systems.	0.966	1.449	1.911
(U)	In FY 2003: Completed design and began fabrication of second-generation miniaturized charge control system. Completed conceptual design of an experiment to quantify the effects of space plasma on tethered power generation systems and determined feasibility of a space flight test to demonstrate on-orbit electrical power generation. Completed interface between dynamic space plasma and meteor models and web-based spacecraft design tools.			
(U)	In FY 2004: Complete model testing of miniaturized charge control system and begin construction of space experiment for the hazardous geosynchronous environment. Develop a space experiment to validate on-orbit electrical power generation and particle scattering capabilities of space tether. Develop initial suite of comprehensive spacecraft environment effect tools for operational use by integrating full range of environment specification and forecast models with spacecraft hazard, trans-ionospheric link degradation, and satellite drag specification tools. Investigate design of active antenna and passive detection hardware for space experiment to demonstrate techniques of lowering radiation belt intensities to protect satellites.			
(U)	In FY 2005: Integrate geosynchronous charge control system onto space test satellite for on-orbit demonstration of hazard mitigation. Refine space tether experiment hardware and finalize space test plan. Complete integration of ionospheric and satellite drag effects into spacecraft environment effect tool suite. Complete hardware suite selection and begin fabrication of payload for space experiment to actively explore space particle dynamics and demonstrate radiation belt remediation technologies.			
(U)				
(U)	MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems.	1.964	1.653	1.432
(U)	In FY 2003: Developed data assimilation techniques to produce improved dynamic radiation belt models using data from multiple compact environment anomaly sensors. Fabricated initial components of miniaturized space environment distributed anomaly resolution sensor for on-orbit detection of space particle, chemical, and impact hazards. Developed detailed design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.			
(U)	In FY 2004: Complete development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Complete concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware development. Refine detailed design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.			
(U)	In FY 2005: Advance global radiation hazard situational awareness model development by expanding number or sensor inputs to improve accuracy and timeliness. Fabricate flight ready engineering model of distributed space hazard sensors needed for space situational awareness. Complete design of active wave experiment to remediate			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5021 Space Systems Survivability**

severe radiation environments. Plan for space test flight of active wave and distributed sensor technologies.

(U)	Total Cost	3.878	4.136	4.775

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602601F, Spacecraft Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5083 Ballistic Missiles Technology**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5083 Ballistic Missiles Technology	0.000	6.802	6.859	5.815	4.069	4.137	4.204	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: This is a new project, but not a new start. The efforts are part of ongoing work performed in PE 0603311F, Ballistic Missile Technology, and are put in this PE to align efforts within the Air Force Research Laboratory organization.

(U) A. Mission Description and Budget Item Justification

This project develops, integrates, and demonstrates advanced technologies for sustainment and modernization of strategic ballistic missiles. The project focuses on developing robust, low maintenance inertial navigation instruments to sustain current ballistic missile systems, as well as provide new, small, low-powered, high precision instrumentation for next generation missile systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation instrumentation applied to emerging vehicle designs and other technologies that sustain current strategic missile systems. Provide critical missile technology concepts to support future space force application and strategic systems.	0.000	3.887	3.920
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Evaluate the most promising navigation instrumentation technologies and integrate the advanced gyro and accelerometer systems into a breadboard demonstration of a reduced size and reduced power navigation instrument system that approaches or exceeds ballistic missile mission goals.			
(U) In FY 2005: Downselect to the most advanced navigational instrumentation designs for the next generation of ballistic missiles. Evaluate the designs and provide improvements to meet the established performance goals. Demonstrate and validate improved navigational technology designs that can meet performance goals.			
(U)			
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation technologies with new vehicle designs to provide robust, flexible, lower cost solutions for sustaining current strategic missile systems. Provide the technological base for future systems.	0.000	2.915	2.939
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Integrate advanced thermal materials into long-glide vehicles to provide greater controllability and selective targeting. Demonstrate lower-cost, robust leading edge, and control surface materials in a test flight to validate improved properties for future vehicle designs. Demonstrate that robust onboard navigation instruments and range safety devices can withstand loads greater than 100G in all axes in laboratory tests.			
(U) In FY 2005: Evaluate advanced thermal materials integrated with long-glide vehicles to provide greater controllability and selective targeting. Evaluate demonstration results of advanced leading edge and control surface			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5083 Ballistic Missiles Technology**

materials and initiate down selection to candidates projected to provide lower cost, robust advanced future vehicle designs. Use results of laboratory testing to improve the capability of onboard navigation instruments and range safety devices to withstand loads greater than 100G in all axes in flight test demonstrations.

(U)

(U)	Total Cost	0.000	6.802	6.859

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0601102F, Defense Research Sciences.									
(U)	PE 0602601F, Space Technology.									
(U)	PE 0603311F, Ballistic Missile Technology.									
(U)	PE 0603601F, Conventional Weapons Technology.									
(U)	PE 0603851F, Intercontinental Ballistic Missile-Dem/Val.									
(U)	PE 0604851F, Intercontinental Ballistic Missile-EMD.									
(U)	PE 0605860F, Rocket System Launch Program-Space.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603401F Advanced Spacecraft Technology**	**682J Spacecraft Vehicles**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
682J	Spacecraft Vehicles	17.982	25.372	8.420	8.335	12.224	12.665	14.969	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates compact, low-cost, spacecraft and launch vehicle power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation activities focus on lightweight, low-cost, low-volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen and sodium sulfur spacecraft batteries and flywheel energy storage systems for extended (five to ten year) satellite missions. The project's power distribution efforts focus on producing lightweight, high-efficiency, standardized power busses for use on future space programs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules.	1.759	2.192	2.164
(U) In FY 2003: Flight demonstrated deployment and operation of large, free-flying, lightweight, flexible, radiation resistant, array of thin film solar cells. Further integrate 32 % efficient multi-junction solar cells and 10% efficient thin film solar cells into full arrays.			
(U) In FY 2004: Demonstrate integration methods for thin-film solar cells on polymer substrates into full arrays. Complete full space qualification testing of 28% efficient solar cells.			
(U) In FY 2005: Demonstrate methods for interconnecting thin-film solar modules into array-sized thin-film blankets. Integrate 28% efficient lattice-mismatch multi-junction solar cells into test coupons.			
(U)			
(U) MAJOR THRUST: Develop innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system.	0.888	0.000	0.000
(U) In FY 2003: Flight demonstrated integrated attitude control and energy storage system. Developed microflywheel demonstration system.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop technologies for long life, efficient, low vibration, lightweight mechanical cryocoolers for space applications.	1.332	1.348	1.274
(U) In FY 2003: Developed high capacity multi-stage cryocooler technologies to meet the needs of high resolution, space-based infrared surveillance and tracking sensors with larger focal planes and optics.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

(U) In FY 2004: Investigate protoflight development of high capacity, multi-stage, low temperature cryocooler system. Develop and characterize performance of second generation design model high capacity 10 Kelvin cryocooler for advanced space surveillance and tracking sensor. Explore development of component cryocooler technologies for regenerative and recuperative cycle devices to transition enabling technology to protoflight cryocooler designs.			
(U) In FY 2005: Refine protoflight development of high capacity, multi-stage, low temperature cryocooler technologies to meet the needs of high resolution, space-based infrared surveillance and tracking sensors with larger focal planes and optics. Expand development of component cryocooler technologies for regenerative and recuperative cycle devices to transition enabling technology to protoflight cryocooler designs.			
(U)			
(U) MAJOR THRUST: Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas.	1.273	3.900	1.585
(U) In FY 2003: Developed spacecraft design to demonstrate multifunctional structures technologies. Completed evaluation of operational grid stiffened structures. Fabricated multifunctional spacecraft bus for small satellites. Completed ground test of full-scale Evolved Expendable Launch Vehicle secondary payload adapter structure.			
(U) In FY 2004: Refine spacecraft to demonstrate multifunctional structures technologies. Complete fabrication of multifunctional spacecraft bus components for small satellites. Flight qualify full-scale Evolved Expendable Launch Vehicle secondary payload adapter. Explore the design and characterize linerless composite cryogenic tanks. Develop large deployable optics structures using nanotechnology-enhanced materials.			
(U) In FY 2005: Further refine spacecraft to demonstrate multifunctional structures technologies. Ground demonstrate sub-scale linerless composite cryogenic tanks. Fabricate and characterize components for large deployable optics systems using nanotechnology-enhanced materials.			
(U)			
(U) MAJOR THRUST: Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems.	3.540	7.026	3.397
(U) In FY 2003: Developed launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Flight demonstrated smart passive payload isolation systems. Ground demonstrated operational active acoustic attenuation system. Flight demonstrated passive acoustic attenuation system. Integrated low shock separation devices into multiple payload adapter. Ground demonstrated smart docking and deployment mechanisms. Completed development of modular vibration-isolating spacecraft transport container.			
(U) In FY 2004: Refine launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Flight demonstrate operational active acoustic attenuation systems. Flight demonstrate low-shock multiple payload adapter technologies. Build deployment and isolation mechanisms for large free-flying solar array and integrate with thin-film solar cell components. Design flight hardware to demonstrate smart docking			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

	and deployment mechanisms. Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Develop micro-electro-mechanical attitude control components.			
(U)	In FY 2005: Further refine launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Complete development of operational active acoustic attenuation systems. Complete development of low-shock multiple payload adapter technologies. Perform flight qualification testing of smart docking and deployment hardware. Characterize performance of full multi-axis flywheel attitude control system with integrated energy storage. Integrate micro-electro-mechanical attitude control components with conventional attitude control systems.			
(U)				
(U)	CONGRESSIONAL ADD: Thin Amorphous Solar Arrays.	6.772	4.660	0.000
(U)	In FY 2003: Developed amorphous silicon solar cells for higher performance, next-generation flexible, thin film solar arrays. These thin film arrays will be three to five times lighter, cost five times less, require five times less stowed volume, and be more radiation resistant than state-of-the-art rigid panel arrays. Increased specific power (Watts/kg) of amorphous silicon solar cells by increasing cell efficiency and developing processes to deposit solar cells on lightweight polymer substrates. Developed monolithic integration technology for the low-cost interconnection of thin film solar cells.			
(U)	In FY 2004: Develop monolithic integration technology for the low-cost interconnection of thin-film amorphous silicon solar cells. Develop lightweight solar array support structures and deployment mechanisms enabled by the thin-film solar cells. Demonstrate the reproducible manufacture of large-area amorphous silicon cells necessary for population of the thin-film solar arrays.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures.	2.418	2.776	0.000
(U)	In FY 2003: Developed a new generation of advanced composite materials to support improved manufacturing techniques for low-cost, lightweight spacecraft adapter and fairing designs. Composite materials decrease primary structure mass and cost by 40% and decrease manufacturing lead times by 50% over conventional metallic structures. Assessed material properties and identify suitable epoxy and fiber materials for spacecraft adapter and fairing applications. Developed procedures to flight qualify suitable materials and confirmed unique manufacturing processes. Fabricated and tested candidate materials identified as viable candidates.			
(U)	In FY 2004: Further develop efforts to develop larger fairings for expendable rockets. This effort focuses on the development of design, analysis, and fabrication techniques that enable larger fairings to be developed than are possible with existing technology. Specifically, this effort will refine the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles.			
(U)	In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

(U)				
(U)	CONGRESSIONAL ADD: Boron Energy Cell Development.	0.000	3.470	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Increase energy conversion efficiency of the Boron Energy Cell, which converts radioisotope beta emissions into electric current. Quantify mission impacts for Department of Defense applications.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	17.982	25.372	8.420

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602601F, Spacecraft Technology.									
(U)	PE 0603218C, Research and Support.									
(U)	PE 0603226E, Experimental Evaluation of Major Innovative Technologies.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603444F MAUI SPACE SURVEILLANCE SYSTEM

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	47.130	51.581	6.306	6.323	6.405	6.513	6.617	Continuing	TBD
4868	Maui Space Surveillance System	47.130	51.581	6.306	6.323	6.405	6.513	6.617	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds technology development at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2004, Congress added $27 million for the MSSS, $8.5 million for High Accuracy Network Determination System, and $10.2 million for Panoramic Survey Telescope And Rapid Response System (Pan-STARRS).

This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	47.888	6.323	6.323
(U)	Current PBR/President's Budget	47.130	51.581	6.306
(U)	Total Adjustments	-0.758	45.258	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.442	
	Congressional Increases		45.700	
	Reprogrammings	-0.122		
	SBIR/STTR Transfer	-0.636		

(U) Significant Program Changes:
Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	0603444F MAUI SPACE SURVEILLANCE SYSTEM	4868 Maui Space Surveillance System

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4868 Maui Space Surveillance System	47.130	51.581	6.306	6.323	6.405	6.513	6.617	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds technology development at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2004, Congress added $27 million for the MSSS, $8.5 million for High Accuracy Network Determination System, and $10.2 million for Panoramic Survey Telescope And Rapid Response System (Pan-STARRS).

This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop technology at the MSSS in Hawaii, as well as operate and upgrade the facility.	32.288	32.881	6.306

(U) In FY 2003: Completed initial design for heavy lift elevator for movement of the 3.6 meter primary mirror and completed environmental studies to support recoating the 3.6 meter primary mirror. Designed and developed integrated data architecture for dissemination of information for MSSS sensors. Optimized use of advanced algorithms for near-real-time post-processing of imagery for high interest objects. Provided technical support to research, development, and operational users and visiting experimenters using the MSSS assets. Provided support to resolve electromagnetic interference problems at the observatory summit. Executed reliability improvements and capability enhancements for the radiometer, adaptive optics, and spectrograph systems to include electronic and fiber board improvements to the radiometer, enhancement of high order wavefront compensation, and characterization of the spectrograph for non-imaging space object identification applications. Developed the capability to collect active signatures of space objects. Conducted lost satellite search and non-imaging space object identification to detect and characterize smaller/fainter objects including Near-Earth Asteroid Tracking.

(U) In FY 2004: Enhance utility by dedicating specific areas to operate at higher classification levels, continuing the upgrade of heavy lift elevator, providing support to resolve electromagnetic interference at site, enhancing reliability and maintainability by upgrading network servers at various classification levels, improving connectivity between sites, and procuring critical state-of-the-art spares. Provide automatic frame selection for daylight imagery that is post-processed using advanced algorithms for increased timeliness. Implement data dissemination architecture with secure, near-real-time, web-based connectivity for release of MSSS sensor information. Conduct technology development efforts using active laser illumination including high precision range rate data collection and demonstrate high precision laser pointing to increase measurement accuracy. Characterize and upgrade the adaptive

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603444F MAUI SPACE SURVEILLANCE SYSTEM**	PROJECT NUMBER AND TITLE **4868 Maui Space Surveillance System**

		FY 2003	FY 2004	FY 2005
	optics system by implementing a tracker upgrade to improve sensitivity and implement diagnostic software capabilities improving resolution. Refurbish MSSS sensors such as the radiometer, long-wave imager, spectrograph, and daylight acquisition sensor for increased sensitivity and resolution. Conduct lost satellite search and non-imaging space object identification to detect and characterize smaller/fainter objects including Near-Earth Asteroid Tracking.			
(U)	In FY 2005: Enhance operational utility by procuring critical sensor and telescope spares, refurbishing the control rooms and upgrading computers for increased personnel efficiency, and maintaining requirements for safety and security in accordance with Air Force regulations.			
(U)				
(U)	CONGRESSIONAL ADD: Panoramic Survey Telescope And Rapid Response System (Pan-STARRS)	12.863	10.200	0.000
(U)	In FY 2003: Began design of the telescope system to include the development of advanced charged coupled devices to detect very dim space objects of the 24th magnitude, a telescope system that uses the charged coupled device detectors, and the hardware/procedures to collect and display the data. Conducted data archiving to support future data collection.			
(U)	In FY 2004: Complete Preliminary Design Review and begin development for telescope system to include the development of advanced charged coupled devices to detect very dim space objects of the 24th magnitude, a telescope system that uses the charged coupled device detectors, and the hardware/procedures to collect and display the data. Design and develop data archiving to support future data collection.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: High Accuracy Network Determination System (HANDS).	1.979	8.500	0.000
(U)	In FY 2003: Demonstrated use of HANDS for high accuracy orbit prediction, non-imaging signatures, and studied the possibilities of use for low resolution imaging.			
(U)	In FY 2004: Deploy additional HANDS sensors in areas of high interest in the Space Surveillance Network and study use of system for detecting and tracking objects in low-earth orbit. Develop large field of view acquisition telescope.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	47.130	51.581	6.306

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0603605F, Advanced									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603444F MAUI SPACE SURVEILLANCE SYSTEM**	PROJECT NUMBER AND TITLE **4868 Maui Space Surveillance System**

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

(U) Weapons Technology. PE 0602500F, Multi-Disciplinary Space Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2004**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	51.688	62.077	51.114	59.564	76.337	81.755	73.055	Continuing	TBD
5031	Advanced Optics & Laser Space Tech	14.012	19.437	19.158	22.755	25.303	26.800	27.814	Continuing	TBD
5032	Advanced Space Materials	6.381	11.615	0.000	0.000	5.813	5.316	3.909	Continuing	TBD
5033	Rocket Propulsion Demonstration	24.369	22.032	22.437	28.155	30.710	32.714	33.239	Continuing	TBD
5034	Advanced Space Sensors	4.511	6.018	9.519	8.654	11.605	16.055	7.633	Continuing	TBD
5062	Advanced Structures for Space Vehicles	2.415	2.975	0.000	0.000	2.906	0.870	0.460	Continuing	TBD

Note: In FY 2003 this was a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities. In FY 2003, only the space unique tasks in the following PEs/Projects transferred to this PE in conjunction with the Space Commission recommendation: PE 0603605F, Projects 3150 and 3647, to Project 5031; PE 0603112F, Projects 2100 and 3946, to Project 5032; PE 0603216F, Project 4922, to Project 5033; and PE 0603203F, Project 665A/PE 0603270F, Projects 431G and 691X, to Project 5034. In FY 2004, efforts in Project 5062, will be complete until FY 2007 when efforts will commence to define spacelift vehicles using the results of the hypersonic engine studies in PE 0602500F, Multi-Disciplinary Space Technology, Project 5027.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates multi-disciplinary space technologies in five projects, each focusing on a separate technology area. 1) Advanced optics and laser space technology demonstrates and assesses space unique advanced optics and high energy laser weapon systems capabilities. 2) Advanced space materials develop and demonstrate materials and processing technologies for future space vehicle components and protection of space sensors from a variety of laser threats. 3) Rocket propulsion develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques for launch and spacecraft applications. 4) Advanced space sensors develops and demonstrates sensor technologies for intelligence, surveillance, and reconnaissance, communications, targeting, and electronic counter-countermeasures for spacecraft applications. 5) Advanced structures for space vehicles develop space unique requirements of a horizontal launched Transatmospheric vehicle operating in an extreme environment.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	54.161	62.610	55.814
(U)	Current PBR/President's Budget	51.688	62.077	51.114
(U)	Total Adjustments	-2.473	-0.533	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.533	
	Congressional Increases			
	Reprogrammings	-0.160		
	SBIR/STTR Transfer	-2.313		

(U) Significant Program Changes:

This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	**5031 Advanced Optics & Laser Space Tech**

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5031	Advanced Optics & Laser Space Tech	14.012	19.437	19.158	22.755	25.303	26.800	27.814	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in PE 0603605F, Projects 3150 and 3647, were transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

This project demonstrates and conducts detailed assessment of space unique technologies needed for advanced optical systems and high-energy laser weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Perform directed energy and space environment assessments on satellites in support of national space control and space situational awareness requirements.	0.019	0.000	0.000
(U) In FY 2003: Provided data to U.S. Space Command for the performance of Laser Clearinghouse functions. Fused finite state models with other satellite data and observables to produce a more complete space situational awareness picture.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate advanced, long-range relay mirror optical technologies such as advanced adaptive optics, beam control, large lightweight optics, optical coatings, throughput, dual line of sight control, spacecraft and optical control integration, beam stabilization, and jitter control.	1.228	5.172	3.670
(U) In FY 2003: Developed system concepts and design technology demonstrations of laser relay mirrors and membrane mirrors to advance global strike, global presence, and ballistic missile defense capabilities for the warfighter. Quantified the performance of a membrane mirror coated with a high-energy laser dielectric coating and designed a space membrane mirror experiment. Developed modeling and simulation tools for space-based relay mirrors.			
(U) In FY 2004: Develop laser relay mirror concepts and design technology demonstrations to advance global strike, global presence, and ballistic missile defense capabilities for the warfighter. Further develop modeling and simulation tools for relay mirrors.			
(U) In FY 2005: Developing critical optical technologies. Integrate mature technologies onto an airborne relay mirror system for developmental and field tests and ultimately an airborne risk reduction demonstration. Complete design of ultra-light mirror space demonstration experiment.			
(U)			
(U) MAJOR THRUST: Perform atmospheric compensation/beam control experiments for applications including	7.926	4.229	4.618

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5031 Advanced Optics & Laser Space Tech**

		FY 2003	FY 2004	FY 2005
	antisatellite weapons, relay mirror systems, satellite tests and diagnostics, and high-resolution satellite imaging.			
(U)	In FY 2003: Performed beam pointing and guidestar radiometry (for atmospheric compensation) tests using a sodium-wavelength laser beacon. Designed and began integration of full aperture point-ahead atmospheric compensation system for low-power laser projection to satellites on weapons-class beam director (3.5 meter telescope). Demonstrated high-accuracy active satellite tracking on 3.5 meter telescope with simultaneous compensated satellite imaging and compensated laser projection to a low-earth-orbit satellite (integrated beam control demonstration).			
(U)	In FY 2004: Complete integration and begin testing of full aperture point-ahead atmospheric compensation system for low-power laser projection to satellites on weapons-class beam director (3.5-meter telescope).			
(U)	In FY 2005: Complete integration and testing of sodium-beacon adaptive optics system including compensated infrared imaging of low earth orbit satellites. Integrate hybrid-beacon full aperture point-ahead atmospheric compensation system on 3.5-meter telescope.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate optical technologies for high bandwidth ground-to-air communications.	0.000	10.036	10.870
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop advanced modular deformable mirrors and adaptive optical control systems. Develop advanced optical filters, infrared sensors, and signal processing systems. Begin design of communications breadboard for automated ground stations.			
(U)	In FY 2005: Develop and build advanced modular deformable mirrors and adaptive optical control systems. Develop advanced optical filters, infrared sensors, and signal processing systems. Develop a portable enclosure system for optical ground terminal.			
(U)				
(U)	CONGRESSIONAL ADD: Aerospace Relay Mirror System.	4.839	0.000	0.000
(U)	In FY 2003: Developed technologies for an aerospace (airborne) relay mirror testbed. Developed and enhanced techniques for dual line of sight control via a coude path and two separate telescopes. Developed, matured, and integrated beam control, optical, and platform hardware to provide risk reduction for a full-scale relay mirror system. Developed a point design for the optical system and control system, and integrated with all subsystems. Tailored and integrated point-ahead beacon technology into the testbed.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	14.012	19.437	19.158

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5031 Advanced Optics & Laser Space Tech**

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0603444F, Maui Space Surveillance System.									
(U)	PE 0603605F, Advanced Weapons Technology.									
(U)	PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	**5032 Advanced Space Materials**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5032 Advanced Space Materials	6.381	11.615	0.000	0.000	5.813	5.316	3.909	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in PE 0603112F, Projects 2100 and 3946, were transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2005, efforts in this project will be delayed until FY 2007 due to higher Air Force priorities.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates materials and processing technologies for transition into Air Force space systems. Materials and processes development is scaled up to the appropriate level to demonstrate materials capability in the relative environment. Subscale components and nonstructural material components are developed and demonstrated to validate expected materials characteristics. Critical data on both structural and nonstructural materials is developed and provided for engineering and system design decisions. Laser hardened materials technologies are developed, demonstrated, and transitioned for the broadband protection of space sensors from a variety of laser threats. Reducing risk in materials technology improves the affordability, reliability, survivability, and operational performance of current and future space systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced materials and processing technologies for space vehicles and subsystems to provide enhanced surveillance capabilities, improved access to space, and improved overall affordability of space vehicles.	1.420	0.000	0.000
(U) In FY 2003: Completed the demonstration of improved material processes with increased yields for robust, high performance, and producible infrared detector materials. Validated and demonstrated materials and materials processing technologies to improve affordability of spacecraft components. Validated measured effects of space exposure on advanced material systems.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate advanced materials technologies that enhance laser hardening of Air Force spacecraft sensors to ensure safety, survivability, and operability in a laser threat environment.	1.320	1.776	0.000
(U) In FY 2003: Identified and evaluated optical limiter materials for the protection of near-infrared to short-wave infrared staring focal plane arrays.			
(U) In FY 2004: Develop optical limiter materials for the protection of near-infrared to short-wave infrared staring focal plane arrays.			
(U) In FY 2005: Not Applicable.			
(U)			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5032 Advanced Space Materials**

(U)	MAJOR THRUST: Develop and demonstrate advanced materials and processing technologies to enable revolutionary improvements in the performance of air breathing and rocket-based aerospace vehicles and weapons.	3.641	9.839	0.000
(U)	In FY 2003: Identified and evaluated cryogenic fluid compatible material and affordable processing technologies for large, lightweight, potentially load bearing tank structures for air-breathing and rocket-based vehicles. Evaluated and characterized ceramic and organic-based composite materials for durable, very high temperature aerospace vehicle and weapon leading edges.			
(U)	In FY 2004: Develop ceramic-based materials (monolithic and composite) capable of being processed into complex shapes for load bearing structures in space access systems and static turbine-based combined cycle and scramjet components. Initiate materials and design concept study on durable reusable high-temperature protection systems for launch vehicles. Develop, characterize and evaluate ceramic-based materials (monolithic and composite) for high temperature protection systems in reusable high-speed systems, especially for leading edges, control surfaces, and high temperature protection seals. Develop and assess metallic materials (monolithic and composite) for space access structures and propulsion system components emphasizing increased operating temperature, environmental compatibility, and durability. Demonstrate innovative material concepts, such as ablative and oxidation - protection coatings coupled with advanced refractory composites, for high-temperature protection system leading edges for reentry vehicles and high-Mach vehicles. Develop analytical modeling tools to predict material behavior in cryogenic and hydrocarbon environments for air-breathing and rocket-based vehicles. Develop and assess jamming and damage protection for sensor and payload in space systems and initiate research for agile infrared filters.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	6.381	11.615	0.000

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602102F, Materials.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0603112F, Advanced Materials for Weapon Systems.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5032 Advanced Space Materials**

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

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE **February 2004**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

PROJECT NUMBER AND TITLE
5033 Rocket Propulsion Demonstration

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5033 Rocket Propulsion Demonstration	24.369	22.032	22.437	28.155	30.710	32.714	33.239	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in PE 0603216F, Project 4922, were transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates advanced and innovative low-cost rocket turbomachinery and components, low-cost space launch propulsion system technologies, and advanced propellants for launch and orbit transfer propulsion. Additionally, this project develops technologies for the Technology for Sustainment of Strategic Systems Phase 1. Characteristics such as environmental acceptability, affordability, reliability, responsiveness, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. This project also develops chemical, electrical, and solar rocket propulsion system technologies for stationkeeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program will improve the performance of expendable systems' payload capabilities by ~20 percent, reduce the launch, operations, and support costs by ~30 percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Technology advances will also lead to seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload. The efforts in this project contribute to the Integrated High Payoff Rocket Propulsion Technology program, a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national space launch needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop liquid rocket propulsion technology for current and future space launch vehicles.	11.176	15.020	11.536
(U) In FY 2003: Tested turbopumps for integration into an advanced hydrogen engine for the Integrated Powerhead Demonstration. Completed redesign and analysis of advanced hydrocarbon engines.			
(U) In FY 2004: Complete integration of components for the Integrated Powerhead Demonstration of advanced, long life, hydrogen-based engine technologies. Initiate component designs and analyses of hydrocarbon demonstration for reusable launch vehicle concepts.			
(U) In FY 2005: Complete testing for the Integrated Powerhead Demonstration. Enhance component designs and analyses of hydrocarbon demonstration for reusable launch vehicle concepts. Scale-up advanced cryogenic upper stage technologies including higher efficiency energy conversion systems..			
(U)			
(U) MAJOR THRUST: Develop solar thermal and solar electric propulsion technologies for existing and future upper stage, orbit transfer vehicles, and satellite formation flying, station keeping, and repositioning.	3.363	3.600	2.412
(U) In FY 2003: Completed demonstration of solar thermal propulsion technologies, such as strut development and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5033 Rocket Propulsion Demonstration**

pointing and tracking, for orbit transfer and maneuvering propulsion technology. Developed preliminary electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of low-earth-orbit to geosynchronous-earth-orbit transfer. Tested initial capability of the advanced small satellite propulsion demonstration to develop microsatellite formation flying capability for Air Force imaging requirements.

(U) In FY 2004: Continue program to develop electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of low-earth orbit to geosynchronous-earth-orbit transfer. Prepare for delivery of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration supporting improved capability for Air Force imaging requirements. Begin next phase solar thermal demonstration.

(U) In FY 2005: Advance development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of low-earth orbit to geosynchronous-earth-orbit transfer. Complete delivery of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration. Enhance solar electric/thermal technology developments improving power efficiency and thruster efficiency. Begin component integration for a high power Hall thruster demonstration.

(U)

(U) MAJOR THRUST: Develop missile propulsion, aging, and surveillance technology for Intercontinental Ballistic Missile to include demonstration of missile propulsion technology and Post Boost Control Systems (PBCS). Efforts support Technologies for the Sustainment of Strategic Systems Program - Phase 1.	3.360	1.490	6.468

(U) In FY 2003: Demonstrated PBCS component technologies with available materials to reduce hardware costs and maintain system performance. Tested strategic sustainment demonstration technologies that integrated advanced propellant, case, and nozzle technologies and demonstrated cost and performance goals.

(U) In FY 2004: Begin fabrication of final PBCS components for testing and demonstration. Fabricate final components (to include propellant, case, and nozzle) for the interim strategic sustainment demonstration motors.

(U) In FY 2005: Complete fabrication of components for the Post Boost Control demonstration test. Complete fabrication and begin integration and testing for the interim strategic sustainment demonstration motors. Commence assessment and fabrication of the final strategic sustainment demonstration motors.

(U)

(U) MAJOR THRUST: Develop electric and advanced chemical based monopropellant propulsion technologies for future satellite propulsion systems.	0.373	1.922	2.021

(U) In FY 2003: Completed brassboard level testing of a pulsed plasma thruster system. Completed preliminary hot fire testing of the thruster integrated with the power-processing unit. Enhanced development of propulsion system for Air Force small satellites required for key Air Force Space Command concepts. Completed preliminary acceptance and verification testing of flight hardware for microsatellite demonstration spacecraft.

(U) In FY 2004: Demonstrate pulsed plasma thruster. Complete development of propulsion system for Air Force small satellites required for key Air Force Space Command Concepts. Develop advanced monopropellant and begin vehicle

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5033 Rocket Propulsion Demonstration**

		FY 2003	FY 2004	FY 2005
	propulsion ground demonstration.			
(U)	In FY 2005: Demonstrate pulsed plasma thruster. Complete development of propulsion system for Air Force small satellites required for key Air Force Space Command Concepts. Develop advanced monopropellant and begin vehicle propulsion ground demonstration.			
(U)				
(U)	MAJOR THRUST: Evaluate reusable hydrocarbon scramjet technology to support rocket-based combined cycle engines.	6.097	0.000	0.000
(U)	In FY 2003: Evaluated reusable hydrocarbon scramjet component technology to support rocket-based combined cycle engines. Components evaluated were consistent with Integrated High Payoff Rocket Propulsion Technology Phase II hydrocarbon boost demonstration in FYs 2005-2006. Determined component technologies to be integrated into combined cycle engine development, as well as hydrocarbon engine components for highly reusable launch.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	Total Cost	24.369	22.032	22.437

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602102F, Materials.									
(U)	PE 0602203F, Aerospace Propulsion.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602601F, Spacecraft Technology.									
(U)	PE 0603114N, Power Projection Advanced Technology.									
(U)	PE 0603216F, Aerospace Propulsion Power Technology.									
(U)	PE 0603401F, Advanced Spacecraft Technology.									
(U)	PE 0603853F, Evolved									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5033 Rocket Propulsion Demonstration**

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

Expendable Launch Vehicle Program.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	**5034 Advanced Space Sensors**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5034 Advanced Space Sensors	4.511	6.018	9.519	8.654	11.605	16.055	7.633	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in PE 0603203F, Project 665A, and PE 0603270F, Projects 431G and 691X, transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates space sensor technologies, including radio frequency sensors; intelligence, surveillance, and reconnaissance sensors; electro-optical sensors; laser warning sensors; targeting and attack radar sensors; and electronic counter-countermeasures (ECCM) and communications. By developing multi-function radar, laser, electronic combat, and ECCM technologies for space applications, this project provides space platforms with the capability to precisely detect, track, and target air- and ground-based, high-value, time-critical targets, while remaining invulnerable to hostile and natural threats.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop a material signature analysis capability to evaluate the physical/chemical origins of paint/camouflage thermal reflectance features, and develop a forward predictive capability validated with empirical measurements.	0.283	0.323	0.194
(U) In FY 2003: Performed chemical analyses and developed an enhanced surface scattering model. Developed and validated a baseline predictive signature prediction model for space-qualified hyperspectral electro-optical sensors.			
(U) In FY 2004: Develop a forward predictive capability validated with empirical measurements. Perform chemical analyses of an expanded target set and continue developing an enhanced surface scattering model. Assess environmental influences on spectral signatures.			
(U) In FY 2005: Expand the development of material signature analysis research into the area of polarimetric signatures. Develop an enhanced system-level modeling capability that incorporates additional signature modalities, including the addition of polarimetric signatures.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate technologies to maximize Global Positioning System (GPS) jam resistance, positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities.	0.951	1.020	2.362
(U) In FY 2003: Designed advanced M-Code technologies. Developed assured reference technologies to operate in space to provide precise time, position, and velocity for multiple platforms. Demonstrated virtual flight test technology for improved assessment of GPS anti-jam technologies.			
(U) In FY 2004: Design direction finding technologies to maximize Navigation Warfare exploitation techniques for enhanced offensive and defensive combat capabilities. Develop assured reference technologies to provide precise			

	time, position, and velocity for on-board and off-board platform applications. Develop antenna wavefront simulation technology to assess anti-jam Global Positioning System (GPS) III techniques.			
(U)	In FY 2005: Demonstrate assured reference technologies to provide precise time, position, and velocity for on-board and off-board platform applications. Demonstrate antenna wavefront simulation technology to assess anti-jam GPS III techniques.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate advanced wide-band electronic combat (EC) radio frequency receiver encoding/pre-processing/sorting concepts and techniques to handle increasing digitization of the modern complex RF signal environment for applications in existing and future space EC systems.	0.430	0.000	0.000
(U)	In FY 2003: Developed requirements analysis and hardware and software designs of future space electronic combat systems.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop space-based support jamming technologies and techniques that will counter advanced radio frequency threats.	1.430	0.000	0.000
(U)	In FY 2003: Completed study of and continued developing and assessing physical requirements for applying space-based support jamming technologies in space unique environments.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop space laser warning sensor technologies for timely alert to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser-guided ordnance) signals.	1.417	0.559	1.111
(U)	In FY 2003: Completed design of space-hardened processor, geolocation, and spectrometer modules. Completed false alarm package hardware and began integration onto flight platform. Completed false alarm test planning. Performed risk reduction analysis for space-hardened geolocation, spectrometer, and processor modules. Fabricated initial components of space laser warning sensor modules.			
(U)	In FY 2004: Integrate false alarm package for space flight. Breadboard geolocation, spectrometer, and algorithm processor modules. Complete fabrication of space-qualified false alarm sensor modules. Plan for on-orbit testing.			
(U)	In FY 2005: Complete designs for space-qualified laser warning sensors for rapid detection and characterization of laser designators, trackers, dazzlers, and weapons. Develop geolocation, spectrometer, and algorithm processor modules, and integrate false-alarm reduction techniques in preparation for space flight test. Initiate characterization of space-qualified false-alarm sensor modules. Fabricate and integrate space-qualified components for space flight			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5034 Advanced Space Sensors**

	engineering test unit. Develop mechanical, electrical, and functional interfaces to a host satellite. Plan for on-orbit testing, data collection, and system evaluation.			
(U)				
(U)	MAJOR THRUST: Develop advanced laser communication component and sub-system technology to support a network-level topology for Airborne Intelligence Surveillance and Reconnaissance (AISR).	0.000	4.116	5.852
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Integrate and test electro-optical communication component technology into an airborne communication testbed, and evaluate performance with ground terminals under simulated space-to-ground, low elevation angle path lengths. Define requirements for laser communication channelization to develop multiple user access capability. Develop aircraft optical network technologies to switch and route high bandwidth laser communication signals to lower level radio frequency systems through a distributed fiber bus providing lower bandwidth link connectivity and redundancy.			
(U)	In FY 2005: Develop an integrated electro-optical communication terminal for evaluation and testing of AISR links between an airborne communication testbed and ground terminals under simulated space to ground atmospheric conditions. Develop subsystem technologies for a shared radio frequency/electro-optical aperture to service high bandwidth communication needs. Examine applicability of shared apertures to multiple user access capability. Develop aircraft optical network to switch and route high bandwidth laser communication signals to lower level radio frequency systems through a distributed fiber bus providing lower bandwidth link connectivity and redundancy.			
(U)	Total Cost	4.511	6.018	9.519

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602204F, Aerospace Sensors.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0603203F, Advanced Aerospace Sensors.									
(U)	PE 0603270F, Electronic Combat Technology.									
(U)	This project has been coordinated through the									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5034 Advanced Space Sensors**

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

Reliance process to harmonize
efforts and eliminate
duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5062 Advanced Structures for Space Vehicles**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5062	Advanced Structures for Space Vehicles	2.415	2.975	0.000	0.000	2.906	0.870	0.460	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique efforts transferred from PE 0603211, Projects 4920 and 486U, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2005, efforts in this project will be delayed until FY 2007 due to higher Air Force priorities.

(U) A. Mission Description and Budget Item Justification

This project identifies, develops, and demonstrates the technologies to enable advanced access-to-space aerospace vehicles that deliver revolutionary capability, operability, responsiveness, and cost-effectiveness. Enabling technologies include thermal protection, structures, vehicle systems, configurations, aerodynamics, and controls. Technology demonstration includes multi-disciplinary system level integration of the enabling technologies.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop the airframe and payload technologies required to enable horizontal launch.	2.415	2.975	0.000
(U) In FY 2003: Developed the airframe and payload technologies required to enable next generation reusable access to space systems including the thermal protection, structural, configuration, and vehicle and payload system technologies that enable aerospace vehicles to exhibit revolutionary capability, operability, responsiveness, and cost-effectiveness. Investigated integration of the multidisciplinary technologies required to design and demonstrated these aerospace vehicle configurations such as materials, munitions, human effectiveness, and both rocket- and airbreathing-based hypersonic propulsion.			
(U) In FY 2004: Continue developing the airframe and payload technologies required to enable next generation reusable access to space systems including the thermal protection, structural, configuration and vehicle and payload system technologies that enable aerospace vehicles to exhibit revolutionary capability, operability, responsiveness, and cost-effectiveness.			
(U) In FY 2005: Not Applicable. Efforts in this project will be delayed until FY 2007 due to higher Air Force priorities.			
(U) Total Cost	2.415	2.975	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) PE 0602500F, Multi-Disciplinary Space Technology.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC**	PROJECT NUMBER AND TITLE **5062 Advanced Structures for Space Vehicles**

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603601F Conventional Weapons Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	45.070	37.198	22.398	22.594	23.024	23.409	23.785	Continuing	0.000
670A Ordnance Technology	21.079	21.463	13.826	13.937	14.193	14.430	14.663	Continuing	0.000
670B Guidance Technology	23.991	15.735	8.572	8.657	8.831	8.979	9.122	Continuing	0.000

Note: In FY 2004, the funding was reduced as the Low-Cost Autonomous Attack System (LOCAAS) Advanced Technology Demonstration (ATD) is transitioning from the initial powered flight test phase of the ATD to the second phase of the ATD.

(U) A. Mission Description and Budget Item Justification

This program develops, demonstrates, and integrates ordnance and advanced guidance technologies for air-launched conventional weapons. The program includes two projects: (1) development of conventional ordnance technologies including warheads, fuzes, and explosives; and (2) development of advanced guidance technologies including seekers, navigation and control, and guidance. Note: In FY 2004, Congress added $1.0 million for the LOCAAS and $6.0 million for Maverick Missile Upgrade Lock-On after Launch (LOAL) - Live Testing.

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

	FY 2003	FY 2004	FY 2005
(U) Previous President's Budget	43.605	30.516	22.456
(U) Current PBR/President's Budget	45.070	37.198	22.398
(U) Total Adjustments	1.465	6.682	
(U) Congressional Program Reductions			
Congressional Rescissions		-0.318	
Congressional Increases		7.000	
Reprogrammings	2.544		
SBIR/STTR Transfer	-1.079		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Ordnance Technology**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
670A Ordnance Technology	21.079	21.463	13.826	13.937	14.193	14.430	14.663	Continuing	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops, demonstrates, and integrates ordnance technologies for enhancing the effectiveness of air-launched conventional weapons. The project develops conventional ordnance including warheads, fuzes, explosives, carriage and release, and munition integration technologies. This project improves the capability for conventional ordnance supporting an Air Expeditionary Force.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced air-delivered munitions fuze and mass-focusing warhead technologies to improve munition effectiveness, allowing for smaller warheads and munition airframes, thereby improving sortie effectiveness and increasing strike aircraft load-outs. Develop a fuzing capability that will transmit function data from penetrating weapons through various hard target mediums.	6.715	7.320	5.350
(U) In FY 2003: Supported the cooperative program with the United Kingdom to design an integrated fuze, an improved target detection device, and a directional warhead package. Improved the design of a fuze using Microwave Monolithic Integrated Circuit technologies that will give burst accuracy of 0.5 meters for weapons that have closure rates up to 2,500 meters per second. Completed design trades for precision-guided munitions with precise, time-of-arrival attributes that can be used to defeat hard and deeply buried targets that will be used to overpower protective tunnel doors and destroy tunnel contents with intruding blast pressures.			
(U) In FY 2004: Complete cooperative program with the United Kingdom to ground test an integrated fuze, an improved target detection device, and a directional warhead package. Continue design of a fuze using Microwave Monolithic Integrated Circuit technologies that will give a burst accuracy of 0.5 meters for weapons that have closure rates up to 2,500 meters per second. Begin designing a hard target influence fuze capable of denying hard and deeply buried facilities access.			
(U) In FY 2005: Continue design of a fuze using Microwave Monolithic Integrated Circuit technologies that will give burst accuracy of 0.5 meter for weapons that have closure rates up to 2,500 meters per second. Continue designing a hard target influence fuze capable of denying hard and deeply buried facilities access.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate conventional munition subsystem and platform integration technologies to include innovative air-delivered munition carriage and release equipment, miniature weapon release concepts, and reduced airframe size providing the capability to safely carry, launch, and communicate with the aerospace vehicle and other multiple miniature weapons. These integration technologies will increase weapon	5.289	3.325	3.301

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Ordnance Technology**

	load-outs and improve sortie effectiveness for current and future strike aircraft while reducing munition airlift requirements.			
(U)	In FY 2003: Completed design of a low-cost, precision-guided weapon with a Circular Error Probable of 1.4 meters and lethal effectiveness against 85% of the MK-83 and BLU-109 targets.			
(U)	In FY 2004: Begin an effort to integrate components and technologies for a weapon that can neutralize chemical and biological warfare facilities. Begin an effort to develop a multi-mode ordnance package effective against a broad range of unhardened ground targets.			
(U)	In FY 2005: Demonstrate a weapon that can neutralize chemical and biological warfare facilities. Continue an effort to develop a multi-mode ordnance package effective against a broad range of unhardened ground targets.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced conventional armament warhead technologies, including heavy metal liners, dense metal cases, and insensitive explosives with increased energy release performance attributes. The goal of these efforts is to destroy hardened targets by more effectively penetrating protective surfaces and by enhancing kill mechanisms against softer surface targets. Note: This effort includes $3.0 million in FY 2003 Congressional Add funding for the BLU-109 Heavy Warhead (tungsten heavy alloy core).	9.075	10.818	5.175
(U)	In FY 2003: Improved the design and began fabrication of a weapon capable of high-speed penetration of extremely hard targets by integrating a new warhead case technology, insensitive explosive, and multiple-event fuze. Completed preliminary design of a unitary warhead penetrator capable of damaging weapons of mass destruction production and storage facilities with minimum collateral damage. Investigated maturing designs of advanced reactive materials such as nano-scale aluminum. Designed new warhead for the BLU-109 with a tungsten heavy alloy core.			
(U)	In FY 2004: Continue designing and fabricating a warhead capable of surviving high-speed penetration of extremely deep targets by integrating a new warhead case technology, insensitive explosives, and a multiple-event fuze. Demonstrate a Tantalum warhead to provide attack capability against armored targets employing 'Active Protection Systems.			
(U)	In FY 2005: Continue designing and fabricating a weapon capable of high-speed penetration of extremely hard targets by integrating new warhead case technology, insensitive explosive, and a multiple-event fuze. Improve insensitive explosive warhead fills with a goal to significantly reduce the fill volume required yet successfully completing the intended ordnance mission.			
(U)	Total Cost	21.079	21.463	13.826

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Ordnance Technology**

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602602F, Conventional Munitions.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670B Guidance Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
670B Guidance Technology	23.991	15.735	8.572	8.657	8.831	8.979	9.122	Continuing	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops, demonstrates, and integrates affordable, autonomous, and adverse weather advanced guidance technologies for conventional armaments delivered from manned and unmanned aerospace vehicles. This project includes development of conventional weapon guidance systems including terminal seekers, midcourse navigation sensors for standoff delivery weapons, and target detection and identification processing algorithms for reducing target location error to improve target kill probability.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced conventional armament seeker technologies for miniature munitions applications. These seeker technologies will autonomously detect, acquire, and guide to targets of interest in adverse weather and battlefield conditions. Also, the seeker technologies will increase the probability of kill and minimize collateral damage while providing increased weapons load-out and improved sortie effectiveness.	2.782	2.417	2.968
(U) In FY 2003: Investigated low-cost, laser radar seeker technologies, like Defense Advanced Research Projects Agency-developed fixed, detector array technology for potential Air Force applications.			
(U) In FY 2004: Begin design of a low-cost, laser detection and ranging seeker that will increase data rate and reduce moving parts of earlier generation laser seeker technologies.			
(U) In FY 2005: Finalize design and begin fabrication of a low-cost, laser detection and ranging seeker that will increase data rate and reduce moving parts of earlier generation laser seeker technologies.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate advanced conventional armament navigation and control technologies to increase armament navigation accuracy, improve stand off range, and enhance weapons control and operation in electronic jamming environments.	1.932	2.175	2.152
(U) In FY 2003: Completed developing interface between a target detection device, fuze, directional warhead, and weapon terminal guidance seeker. Designed a munition navigation system using micro-electromechanical system technology to provide an accurate (less than one meter), miniature (less than 25 cubic inches), and affordable (less than $6,000 per unit) Global Positioning System/Inertial Measurement Unit navigation system sized for munition applications.			
(U) In FY 2004: Continue developing a munition navigation system using micro-electromechanical system technology to provide an accurate (less than one meter), miniature (less than 25 cubic inches), and affordable (less than $6,000 per unit) Global Positioning System/Inertial Measurement Unit navigation system.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670B Guidance Technology**

(U)	In FY 2005: Continue developing a munition navigation system using micro-electromechanical system technology to provide an accurate (less than one meter), miniature (less than 25 cubic inches), and affordable (less than $6,000 per unit) Global Positioning System/Inertial Measurement Unit navigation system.			
(U)				
(U)	MAJOR THRUST: Integrate advanced conventional guidance technologies including seekers, processors, controls, datalinks, and algorithms to provide improved adverse weather performance, faster processing of target information, higher probability of target detection, an operationally acceptable target false alarm rate, and enhance the effectiveness of miniature munitions against both mobile and fixed ground targets.	4.898	4.202	3.452
(U)	In FY 2003: Investigated low-cost seeker, guidance hardware, and autonomous target recognition software technologies for a small bomb to attack mobile and re-locatable targets.			
(U)	In FY 2004: Design a data link for Low Cost Autonomous Attack System (LOCAAS) to provide a capability to perform re-targeting, in-flight capability after munition has separated from launch aircraft.			
(U)	In FY 2005: Develop, fabricate, and flight test a datalink on the LOCAAS providing the capability to re-target, in-flight after munition has separated from launch aircraft.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop technologies in support of the Low Cost Autonomous Attack System (LOCAAS) program. Note: This effort includes Congressional Adds in FY 2003 ($3.5 million) and in FY 2004 ($1.0 million).	14.379	0.992	0.000
(U)	In FY 2003: Enhanced the current LOCAAS Advanced Technology Demonstration (ATD) program by adding and completing more flight and ground testing. Additional LOCAAS ATD tasks included flight-testing of a LOCAAS with a live warhead to demonstrate that the integrated technologies perform as expected.			
(U)	In FY 2004: Complement the current LOCAAS development program by accelerating the fabrication, integration, and flight testing of a datalink on the weapon.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Maverick Missile Upgrade Lock-On After Launch (LOAL) - Live Testing.	0.000	5.949	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct an operational utility evaluation of a Maverick Missile enhanced with a communication subsystem. Test a Maverick missile with a data communication system to prove that it can be targeted/retargeted after launch.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	23.991	15.735	8.572

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670B Guidance Technology**

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

(U) **D. Acquisition Strategy**
Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603605F Advanced Weapons Technology

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	71.649	61.221	31.103	29.168	31.667	30.226	30.705	Continuing	Continuing
3150	Advanced Optics Technology	23.168	24.837	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
3151	High Power Solid State Laser Technology	27.972	19.446	15.085	15.601	15.890	16.157	16.413	Continuing	Continuing
3152	High Power Microwave Technology	12.424	8.343	11.504	11.559	13.649	11.910	12.102	Continuing	Continuing
3647	High Energy Laser Technology	8.085	8.595	4.514	2.008	2.128	2.159	2.190	Continuing	Continuing

Note: In FY 2003, space unique tasks in Projects 3150 and 3647 were transferred to PE 0603500F in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2003, this program received $10 million as part of the Iraqi Freedom Fund which is included in the above cost table.

(U) **A. Mission Description and Budget Item Justification**

This program provides for the development and demonstration of advanced directed energy and optical concepts that are not space unique. In solid state lasers, compact, reliable, relatively high power, cost-effective single devices and arrays of devices are demonstrated. In high power microwaves, technologies such as narrowband and wideband devices and antennas are demonstrated. In high energy lasers, technologies such as high power chemical lasers and beam control technologies are demonstrated.

Note: In FY 2004, Congress added $2.3 million for Geo Light Imaging National Testbed (GLINT), $4.3 million for Mobile Active Targeting Resource for Integrated Experiments (MATRIX), $1.0 million for Advanced Technology for Infrared Countermeasure Component Improvement, $2.5 million for Aerospace Relay Mirror System Demonstration, $8.5 million for Applications of LIDAR to Vehicles with Analysis, $4.0 million for Laser Illuminated Viewing and Ranging Sensor Development, $4.3 million for the Laser Spark Countermeasure Program, $3.4 million for the Low Speed Air Data Sensor for Special Operations Aircraft, $3.25 million for the Texas-New Mexico Sky Survey, and $1.1 million for the Wafer Integrated Semiconductor Laser.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	53.381	27.024	30.229
(U)	Current PBR/President's Budget	71.649	61.221	31.103
(U)	Total Adjustments	18.268	34.197	
(U)	Congressional Program Reductions		-0.127	
	Congressional Rescissions		-0.526	
	Congressional Increases		34.850	
	Reprogrammings	18.977		
	SBIR/STTR Transfer	-0.709		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603605F Advanced Weapons Technology**	**3150 Advanced Optics Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3150 Advanced Optics Technology	23.168	24.837	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in Project 3150 were transferred to PE 0603500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project develops advanced optical technologies for various strategic and tactical beam control applications.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	0.255	0.000	0.000
(U) In FY 2003: This project previously included space unique funding that has been transferred to PE 0603500F, Multi-disciplinary Space Technology. These funds represent the associated civilian salaries that were inadvertently left behind.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Applications of Lidar to Vehicles with Analysis.	11.379	8.287	0.000
(U) In FY 2003: Explored the utility of an operational Field Laser Demonstrator laser radar integrated with the Advanced Electro-Optical System for deep space metric and space object identification missions, microsatellite tracking, and ballistic missile defense discrimination. Investigated vibrometry, polarimetry, and 3D imaging using laser radars to provide detailed information on satellites. Investigated using laser radars to provide a range of battlefield information such as battle damage assessment and camouflage penetration.			
(U) In FY 2004: Demonstrate tracking ability using the Field Laser Demonstrator's Hi-Class laser radar for deep space metric and space object identification missions, microsatellite tracking, and ballistic missile defense discrimination. Investigate novel concepts for using laser radars to provide detailed information on satellites. Investigate laser radars to provide a range of battlefield information such as battle damage assessment and camouflage penetration. Investigate eye-safe laser radars and airborne demonstrations of laser sensing to battlefield information such as combat identification, battle damage assessment, and camouflage penetration.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Laser Illuminated Viewing and Ranging Sensor Development.	4.155	4.000	0.000
(U) In FY 2003: Developed and demonstrated technologies for eye-safe active laser sensing systems for gathering			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3150 Advanced Optics Technology**

	battlefield images. Developed advanced sensor technology for eye-safe laser imaging including gated transferred electron bombarded charged coupled devices cameras and laser imaging beam control assemblies.			
(U)	In FY 2004: Develop and demonstrate eye-safe laser sensing technologies for obtaining battlefield intelligence such as target imagery, target identification, and battle damage assessment. Complete development of a gated electron bombarded active pixel sensor mated with an advanced imaging chip. Complete design and delivery of a Laser Illuminated Viewing and Ranging Sensor subsystem (sensor and optics) for integration into an unmanned air vehicle ball turret imaging system.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Geosynchronous Light Imaging National Testbed.	2.333	2.500	0.000
(U)	In FY 2003: Continued development and integration of hardware for the Geo Light Imaging National Testbed (GLINT) at White Sands Missile Range, New Mexico. Built one heliostat and a partially completed collector. Performed field experiment to collect light from stars.			
(U)	In FY 2004: Evaluate and demonstrate concepts and components for active imaging of space objects with continued development and integration of hardware. Build one heliostat demonstration unit and one mini-receiver. Perform a field experiment to test hardware performance and demonstrate imaging concept under controlled conditions.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Mobile Active Tracking Resource for Integrated Experiments (MATRIX).	5.046	4.300	0.000
(U)	In FY 2003: Developed a first generation testbed for assessment of future tactical laser beam control/fire control sensors. Evaluated tracking, discrimination, and targeting algorithms for tactical high energy lasers and surveillance/situational awareness missions.			
(U)	In FY 2004: Develop/enhance ground-based and airborne beam control and fire control testbeds to demonstrate various active and passive sensors for high energy laser beam control. Concentrate on beam control and fire control enhancements for the Advanced Tactical Laser, but also support risk reduction decisions for other future laser weapons. Perform ground testing in New Mexico and Hawaii.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Aerospace Relay Mirror System Demonstration.	0.000	2.500	0.000
(U)	In FY 2003: Not Applicable. Added to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, in FY 2003.			
(U)	In FY 2004: Acquire initial components and software build to investigate using high altitude relay mirrors to greatly extend the range of various optical systems including high energy laser weapons. Test and integrate components into a laboratory demonstration that will verify scaleable system performance. Determine platform integration costs and			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3150 Advanced Optics Technology**

	identify potential field demonstration options. The cost, applicability, and manufacturability of lightweight telescopes and high energy optics will be researched for future testbed upgrades.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Texas-New Mexico Sky Survey.	0.000	3.250	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop technologies to enhance the ability to detect, track, and characterize Earth orbiting satellites. Redesign of the prime focus corrector of the Hobby-Eberly Telescope. Complete the optical design for a wide-field search telescope.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	23.168	24.837	0.000

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0603444F, Maui Space Surveillance Systems.									
(U)	PE 0602102F, Materials.									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3150 Advanced Optics Technology**

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

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3151 High Power Solid State Laser Technology**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3151	High Power Solid State Laser Technology	27.972	19.446	15.085	15.601	15.890	16.157	16.413	Continuing	Continuing
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project provides revolutionary breakthroughs in compact, robust, and affordable laser system technology for a wide range of military applications requiring small compact laser sources. This is a long-term technology development project with both near-term and long-term payoffs. Near-term goals include developing compact, reliable infrared sources that can be used for a range of applications including night vision systems, landing zone markers, remote sensing, and covert communication systems. Longer-term goals focus on producing compact, significantly higher power sources that could be applied to military weapons-type applications including aircraft self-protection. This project leads the development of, and builds upon, a wide range of commercial advancements. Commercially available solid state lasers are widely used due to their low-cost, small size and weight, high reliability, and high efficiency in converting electricity to laser energy. This project preserves these attractive features while continually scaling output to higher powers and efficiencies and to military application-specific wavelengths. This project is divided into two technology areas. The first area investigates methods to develop low-cost, scalable, high power solid state lasers. This effort builds upon a strong industrial technology base. The second area develops wavelength specific solid state lasers for military applications such as infrared countermeasures.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U)	MAJOR THRUST: Demonstrate scalability of high power solid state laser architectures for tactical directed energy applications such as unmanned aerial vehicle target designators/imagers and next generation weapons/components for applications such as advanced gunship weapons and airborne laser illuminators.	4.759	7.076	8.477
(U)	In FY 2003: Participated in the Joint High Power Solid State Laser program to develop and demonstrate multiple approaches for future directed energy, weapons-class electric laser technology at power levels greater than 10 kilowatts, with scalability to 100 kilowatts. Various approaches selected for development and demonstration by the Army, Air Force, High Energy Laser Joint Technology Office.			
(U)	In FY 2004: As part of the Joint High Power Solid State Laser program, demonstrate 10 kilowatts using a modular approach. Begin design for 25 kilowatt demonstrator laser. Investigate systems-level issues such as weight and volume.			
(U)	In FY 2005: As part of the Joint High Power Solid State Laser program, demonstrate 25 kilowatts using a modular approach that has scalability to 100 kilowatts. Address systems-level issues such as weight and volume. Investigate systems-level issues such as power and thermal management requirements. Factors such as performance, cost, etc. will be evaluated between the various approaches funded by the Army, Air Force, and High Energy Laser Joint Technology Office.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3151 High Power Solid State Laser Technology**

(U)	MAJOR THRUST: Develop and demonstrate high energy laser technologies for airborne tactical applications, including air-to-air and surface-to-air scenarios. Detect and track tactical targets in clutter at long ranges.	0.528	3.613	6.608
(U)	In FY 2003: Addressed technologies including lasers for long-range detection of targets in clutter; high power compact laser scalability; and advanced beam control to compensate for platform vibration, atmospheric jitter, and aero-optic effects. Conducted laser effects testing and completed first phase of the development of a multi-kilowatt solid state laser testbed to determine required energy levels, propagation effects, and beam control requirements for tactical applications such as defeating next generation air-to-air threats.			
(U)	In FY 2004: Investigate technologies such as lasers for long-range detection of targets in clutter; high power compact lasers; and advanced beam control to compensate for platform vibration, atmospheric jitter, and aero-optic effects. Complete laser effects testing using surrogate laser sources. Complete development and begin installation of a multi-kilowatt solid state laser testbed to confirm previous test results at system power levels and wavelengths.			
(U)	In FY 2005: Detect and track tactical targets in clutter at long ranges. Demonstrate scalable high-power compact lasers and advanced beam control to control platform vibration, atmospheric jitter, and aero-optic effects. Complete laser effects testing using a multi-kilowatt laser to determine required energy levels for tactical applications that address defeating next generation air-to-air threats.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate laser source technologies needed to counter current air-to-air and surface-to-air missile threats.	3.351	3.257	0.000
(U)	In FY 2003: Demonstrated a reliable and compact multispectral (bands I, II, and IV), solid state laser for countering current generation threats to aircraft platforms.			
(U)	In FY 2004: Complete demonstration of a low-cost, reliable, and compact multispectral (bands I, II, and IV), solid state laser brassboard for future integration into large aircraft platforms.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	MAJOR THRUST: Develop solid state laser technologies that support enhancing the Battlefield Air Operations kit performance and reducing the weight by replacing separate and independent systems now fielded and incorporating the capabilities into a single unit. Part of this effort was funded from the Iraqi Freedom Fund.	19.334	0.000	0.000
(U)	In FY 2003: Developed solid state laser technologies to support Battlefield Air Operations applications such as target ranging, target designation, and wind measurement. Undertook overall systems integration of the laser components (wind sensor, rangefinder, designator, visible and infrared aim lights) with other modules (optics, geo-location, processor/electronics, power, etc.)			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3151 High Power Solid State Laser Technology**

(U)	CONGRESSIONAL ADD: Low Speed Air Data Sensor for Special Operations Aircraft.	0.000	3.400	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop fiber optic laser-based data technology that will provide low air speed indications down to zero knots for all fixed wing and rotary aircraft to increase safety operating in and out of landing zones.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Technology for Infrared Countermeasures Component Improvement.	0.000	1.000	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Accelerate the potential deployment of the previously developed mid-infrared semiconductor laser brassboard for infrared countermeasures applications. Initiate a risk reduction effort to investigate the environmental survivability issues for the laser transmitter. Demonstrate that a mid-infrared semiconductor laser transmitter can survive operational military random vibration and temperature environments. A series of rapid design/test iterations shall be conducted on the sub-scale demonstration unit in order to isolate the environmental impact on key subassemblies in the design such as the cryogenic cooling subassembly.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Wafer Integrated Semiconductor Laser.	0.000	1.100	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Improve the reliability and lower the cost of high power laser diode arrays. Develop the technology for integrating turning mirrors and micro-lenses onto a laser chip, thus implementing more functions of the laser during the semiconductor manufacturing process.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	Total Cost	27.972	19.446	15.085

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602102F, Materials.									
(U)	PE 0603270F, Electronic Combat Technology.									
(U)	PE 0602605F, Directed Energy Technology.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3151 High Power Solid State Laser Technology**

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

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3152 High Power Microwave Technology**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3152 High Power Microwave Technology	12.424	8.343	11.504	11.559	13.649	11.910	12.102	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops high power microwave (HPM) generation and transmission technologies that support a wide range of Air Force missions such as the potential disruption, degradation, damage, or destruction of an adversary's electronic infrastructure and military capability. These targeted capabilities include local computer and communication systems, as well as large and small air defense and command and control systems. In many cases, this effect can be generated covertly with no collateral structural or human damage. In addition, millimeter wave force protection technologies are developed. It also develops a susceptibility/vulnerability/lethality data base to identify potential vulnerabilities of U.S. systems to HPM threats and to provide a basis for future offensive and defensive weapon system decisions. Representative U.S. and foreign assets are tested to understand real system susceptibilities. Both wideband (wide frequency range) and narrowband (very small frequency range) technologies are being developed.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate HPM technologies to disrupt, degrade, damage, or destroy an adversary's electronic systems.	4.724	3.465	1.324
(U) In FY 2003: Completed a repetitively pulsed gigawatt-class HPM experiment. Conducted wideband field experiments with integrated compact devices to demonstrate effectiveness of wideband HPM for munitions and airborne electronic attack. Conducted initial ground-based, field experiment to demonstrate effectiveness of air-delivered HPM munitions.			
(U) In FY 2004: Demonstrate an integrated repetitively pulsed gigawatt-class HPM breadboard. Conduct wideband field experiments with integrated compact devices to demonstrate effectiveness of wideband HPM for munitions and airborne electronic attack. Conduct additional ground-based, field experiments demonstrating effectiveness of air-delivered HPM munitions. Conduct an integrated wideband concealed weapon identification experiment.			
(U) In FY 2005: Demonstrate pulsed power and narrowband HPM source capability applicable to munitions and airborne concepts. Demonstrate a repetitively pulsed multi-gigawatt-class HPM integration experiment. Demonstrate brassboard wideband concealed weapon identification concept.			
(U)			
(U) MAJOR THRUST: Conduct effects experimentation to expand and refine data library and support susceptibility predictions.	2.270	1.361	0.782
(U) In FY 2003: Applied computer codes to predict HPM coupling to targets and validate code prediction accuracy. Investigated and developed models to quantify the effectiveness of HPM waveforms against electronic targets of interest applicable to munitions or airborne platforms. Refined the ability to calculate probability of kill for			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3152 High Power Microwave Technology**

	representative targets.			
(U)	In FY 2004: Predict HPM coupling to targets with enhanced computer codes and validate code prediction accuracy. Further refine models to quantify the effectiveness of HPM waveforms against electronic targets of interest applicable to munitions or airborne applications. Enhance the ability to calculate probability of kill for additional representative targets.			
(U)	In FY 2005: Provide dynamic data library to users and continue effects experimentation to populate and update the data library. Transition computer codes for the prediction of electromagnetic coupling on targets to users. Expand the evaluation and quantification of HPM waveform effectiveness against new and evolving electronic targets of interest. Transition computer codes for calculation of probability-of-kill for representative targets.			
(U)				
(U)	MAJOR THRUST: Develop and evaluate active denial technologies for non-lethal, anti-personnel weapon applications such as ground force protection from a standoff aircraft.	1.967	2.649	4.650
(U)	In FY 2003: Investigated the engineering design of next-generation millimeter wave sources for airborne active denial technology. Perform computational physics simulations to analyze capability to validate airborne source design before construction. Analyzed critical technologies for airborne active denial including the use of unique computational simulation.			
(U)	In FY 2004: Acquire knowledge and capabilities critical for future active denial systems via field support of operation/testing/demonstration of the first ground-based system. Begin the development of millimeter wave source for airborne applications including continuation of interactions with system specific computational physics simulations to validate design before source construction. Improve active denial system specific computational physics simulations capability for millimeter wave sources. Complete conceptual design study for mobile ground-based test stand for future airborne level radiating system demonstration. Update subsystem approaches based on original airborne technical feasibility study. Provide technical expertise and background to external organizations tailoring active denial concepts and capabilities to their needs.			
(U)	In FY 2005: Provide user support operation/testing/demonstration of first ground-based development spiral product. Develop and evaluate technologies for non-lethal weapons applications. Continue the development of millimeter wave source for airborne applications. Baseline computational physics simulations of millimeter-wave sources against the draft detailed design drawings. Investigate updated subsystem approaches based on the original airborne technical feasibility study. Provide technical expertise and background to external organizations tailoring Active Denial concepts and capabilities to their needs.			
(U)				
(U)	MAJOR THRUST: Develop the technology to integrate HPM devices on aerial platforms and investigate specific target sets of interest.	3.463	0.868	4.748
(U)	In FY 2003: Conducted target identification efforts to include individual targets, groups, and clusters. Conducted			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3152 High Power Microwave Technology**

experiments with an HPM source within a new, appropriately sized transverse electromagnetic cell anechoic chamber. Installed and used a trans/twist reflector antenna on the existing anechoic chamber for smaller experiments. Performed integration tests on existing aircraft to define the vehicle integration environment for an HPM device. Obtained hardware and software interface specifications for several aircraft in order to integrate sources on the aircraft. Started integration, thermal control, and target studies for such concepts.

(U) In FY 2004: Continue airborne electronic attack specific target identification efforts for individual targets and group and/or cluster of targets. Conduct additional HPM experiments in the transverse electromagnetic cell anechoic chamber and the upgraded smaller anechoic chamber. Begin investigation of source to aircraft integration issues (e.g., electrical, interface, and thermal control). Define aircraft alterations and source shielding required to mount an HPM source on an aircraft. Begin investigating the feasibility of using a wideband HPM source to geolocate and identify targets of interest and perform battle damage assessment.

(U) In FY 2005: Proceed with target identification efforts to include foreign and domestic and individual, group and cluster targets. Perform target lethality assessments. Maintain and upgrade the test facilities. Investigate source to aircraft integration issues such as electrical, interface, thermal control, (center of) mass, antennas, electromagnetic interference/electromagnetic compatibility, and x-rays. Test determined source shielding requirements for mounting a source on an aircraft. Investigate the feasibility of using ultra-wideband HPM to geolocate and identify targets of interest and perform battle damage assessment.

(U)	Total Cost	12.424	8.343	11.504

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602202F, Human Systems Technology.									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0603851M, Nonlethal Weapons - Demonstration/Validation.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3152 High Power Microwave Technology**

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

duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603605F Advanced Weapons Technology**	**3647 High Energy Laser Technology**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3647 High Energy Laser Technology	8.085	8.595	4.514	2.008	2.128	2.159	2.190	Continuing	Continuing
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in Project 3647 were transferred to PE 0603500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

(U) A. Mission Description and Budget Item Justification

This project provides for the development, demonstration, and detailed assessment of non-space unique technologies needed for high energy laser weapons. Near-term focus is on airborne high energy laser missions, although the technology developed for this project is directly applicable to most high energy laser applications. Critical technologies developed and demonstrated include advanced high energy laser devices and laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most high energy laser applications. Detailed computational models to establish high energy laser weapon effectiveness and target vulnerability are developed.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	1.192	0.000	0.000
(U) In FY 3003: This project previously included space unique efforts which have been transferred to PE 0603500F, Multi-disciplinary Space Advanced Development Technology. These funds represent the associated civilian salaries that were inadvertently left behind.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop and demonstrate the technology for scalable, high energy laser devices with improved efficiency for insertion in tactical airborne lasers and other potential weapon applications.	0.781	2.257	2.585
(U) In FY 2003: Evaluated, demonstrated, and enhanced multiple high pressure ejector nozzles performance using modeling and simulation and laboratory nozzle test stand evaluations. Validated performance of laser device components.			
(U) In FY 2004: Demonstrate optimized high pressure ejector nozzles performance for airborne laser systems. Demonstrate advanced iodine generation, iodine injection, and advanced chemical oxygen iodine test sequence utilizing a laboratory test stand. Investigate chemical recirculation on tactical airborne platforms to greatly reduce the amount of chemicals carried onboard the aircraft.			
(U) In FY 2005: Conduct follow-on demonstrations of advanced iodine generation, iodine injection, and advanced chemical oxygen iodine test sequence utilizing the laboratory test stand. Integrate the best iodine generation concept into a laser device to predict overall device-level performance and identify device-level issues. Perform laboratory			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3647 High Energy Laser Technology**

	demonstrations of closed-cycle chemical approaches for use on tactical airborne platforms.			
(U)				
(U)	MAJOR THRUST: Develop and evaluate beam control and compensation techniques including correcting for atmospheric attenuation and distortion of high energy laser beams propagating from airborne platforms.	3.564	2.038	1.929
(U)	In FY 2003: Completed experimental testing of advanced active tracking and atmospheric compensation concepts. Conduct field testing of advanced beam control architectures against a scaled target. Assessed advanced technology improvements to support Airborne Laser block upgrades. Refined, through modeling and simulation, improved wave front sensors and the two-beacon concept. Transitioned appropriate technology to the Airborne Laser System Program Office.			
(U)	In FY 2004: Demonstrate advanced tracking methods and adaptive optics compensation techniques that double the Strehl ratio (peak laser intensity on target) in stressing atmospheric turbulence environments. Demonstrate, in the field, the performance of various wavefront sensors to maximize the ability to correct for atmospheric disturbances. Complete demonstration and evaluation of the compensated beacon illumination technique. Anchor wave optics propagation code to demonstrated beam control performance. Transition appropriate technology to the Airborne Laser System Program Office.			
(U)	In FY 2005: Complete beam control technology demonstration and transition of these technologies to the Airborne Laser System Program Office.			
(U)				
(U)	MAJOR THRUST: Performed vulnerability assessments on potential high energy laser targets to provide critical design data for laser systems, both to defeat these targets and to understand the potential for collateral damage to other targets in the area.	0.371	0.000	0.000
(U)	In FY 2003: Updated target system response databases for improved predictive avoidance analyses.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Sodium Wavelength Laser.	2.177	0.000	0.000
(U)	In FY 2003: Fabricated brassboard sodium-wavelength laser to be use as mesospheric beacon for adaptive optics systems on large-aperture telescopes to significantly increase atmospheric compensation of laser beams by measuring effects to much higher altitudes. Achieved 21 watts output power and generated magnitude 7.1 mesospheric sodium guidestar. Completed series of field tests and experiments to characterize sodium guidestar radiometry using laser outputs of 1-21 watts, with and without atmospheric compensation. Designed, procured parts, assembled, and tested 50 watt laser.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3647 High Energy Laser Technology**

(U)				
(U)	CONGRESSIONAL ADD: Laser Spark Countermeasure Program.	0.000	4.300	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Perform laboratory effects tests and modeling to resolve measured differences in the damage threshold of different focal plane arrays and expand the database to include additional pulse length data and at least one additional focal plane array type. Perform laboratory effects testing to extend previous results into the ultra short pulse length regime. Perform and document a countermeasure effectiveness study for selected operational scenarios. Design, fabricate, and use a brass board countermeasure laser system in a field demonstration test to show the effectiveness of the Spark countermeasure (at relatively low power) against both conscan and imaging test assets with a single threat independent pulse format.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	8.085	8.595	4.514

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									
(U)	The technology efforts in this									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3647 High Energy Laser Technology**

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

PE that are supporting future enhancements to airborne lasers have been coordinated with the Airborne Laser program office.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603723F Environmental Engineering Technology

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	1.152	1.190	0.000	0.000	0.000	0.000	0.000	0.000	TBD
2103	Environmental Quality Technology	1.152	1.190	0.000	0.000	0.000	0.000	0.000	0.000	TBD

Note: In FY 2000, the Air Force terminated this program. However, Congress restored $1.5 million for Environmental Quality Technology and added $4.0 million for the Environmental Systems Management Analysis and Reporting Network (E-SMART) in FY 2000, added $1.0 million for Joint Environmental Clean-Up in FY 2001, added $1.2 million for Bioreactor Technologies Evaluation and Testing in FY 2003, and added $1.2 million for Bioreactor Demonstrations and Deployments in FY 2004.

(U) **A. Mission Description and Budget Item Justification**

This program develops and demonstrates advanced technologies to address Air Force-unique environmental compliance, site remediation, and pollution prevention problems.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates advanced technologies to address Air Force environmental problems.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	1.187	0.000	0.000
(U)	Current PBR/President's Budget	1.152	1.190	0.000
(U)	Total Adjustments	-0.035	1.190	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.010	
	Congressional Increases		1.200	
	Reprogrammings			
	SBIR/STTR Transfer	-0.035		

(U) Significant Program Changes:

In FY 2000, the Air Force terminated this program. However, Congress restored $1.5 million for Environmental Quality Technology and added $4.0 million for the Environmental Systems Management Analysis and Reporting Network (E-SMART) in FY 2000, added $1.0 million for Joint Environmental Clean-Up in FY 2001, added $1.2 million for Bioreactor Technologies Evaluation and Testing in FY 2003, and added $1.2 million for Bioreactor Demonstrations and Deployments in FY 2004.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603723F Environmental Engineering Technology**	PROJECT NUMBER AND TITLE **2103 Environmental Quality Technology**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
2103 Environmental Quality Technology	1.152	1.190	0.000	0.000	0.000	0.000	0.000	0.000	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates advanced technologies to address Air Force-unique environmental compliance, site remediation, and pollution prevention problems.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates advanced technologies to address Air Force environmental problems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) CONGRESSIONAL ADD: Bioreactor Technologies Evaluation and Testing	1.152	1.190	0.000
(U) In FY 2003: Initiate Congressionally-directed effort to demonstrate bioreactor technologies to treat dilute aqueous waste streams and reduce the toxicity of wastewater.			
(U) In FY 2004: Continue Congressionally-directed effort to demonstrate bioreactor technologies to treat dilute aqueous waste streams and reduce the toxicity of wastewater.			
(U) In FY 2005: No planned activity.			
(U) Total Cost	1.152	1.190	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0602102F, Materials.									
(U) PE 0602202F, Human Effectiveness Applied Research.									
(U) PE 0602203F, Aerospace Propulsion.									
(U) PE 0603112F, Advanced Materials for Weapon Systems.									
(U) PE 0603211F, Aerospace Structures.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603723F Environmental Engineering Technology**	PROJECT NUMBER AND TITLE **2103 Environmental Quality Technology**

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

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

(U) PE 0603716D, Strategic Environmental Research and Development Program.

(U) PE 0603851D, Environmental Security Technology Certification Program.

(U) PE 0604706F, Life Support Systems.

(U) PE 0604708F, Other Operational Equipment.

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

(U) D. Acquisition Strategy

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	43.160	44.917	28.524	30.832	38.144	30.744	33.193	Continuing	TBD
4072	Dominant Battlespace Awareness	23.105	24.894	11.785	11.987	16.087	13.191	13.090	Continuing	TBD
4216	Battlespace Information Exchange	9.596	9.352	6.469	6.522	6.642	6.753	6.862	Continuing	TBD
4872	Aerospace Information Dominance	8.680	8.424	8.390	10.426	13.483	8.836	11.245	Continuing	TBD
4925	Collaborative Info Superiority	1.779	2.247	1.880	1.897	1.932	1.964	1.996	Continuing	TBD

Note: In FY 2004 Project 4872, Dynamic Aerospace C2 and Execution, changed to Aerospace Information Dominance, and Project 4925, Collaborative C2, changed to Collaborative Info Superiority.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates Aerospace Command, Control, Communications, and Intelligence (C3I) technologies for the warfighter. The technologies address the ability to support the global information exchange of correlated and fused information to ensure the Air Force can plan and execute missions in a dynamic environment. The Dominant Battlespace Awareness project will provide affordable operational data capabilities for personnel to understand militarily relevant situations, on a consistent basis, with the precision and timeliness needed to accomplish the mission. The Battlespace Information Exchange project will develop the reliable, secure, jam-resistant, inter-operable worldwide global information enterprise capabilities, providing the Air Force assured communications and reach-back capability in a joint/coalition environment. The Aerospace Information Dominance project provides the technology and demonstrations needed to allow the warfighter to plan, assess, execute, monitor, and re-plan on the compressed time scales required for tomorrow's conflicts, whether they be combat or peacekeeping missions. The Collaborative Information Superiority project provides the technology and demonstrations needed to establish virtual, distributed Air Operations Centers (AOC), allowing the majority of the AOC resources to remain in the Continental United States, while only a small command element is deployed forward. The resultant products of this program will be technologies needed to build the capability to dynamically plan and replan over a secure network. Note: In FY 2004, Congress added $3.0 million for Fusion Signals Intelligence Enhancements for Network Centric Intelligence, Surveillance and Reconnaissance, $2.0 million for Automatic Acoustic Target Recognition, $4.8 million for Identification of Time-Critical Targets (Targets Under Trees), $3.0 million for Information Authentication and Protection, and $1.0 million for Effects-Based Operations. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing upgrades and/or new system developments that have military utility and address warfighter needs.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	45.030	31.538	28.599
(U)	Current PBR/President's Budget	43.160	44.917	28.524
(U)	Total Adjustments	-1.870	13.379	
(U)	Congressional Program Reductions		-0.037	
	Congressional Rescissions		-0.384	
	Congressional Increases		13.800	
	Reprogrammings	-0.626		
	SBIR/STTR Transfer	-1.244		

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**		PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4072 Dominant Battlespace Awareness**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4072 Dominant Battlespace Awareness	23.105	24.894	11.785	11.987	16.087	13.191	13.090	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops, integrates, and demonstrates advanced technologies to achieve Dominant Battlespace Awareness (DBA) and Predictive Battlespace Awareness (PBA) using information from all sources, exploiting government and commercial technologies in support of the Global Strike Task Force and the Space and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Task Force. DBA is the information required to support dynamic planning and execution with the accuracy, fidelity, and timeliness needed to dominate in battle. Technology development includes: tasking information collectors (intelligence, surveillance, and reconnaissance (ISR) platforms, national intelligence sources, etc,); correlating and geo-registering the collected data; exploiting the data to extract information of military significance; fusing information from multiple sources to create a digital representation of the battlespace; assessing the situation; predicting enemy course of action; and archiving the results for ready use by decision makers. This is a dynamic process that involves technologies for information access, extraction, fusion, processing, storage, and retrieval, as well as technologies for machine reasoning, pattern recognition, and timeline analysis.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced data handling and event visualization technologies.	4.411	4.135	3.391

(U) In FY 2003: Developed and demonstrated automated capabilities to access, extract, process, and display fused multi-source intelligence for in-time situational awareness. Developed tools for timeline, event, and motion pattern recognition to support analysis, visualization, and decision aids to detect enemy activity. Developed probabilistic approaches for accumulation of data/information to support target/activity identification and situational awareness. Developed a capability for precise geo-location and identification of targets exploiting multi-sensor data. Developed technologies to use multiple source correlation of sensor reports to optimize allocation of sensor resources.

(U) In FY 2004: Develop and deliver probabilistic approaches for accumulation of data/information to support target/activity identification and situational awareness, in support of Predictive Battlespace Awareness (PBA). Complete development of the interface required to feed fused sensor information and derived higher levels of intelligence, such as enemy force structures, lines of communications, and possible courses of actions, into effects-based operations tools and decision aids. Continue development of tools for timeline, event, and motion pattern recognition to support analysis, visualization, and decision aids to detect enemy activity. Initiate development of an operations-based approach for intelligent and adaptive intelligence, surveillance, and reconnaissance (ISR) management, based upon quantified information deficiencies in the fused data-space. Initiate development of a fusion evaluation environment and provide the analysis, evaluation, and transition of fusion products to the warfighter.

(U) In FY 2005: Complete probabilistic approaches for accumulation of data/information to support target/activity identification and situation awareness in support of PBA. Complete development and deliver tools for timeline, event

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4072 Dominant Battlespace Awareness**

	and motion pattern recognition to support analysis, visualization and decision aids to detect enemy activity. Continue to develop an Operations-based approach for intelligent and adaptive ISR management, based upon quantified information deficiencies in the fused data-space. Continue to develop and deliver an initial fusion evaluation environment, providing for the analysis, evaluation, and transition of fusion products to the warfighter.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced signal and data exploitation technologies for detection, tracking, identification, and targeting of time-critical targets, and information extraction technologies for situational awareness. Note: This effort includes $2.8 million in FY 2003 Congressional Add funding for Fusion Signals Intelligence (SIGINT) Enhancements to Electronic Intelligence and $3.0 million for FY 2004 Congressional Add funding for Fusion SIGINT Enhancements for Network Centric ISR.	7.597	7.590	2.992
(U)	In FY 2003: Developed tools to extract information from data derived from image, and measurement and signature intelligence (MASINT). Developed and demonstrated information extraction tools that automatically extract events and their relationships from free form text, allowing the warfighter more time to perform analysis.			
(U)	In FY 2004: Complete the development of tools to extract information from data derived from image, and measurement and MASINT. Continue to develop and demonstrate information extraction tools that automatically extract events and their relationships from free text, including human intelligence and communication intelligence sources, allowing the warfighter more time to perform analysis. Initiate development of an exploitation toolkit for advanced ISR platforms that provide the detection and tracking of air and ground targets. Initiate investigation of tools for the exploitation of High Range Resolution, Identification Friend or Foe, and Synthetic Aperture Radar sensor characteristics for feature-aided tracking and targeting. Start development of automated sensor management tools to support collection planning for ISR platforms.			
(U)	In FY 2005: Complete development and demonstration of intermediate information extraction tools and initiate development of advanced text exploitation tools that automatically extract events and their relationships from free text, including human intelligence and communication intelligence sources, allowing the warfighter more time to perform analysis. Continue the development and deliver an exploitation toolkit for advanced intelligence, surveillance, and reconnaissance (ISR) platforms that provide the detection and tracking of air and ground targets. Deliver tools for the exploition of High Range Resolution, Identification Friend or Foe, and Synthetic Aperture Radar sensor characteristics for feature aided tracking and targeting. Continue to develop and deliver automated sensor management tools to support collection planning for ISR platforms. Initiate development of algorithms for the dynamic tasking of ISR assets (Unmanned Aireal Vehicle/Manned/Space ISR collectors) based upon the exploitation and fusion of multi-source/multi-platform information, in order to provide timely dissemination of useable intelligence to allied/coalition forces.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced data and information fusion	11.097	13.169	5.402

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4072 Dominant Battlespace Awareness**

capabilities to support multi-source capabilities, new sensor types, cognitive models, and automated fusion process management. Note: This effort includes $1.75 million in FY 2003 and $2.0 million in FY 2004 Congressional Add funding for Automatic Acoustic Target Recognition and $3.9 million in FY 2003 and $4.8 million in FY 2004 Congressional Add funding for Identification of Time-Critical Targets.

(U) In FY 2003: Developed and demonstrated an all-source advanced capability for the detection and tracking of time-critical targets. Demonstrated fusion systems and architectures capable of exploiting multiple sources to find, fix, identify, and track moving air and ground targets, and to detect and track targets employing camouflage, concealment, and deception techniques. Developed fusion algorithms and tools to exploit fused sensor information to provide higher levels of intelligence such as enemy force structures, lines of communication, and possible courses of action. Initiated collaborative collection and fusion of intelligence, surveillance, and reconnaissance information to improve accuracy and timeliness for situational awareness and targeting.

(U) In FY 2004: Demonstrate and deliver an all-source advanced capability for the detection and tracking of time-critical targets that employ camouflage, concealment, and deception techniques. Complete the demonstration of fusion system architectures capable of exploiting multiple sources of data to provide situational awareness, indications and warnings, and time-critical target identification and tracking. Complete the development of fusion algorithms and tools to exploit fused sensor information to provide higher levels of intelligence, such as enemy force structures, lines of communications, and possible courses of action. Complete the collaborative collection and fusion of ISR information to improve accuracy and timeliness for situational awareness and targeting. Develop, complete, and demonstrate a capability for fusing signal intelligence, moving target indicator, foliage penetrating radar, and imagery data for the detection and tracking of time-critical targets.

(U) In FY 2005: Develop and demonstrate multi-intelligence data mining and reasoning techniques to locate hard to find targets within the context of a continuously changing battlefield environment. Initiate development of approaches and techniques for reasoning about enemy movements and actions, from historical databases and real-time multi-source information, to be able to find, identify, and track difficult targets that employ concealment, camouflage, and deception techniques. Initiate an investigation of reasoning techniques to aid the analyst in understanding the dynamics of the battlefield.

		FY 2003	FY 2004	FY 2005
(U)	Total Cost	23.105	24.894	11.785

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602702F, Command, Control, and Communications									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4072 Dominant Battlespace Awareness**

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

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603742F, Combat Identification Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603789F C3I Advanced Development**	**4216 Battlespace Information Exchange**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4216 Battlespace Information Exchange	9.596	9.352	6.469	6.522	6.642	6.753	6.862	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced communications technologies to implement a secure information grid for the worldwide information exchange of near-real-time multimedia (i.e., voice, data, video, and imagery) information in a joint/coalition environment. This secure information grid will be rapidly deployable, mobile, interoperable, and seamless between aircraft, either en route or in theater, and Air Operations Centers. It will: a) provide interoperability across echelon, Service, and multi-national force boundaries; b) support mobile information superiority, sensor-to-shooter operations, and the battle management decision process; and c) provide in-transit visibility of en route aircraft, cargo, mission status, and reachback capabilities for aircraft to operations centers in the Continental United States (i.e., updating information and mission changes to en route aircraft). Technology developments include an information assurance decision support system, advanced information management, multi-level secure communications, secure survivable networks, mission and content-based routing, quality-of-service mechanisms, and communications transmission systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach in the Air Mobility Command (AMC) environment.	1.152	1.329	1.795
(U) In FY 2003: Demonstrated an Intelligent Information Manager agent that will throttle and regulate mission information flow among AMC components based on changing system capabilities. Integrated the airborne components of Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller to produce a combined commercial/military global communications system, a dynamically switched network, and an intelligent heterogeneous database access interface to prioritize and control resources in a mobility environment.			
(U) In FY 2004: Finalize and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach in the AMC environment. Complete and demonstrate an intelligent information manager agent that will autonomously throttle and regulate mission information flow among AMC components based on changing system capabilities. Complete Phase 1 integration in an AMC airlifter (carry-on capability) of the airborne components of the Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller to produce a combined commercial/military global communications system, a dynamically switched network, and an intelligent heterogeneous database access interface to prioritize and control resources in a mobility environment.			
(U) In FY 2005: Further develop the Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller into a software application for a software defined radio in preparation for transitioning the			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4216 Battlespace Information Exchange**

	capability to the Joint Tactical Radio System clusters.			
(U)				
(U)	MAJOR THRUST: Develop advanced network protocols and commercial management technologies to provide communications from deployed aircraft and ground elements to the Air Mobility Command (AMC) Tanker Airlift Control Center (TACC), as well as in-transit visibility at the TACC of all aircraft, personnel, and cargo.	1.160	1.654	0.000
(U)	In FY 2003: Demonstrated technology to dynamically reconfigure the network and communications systems to optimally match the requirements for information transfer with changing transmission path availability. Integrated and demonstrated the ground-based components of the Intelligent Information Manager, Integrated Network Controller, and Global Media Access Controller in AMC's TACC and AMC's forward deployed unit, the Tanker Airlift Control Element, resulting in a seamless information infrastructure providing total asset visibility and enhanced situation awareness.			
(U)	In FY 2004: Complete the demonstration of technology to dynamically reconfigure the network and communications systems to optimally match the requirements for information transfer with changing transmission path availability. Complete development and integration of mechanisms that intelligently and dynamically negotiate quality of service and bandwidth between applications and network transport services based on mission priorities. Continue to integrate and demonstrate additional capabilities for ground-based components of the Intelligent Information Manager, Intelligent Network Controller, and Global Media Access Controller into AMC, Air Combat Command, and other DoD users' communications architecture, resulting in a seamless information infrastructure, providing total asset visibility and enhanced situational awareness.			
(U)	In FY 2005: Not Applicable. Effort will be completed in FY 2004.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate improved global networking and resource management technologies that provide reliable efficient, secure, interoperable, and dynamic deployable communications.	0.950	1.809	0.000
(U)	In FY 2003: Completed the adaptive communications controller system(s), integrating additional and emerging media types for increased bandwidth capability. Developed and integrated mechanisms that intelligently and dynamically negotiate quality of service and bandwidth between applications and network transport services based on mission priorities. Completed development of affordable multi-level secure network management capabilities to provide commanders with status and control of information grid network resources.			
(U)	In FY 2004: Complete the development and integration of mechanisms that intelligently and dynamically negotiate quality of service and bandwidth between applications and network transport services, based on mission priorities. Develop and demonstrate advanced cross-domain network management technology for enabling the exchange of network management, command and control applications status, and information assurance events, across security domains. Develop and demonstrate a highly flexible real-time controlled interface that parses and filters protocol level information with a fine degree of granularity. This advanced cross domain technology will enable the eventual			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4216 Battlespace Information Exchange**

	development of a Network Common Operational Picture for situational awareness to assist in gauging the overall security and health of the multi-level information infrastructure.			
(U)	In FY 2005: Not Applicable. Effort will be completed in FY 2004.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate intelligent networking transport and management technology to provide assured, seamless, battlespace connectivity to the aerospace forces with a greatly reduced footprint.	1.255	1.123	1.895
(U)	In FY 2003: Developed and demonstrated technology to support an en route and in-theater information grid for the worldwide exchange of near-real-time multimedia (i.e., voice, data, video, and imagery). Developed and demonstrated beyond line of sight wideband technologies between airborne platforms and ground terminals.			
(U)	In FY 2004: Develop and demonstrate user-friendly, assured wideband wireless intelligent networking capability that automatically senses and adapts to its environment and service demands. Conduct preliminary lab demonstration of a self-organizing wideband network among simulated airborne platforms.			
(U)	In FY 2005: Study, define, and develop mission and content delivery network mechanisms. Refine and enhance intelligent networking technology, which will adapt to its environment and varying demands for service, while providing mission and context-based quality-of-service (QoS) routing. Merge wideband wireless intelligent networking with context-based QoS routing and fashion for ease of implementation into, and the expansion of, the common Joint Service Network Service Layer.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate secure wideband assured networking for small cavity munitions (e.g. Joint Direct Attack Munition, etc.) and integration with the developing airborne segment of the Global Grid. Note: This effort started in FY 2004 in Project 4925.	0.000	0.000	2.294
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Design and brassboard affordable high-capacity data links that are miniaturized to fit within the confines of minature munitions. Data networking will support command and control of the munition and cooperative situational awareness and battle-damage-assessment with other weapon platforms.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate an enterprise management system that collects and evaluates status information from multiple systems and sources, monitors enterprise integrity, analyzes situations, and displays enterprise-wide information.	0.958	0.437	0.485
(U)	In FY 2003: Completed development and demonstrated technologies that integrate, illuminate, and manage command and control (C2) assets within the air operations center C2 process. Developed and demonstrated advanced application and network technologies that provide the capability to monitor, understand, and maintain the status of distributed C2 weapon systems. Development of interface methodologies for seamless integration of theater battle			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4216 Battlespace Information Exchange**

	management applications into the joint battlespace infosphere.			
(U)	In FY 2004: Initiate the development of an integrated command and control Enterprise Management System tool suite, comprised of common, scalable, and tailorable visualizations and management-control capabilities to support various fixed and deployed operations of command, control, and communications centers.			
(U)	In FY 2005: Complete demonstration of an enterprise management system that collects and evaluates status information from multiple systems in multiple security domains to display enterprise-wide information without compromising security in the individual domains.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate an information assurance decision support system to provide real-time defensive courses-of-action.	0.921	0.000	0.000
(U)	In FY 2003: Developed and demonstrated an information assurance decision support system to provide real-time defensive courses-of-action relating to intrusion detection, intrusion response, and information system recovery. Demonstrated data correlation and data fusion tools for detection of large-scale coordinated attacks and provided automatic forensics analysis of attack information. Developed the capability to assess attacks and sophistication of the threat level against the mission. Initiated development and demonstration of automated deployment of defensive counter measures.			
(U)	In FY 2004: Not Applicable. Effort was discontinued due to higher Air Force priorities.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Information Protection and Authentication.	3.200	3.000	0.000
(U)	In FY 2003: Developed and demonstrated information hiding, steganography, and digital watermarking for information protection and authentication systems. Developed steganographic techniques for data embedding, tamper detection and proofing, image and video content authentication, and secure information dissemination. Began investigation of new generation methods for digital security using steganographic techniques and for detection of digital forgeries without watermarks.			
(U)	In FY 2004: Continue development and demonstration of information hiding, steganography, and digital watermarking for information protection and authentication systems. Continue development of steganographic techniques for data embedding, tamper detection and proofing, image and video content authentication, and secure information dissemination. Continue investigation of new generation methods for digital security using steganographic techniques and for detection of digital forgeries without watermarks.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	9.596	9.352	6.469

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4216 Battlespace Information Exchange**

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

(U) **D. Acquisition Strategy**
Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603789F C3I Advanced Development**	**4872 Aerospace Information Dominance**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4872 Aerospace Information Dominance	8.680	8.424	8.390	10.426	13.483	8.836	11.245	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

In order to achieve information dominance for the Expeditionary Aerospace Force, the Air Force must be able to plan, assess, monitor, and replan missions rapidly in a dynamic environment. This project develops and demonstrates technologies necessary for dynamic decision making. It provides the technology and demonstrations needed to enable the warfighter to plan, assess, execute, monitor, and replan on the compressed time scales required for tomorrow's conflicts, whether they be combat or operations other than war. It will develop and demonstrate a new generation of planning assessment technologies that enable a new paradigm of effects-based operations, allowing the aerospace commanders to determine the desired operational effects and prosecute the mission accordingly. It will develop innovative capabilities capable of realizing a strategy to task approach to aerospace warfare exploiting a link between command, strategy, and assessment functions. It will develop and demonstrate distributed Information technologies that provide the commander and staff with seamless access to tailored multi-media, multi-spectral data within a mobile, dynamic Air Operations Center. Knowledge-based intelligent information technologies will be developed to support robust, real-time, large-scale Air Force command and control (C2) systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate distributed information technologies that are scalable and reconfigurable and provide seamless access to tailored multi-media, multi-spectral data for commanders and staff in mobile, dynamic C2 centers.	2.067	1.776	2.693

(U) In FY 2003: Developed and demonstrated multi-user collaborative interaction technology for adaptive visualization and presentation to enhance joint force battle plan simulation, assessment, and implementation focused on aerospace operations within the battlespace infosphere. Developed technology that integrates offensive, defensive, and support elements into an aerospace command center that provides the Expeditionary Aerospace Force a cohesive environment for planning, execution, and assessment. Developed embedded training technologies to provide rapid mission readiness for the warfighter.

(U) In FY 2004: Demonstrate multi-user collaborative interaction technology for adaptive visualization and presentation to enhance joint force battle plan simulation, assessment, and implementation, focused on aerospace operations within the battlespace infosphere. Deliver and demonstrate technology that integrates offensive, defensive, and support elements into an aerospace command center that provides the Expeditionary Air Force a cohesive environment for planning, execution and assessment. Complete and transition to the Theater Battle Management Core System Program Office an integrated C2 system capability spiral that provides seamless access to tailored multi-media, multi-spectral data for commanders and staff within the AOC weapon system, allowing them to monitor the status of the C2 system. Initiate the design and development of a baseline of critical functionality and supporting infrastructure

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4872 Aerospace Information Dominance**

	that will support the evolving Advanced Technology AOC weapon system and its split-operations concept. Define essential elements of information for the Advanced Technology AOC and develop methodologies and information representations that can be seamlessly exchanged across security boundaries.			
(U)	In FY 2005: Continue to design and develop a baseline of critical functionality and supporting infrastructure that will support the evolving Advanced Technology AOC weapon system and its split operations concept. Initiate and develop a capability for the commander to monitor, and repair where necessary, the health of the information superiority function within the AOC weapon system. Investigate the demonstration of a core set of functionality and supporting infrastructure of an Advanced Technology AOC weapon system enabling the ability to plan, direct, coordinate, and control air forces and operations across security boundaries. Initiate and develop an automatic options generation capability for correcting failures and degradations within the command and control (C2) system of the Advanced Technology AOC weapon system. Initiate and develop highly efficient business processes and tools to support information exchange between the Aerospace Operations Center and other C2 centers in the Theater Air Control Structure.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate the integration of planning tools and information-based intelligent agents for adaptive replanning and decision support tools for aerospace C2 systems.	2.107	1.553	0.399
(U)	In FY 2003: Developed and integrated planning and information-based intelligent agents for adaptive replanning. Developed and demonstrated improved integrated flight management capabilities for mobility operations such as an improved search, retrieval, and handling of data and information required for optimal use of available mobility resources. Developed and demonstrated continuous updating of the type, location, and status of DoD transportation assets to improve situational awareness.			
(U)	In FY 2004: Demonstrate improved integrated flight management capabilities for mobility operations, such as improved search, retrieval, and handling of data and information required for optimal use of available mobility resources. Complete the development of tools to continuously update type, location, and status of DoD transportation assets to improve situational awareness. Demonstrate decision support tools and technologies to better manage and define the defense transportation system, accomplish mission viability and conflict analyses, and course of action assessment and evaluation.			
(U)	In FY 2005: Begin developing tools and technologies to revolutionize air mobility information superiority to respond swiftly and effectively to global demands across all spectrums of operations from humanitarian relief to a major conflict. Enable the capability to rapidly synchronize theater information superiority capabilities between combat and mobility forces to support time critical mobility and the seamless interoperability of DoD, Civil, and Coalition units for air traffic control. Initiate development of advanced reasoning techniques for mobility courses-of-action development. Explore the use of advanced computer mark-up languages and initiate the development of common mobility ontology to improve automation of the decision support tools for increased situational awareness, planning,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4872 Aerospace Information Dominance**

	and execution management.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate publish, subscribe, and query information management services that aggregate, share, and tailor information products, enabling horizontal integration of Air Force command, control, communication, computers, intelligence, surveillance, and reconnaissance information management systems.	2.575	2.357	2.793
(U)	In FY 2003: Developed and demonstrated the techniques to produce and manage information objects within the Joint Battlespace Infosphere from numerous web-enabled information sources, to customize information products, and to deliver decision-quality information to any warfighter. Developed and demonstrated data system wrapper technologies to dynamically integrate disparate command and control, intelligence, surveillance, and reconnaissance information systems into the Joint Battlespace Infosphere (JBI). Evaluated and integrated core JBI information management services that enable information exchange among disparate information systems.			
(U)	In FY 2004: Continue to develop and demonstrate the techniques to manage information objects within the Joint Battlespace Infosphere (JBI), from diverse information sources and data environments. Develop and demonstrate data system wrapper technologies to dynamically integrate disparate and legacy command and control, intelligence, surveillance, and reconnaissance information systems into the JBI. Continue to evaluate and integrate core JBI information management services to enable information exchange among disparate information systems.			
(U)	In FY 2005: Demonstrate the techniques to manage thousands of information objects from diverse information sources and data environments within a command and control information space. Complete the integration and demonstrate information management services that enable information exchange among disparate information systems. Evaluate and demonstrate technologies that enable the selective dissemination of information objects across multiple security level boundaries.			
(U)				
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate an effects-based approach for the next generation of planning and assessment techniques that enable aerospace commanders to determine the desired operational effects at the right place at the right time. Note: This effort includes $1.0 million of FY 2004 Congressional Add funds for Effects-Based Operations.	1.931	2.738	2.505
(U)	In FY 2003: Demonstrated the effects-based operations capability through active template technologies to provide recommended priorities, resource availability, and provide the information to the battle managers in time to achieve mission objectives. Developed and demonstrated effects-based tools to operate in the battlespace infosphere that will allow the commander and his/her staff to make decisions with uncertain, ambiguous, or vague information during the course of an aerospace campaign. Developed a dynamic tasking toolkit that enables the warfighter to develop a comprehensive, coherent, and integrated joint aerospace operations plan.			
(U)	In FY 2004: Complete the demonstration of effects-based operational capability, using planning and decision-aid technologies that provide recommended priorities, resource availability, tasking, and scheduling to the battle			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4872 Aerospace Information Dominance**

managers in time to achieve mission objectives. Complete demonstration of combat air forces' and mobility air forces' command and control tools to operate in the battlespace infosphere, which will allow the commander and his/her staff to quickly obtain relevant information, and make timely decisions during the course of a global aerospace campaign. Develop and complete a dynamic tasking process architecture that enables the warfighter to develop a comprehensive, coherent, and integrated joint aerospace operations plan, which can be dynamically executed.

(U) In FY 2005: Initiate design of new concepts and technologies supporting effects-based planning, execution, and assessment by enabling the generation, tasking, and assessment of effects-based Dynamic Air Execution Orders. Investigate various capabilities to support Aerospace Operation Center (AOC) personnel in developing and assessing, in near-real-time, various course of action options based upon commander's intent and knowledge gained from predictive battlespace awareness tools and processes. Initiate investigation of advanced information technologies to shorten the current execution timelines while also allowing significant reductions in the number of personnel required in an AOC.

(U)	Total Cost	8.680	8.424	8.390

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602702F, Command, Control, and Communications									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4925 Collaborative Info Superiority**	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4925 Collaborative Info Superiority	1.779	2.247	1.880	1.897	1.932	1.964	1.996	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

This project develops and demonstrates technologies for the next generation of distributed collaborative environments, which will provide cross-disciplinary information to a decision-maker when, where, and how it is needed. Technologies developed will demonstrate advanced integrated information architectures for the near-real-time transfer of large volumes of information over existing and future Air Force Information Superiority systems. The application of these new technologies will allow reconfiguration and adaptation of existing operational aerospace systems to support seamless integrated operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop, demonstrate, and integrate a broad range of technologies that have application within an embedded information architecture applicable to manned and unmanned vehicles.	0.244	0.457	0.598
(U) In FY 2003: Developed next generation collaborative environments and integrated aerospace information architectures for advanced Air Force enterprises. Demonstrated technology to perform platform information mining and collaborative environments for simulation-based acquisition.			
(U) In FY 2004: Develop, demonstrate, and integrate technologies to address a broad range of sensor-to-decision maker-to-shooter functions and concepts of operations. Initiate development of a time-critical target (TCT) automated decision-aiding capability to deny the enemy the sanctuary of time, for use in a command and control (C2) facility. Initiate development of airborne platform capabilities to engage in the TCT environment either as information sources or information sinks (using both on-board and off-board resources) to maximize exploitation of fielded assets to reduce the timeline of the TCT kill chain. Complete and demonstrate technology to perform platform information mining and collaborative environments for simulation-based acquisition.			
(U) In FY 2005: Continue the development of a TCT automated decision-aiding capability for an Advanced Technology Aerospace Operations Center type of facility to deny the enemy the sanctuary of time. Continue development of airborne platform capabilities to engage in this environment either as information sources or sinks (on- and off-board resources) toward the end of assuring maximum exploitation of fielded assets in accomplishing the maximum strike responsiveness of the shooting elements for completing the TCT kill chain. Initiate development of distributive collaborative environments for C2 warfighter decision making for a broad range of operations other than war including modeling of non-combatant, neutral, and adversarial forces with social, economic, political, and cultural influences.			
(U)			
(U) MAJOR THRUST: Develop communication technologies to increase aerospace platform information transfer capacity.	0.840	1.188	0.659

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT NUMBER AND TITLE **4925 Collaborative Info Superiority**

(U)	In FY 2003: Developed technology to increase aerospace platform information transfer capacity for exchange of time-critical threat, sensor, and C2 information between aircraft and cooperating space, airborne, and surface communication assets. Completed the design and begin the fabrication of high-capacity, bandwidth efficient, modem technology for point-to-point and multiple platform connectivity.			
(U)	In FY 2004: Continue to develop technology to increase aerospace platform information transfer capacity for the exchange of time-critical threat, sensor, and command and control (C2) information between aircraft and cooperating space, airborne, and surface communication assets. Complete the fabrication of high-capacity, bandwidth efficient, modem technology for point-to-point and multiple platform connectivity. Initiate development of an initial weapon data link capability for modernization of aerospace and C2 platforms to support the system-of-systems interoperability within the Global Strike Task Force concept. Start investigations of the interface of weapon systems to the C2 structure that will implement a high tempo, weapons on target capability. Begin definition of munitions data link capabilities and munitions-to-weapon platform pairing.			
(U)	In FY 2005: Complete development and demonstration of an increased aerospace platform information transfer capacity exchange of time-critical threat, sensor, and C2 information between aircraft and cooperating space, airborne, and surface communication assets. Note: In FY 2005, the development of an initial munitions data link capability will move to Project 4216.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate embedded information system technologies to support a transparent framework for seamless, rapid insertion of battlespace infosphere technology.	0.695	0.602	0.623
(U)	In FY 2003: Developed techniques for inserting battlespace infosphere technology that do not require a comprehensive re-test of the entire C2 system. Developed capability for modernization of aerospace and C2 platforms to support system-of-systems interoperability within the battlespace infosphere.			
(U)	In FY 2004: Complete development techniques for inserting battlespace infosphere technology that do not require a comprehensive re-test of the entire C2 system. Complete the demonstration of capability for modernization of aerospace and C2 platforms to support system-of-systems interoperability within the battlespace infosphere. Initiate development of embedded information technology to support command and control of autonomous unmanned systems.			
(U)	In FY 2005: Continue development of embedded information technology to support the Aerospace Operations Center management of unmanned and autonomous systems.			
(U)	Total Cost	1.779	2.247	1.880

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT NUMBER AND TITLE 4925 Collaborative Info Superiority

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:									
(U)	PE 0602702F, Command, Control, and Communications									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603850F Integrated Broadcast Service (DEM/VAL)**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	8.464	2.294	0.000	0.000	0.000	0.000	Continuing	TBD
4778 Integrated Broadcast Service	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5151 Blue Force Tracking	0.000	8.464	2.294	0.000	0.000	0.000	0.000	Continuing	TBD

In FY2004, Project Number 635151, Joint Blue Force Situation Awareness (JBFSA) ACTD, efforts were transferred from PE0207028F, Joint Expeditionary Force Experiment (JEFX), Project Number 674991, Joint Distributed Engineering Plant.

(U) **A. Mission Description and Budget Item Justification**

JBFSA ACTD - The Joint Blue Force Situation Awareness (JBFSA) ACTD is a continuation of an ACTD started in 2003. Because the ground forces use different communications and distribution methods to develop the Blue Force ground picture, there are latency and granularity problems in the Blue Force ground picture, resulting in a lack of data interoperability. This ACTD will develop, integrate, and sustain web-enabled Common Operating Picture (COP) capabilities for Blue Force Tracking that will be interoperable with Service systems. All candidate solutions for these capabilities will be tested under this ACTD before migration to the Service for sustainment. The ACTD begins transition and starts Extended User Evaluation (EUE). The ACTD begins work solving coalition and multi-level security issues.

FIOP - The Family of Interoperable Operational Pictures is a program designed to implement web-based technologies into Systems of Record, making their data and thus the Common operational and tactical pictures consistent throughout the Services and at all echelons of Combat Operations. The Joint Requirements Oversight Council (JROC) directed"...provide an all source picture of the Battlespace containing actionable decision quality information through the fusion of existing databases." in JROC Memorandum 156-02. Ultimately, the efforts described will lead to the underpinnings of Network Centric Operational Warfare.

FIOP Joint Blue Force Situational Awareness (JBFSA) - Many DoD systems provide data regarding friendly forces. There is no single system or mission application that provides a totally integrated (i.e. all blue force data) set of data to the warfighter. This task will perform the systems engineering, architecture development and integration activities leading to a secure, web-based blue force data dissemination network service. This task is being led by the Army and is being done in coordination with the Blue Force Tracking and Single Integrated Ground Picture programs and the Joint Blue Force Situational Awareness Advanced Concept Technology Demonstration.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing systems.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603850F Integrated Broadcast Service (DEM/VAL)**

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget		8.537	8.558
(U)	Current PBR/President's Budget	0.000	8.464	2.294
(U)	Total Adjustments	0.000	-0.073	
(U)	Congressional Program Reductions		-0.073	
	Congressional Rescissions			
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603850F Integrated Broadcast Service (DEM/VAL)**	**4778 Integrated Broadcast Service**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4778 Integrated Broadcast Service	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

In FY 03, the Air Force funds this ACTD in the Joint Expeditionary Force Experiment (JEFX) program (PE 0207028F).

(U) A. Mission Description and Budget Item Justification

The Air Force's Blue Force Tracking ACTD is a continuation of an ACTD started in 2003. Because the ground forces use different communications and distribution methods to develop the Blue Force ground picture, there are latency and granularity problems in the Blue Force ground picture, resulting in a lack of data interoperability. This ACTD will develop, integrate, and sustain web-enable Common Operating Picture (COP) capabilities for Blue Force Tracking that will be interoperable with Service systems. All candidate solutions for these capabilities will be tested under this ACTD before migration to the Service for sustainment.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) Accomplishments/Planned Program	0.000	0.000	
(U) No Activity	0.000		
(U) Training, Tactics, Procedure (TTP)/CONOP Development			
(U) Field Tests			
(U) Spiral 3 software development			
(U) Total Cost	0.000	0.000	0.000

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost

(U) Not applicable.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603850F Integrated Broadcast Service (DEM/VAL)**	**5151 Blue Force Tracking**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5151 Blue Force Tracking	0.000	8.464	2.294	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

In FY2004, Project Number 635151, Joint Blue Force Situation Awareness (JBFSA) ACTD, efforts were transferred from PE0207028F, Joint Expeditionary Force Experiment (JEFX), Project Number 674991, Joint Distributed Engineering Plant.

(U) A. Mission Description and Budget Item Justification

Joint Blue Force Situation Awareness (JBFSA) ACTD - The JBFSA ACTD is a continuation of an ACTD started in 2003. Because the ground forces use different communications and distribution methods to develop the Blue Force ground picture, there are latency and granularity problems in the Blue Force ground picture, resulting in a lack of data interoperability. This ACTD will develop, integrate, and sustain web-enabled Common Operating Picture (COP) capabilities for Blue Force Tracking that will be interoperable with Service systems. All candidate solutions for these capabilities will be tested under this ACTD before migration to the Service for sustainment. The ACTD begins transition and starts Extended User Evaluation (EUE). The ACTD begins work solving coalition and multi-level security issues.

FIOP - The Family of Interoperable Operational Pictures is a program designed to implement web-based technologies into Systems of Record, making their data and thus the Common operational and tactical pictures consistent throughout the Services and at all echelons of Combat Operations. The Joint Requirements Oversight Council (JROC) directed"...provide an all source picture of the Battlespace containing actionable decision quality information through the fusion of existing databases." in JROC Memorandum 156-02. Ultimately, the efforts described will lead to the underpinnings of Network Centric Operational Warfare.

FIOP Joint Blue Force Situational Awareness (JBFSA) - Many DoD systems provide data regarding friendly forces. There is no single system or mission application that provides a totally integrated (i.e. all blue force data) set of data to the warfighter. This task will perform the systems engineering, architecture development and integration activities leading to a secure, web-based blue force data dissemination network service. This task is being led by the Army and is being done in coordination with the Blue Force Tracking and Single Integrated Ground Picture programs and the Joint Blue Force Situational Awareness Advanced Concept Technology Demonstration.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) Accomplishments Planned Program	0.000	0.000	0.000
(U) No Activity	0.000		
(U) Engineering, Integration & Testing		1.767	0.920
(U) Demonstration/Exercise Support			0.339
(U) CONOPS/Tactics, Techniques, and Procedures (TTP) & Documentation Development		0.180	0.230
(U) Purchase/Lease and Installation of BFT Devices, Training, and Purchase of Satellite Communications (SATCOM) air time		0.500	

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603850F Integrated Broadcast Service (DEM/VAL)**	PROJECT NUMBER AND TITLE **5151 Blue Force Tracking**

(U)	Transition Support			0.575
(U)	SPO Operations		0.230	0.230
(U)	FIOP Joint Blue Force Situational Awareness Integrated Architecture Development and Interoperability enhancements		5.787	0.000
(U)	Total Cost	0.000	8.464	2.294

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Not Applicable									

The funding for the FIOP effort for the future years has been transferred to PE 0207443, Family of Interoperable Operational Pictures.

(U) D. Acquisition Strategy

The Acquisition Strategy for this effort will be to use existing precompeted contracts and add task/delivery orders to them.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2004**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603924F High Energy Laser Advanced Technology Program

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	0.000	10.818	8.547	6.136	3.826	3.887	3.958	0.000	0.000
5095	High Energy Laser Advanced Technology Program	0.000	10.818	8.547	6.136	3.826	3.887	3.958	0.000	0.000

Note: In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the High Energy Laser (HEL) Joint Technology Office (JTO).

(U) A. Mission Description and Budget Item Justification

This program funds HEL advanced technology development through the HEL JTO. HEL weapon systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DOD HEL Science and Technology program. In general, efforts funded under this program are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, beam control, optics, propagation, and free electron lasers.

This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	10.910	8.569
(U)	Current PBR/President's Budget	0.000	10.818	8.547
(U)	Total Adjustments	0.000	-0.092	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-0.092	
	Congressional Increases			
	Reprogrammings			
	SBIR/STTR Transfer			

(U) Significant Program Changes:

In FY 2004, this program was transferred to the Air Force by the Office of the Secretary of Defense. The Air Force continues the tri-Service operation of the program under the HEL JTO.

Exhibit R-2a, RDT&E Project Justification			DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603924F High Energy Laser Advanced Technology Program**	PROJECT NUMBER AND TITLE **5095 High Energy Laser Advanced Technology Program**	

	Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5095	High Energy Laser Advanced Technology Program	0.000	10.818	8.547	6.136	3.826	3.887	3.958	0.000	0.000
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds HEL advanced technology development through the HEL JTO. HEL weapon systems have many potential advantages, including speed-of-light velocity, high precision, significant magazine depth, low-cost per kill, and reduced logistics requirements. As a result, HELs have the potential to perform a wide variety of military missions including interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. This program is part of an overall DOD HEL Science and Technology program. In general, efforts funded under this program are chosen for their potential to have major impact on multiple HEL systems and on multiple Service missions while complementing Service/Agency programs that are directed at more specific Service needs. A broad range of technologies are addressed in key areas such as chemical lasers, solid state lasers, beam control, optics, propagation, and free electron lasers.

This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) In FY 2003, this activity was performed under PE 0603924D8Z, High Energy Laser Research. The FY 2003 funding was approximately $13.6 million.			
(U)			
(U) MAJOR THRUST: Develop solid state lasers that have potential as future high energy laser (HEL) weapon laser devices because of their inherent small size and the fact that they require only electrical energy in order to run, thereby greatly simplifying systems engineering and supportability.	0.000	5.500	5.500
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Participate in the Joint High Power Solid State Laser project to accelerate the demonstration of solid state lasers at initial weapon grade power levels. Continue development of a 25 kilowatt solid state laboratory laser. Begin development of a design for a 100 kilowatt laser. Begin assembly of successful pieces from individual applied research projects (e.g., reliable pump diode lasers, diode-laser drivers, thin-disk amplifiers, phase-conjugate mirrors, mist cooling) into an advanced demonstration of solid state laser sub-systems scalable to weapon power levels.			
(U) In FY 2005: Participate in the Joint High Power Solid State Laser project to demonstrate a 25 kilowatt laser. Continue development of a design for a 100 kilowatt laser. Factors such as performance, cost, etc. will be evaluated between the various approaches funded by the Army, Air Force, and High Energy Laser Joint Technology Office. Continue to assemble successful pieces from individual applied research projects (e.g., reliable pump diode lasers,			

Exhibit R-2a, RDT&E Project Justification	DATE February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603924F High Energy Laser Advanced Technology Program**	**5095 High Energy Laser Advanced Technology Program**

	diode-laser drivers, thin-disk amplifiers, phase-conjugate mirrors, mist cooling) into an advanced demonstration of solid state laser sub-systems.			
(U)				
(U)	MAJOR THRUST: Develop beam-control technologies for surface, air, and space mission areas, as well as develop supporting technologies.	0.000	2.718	1.447
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Using successful pieces from individual applied research projects (e.g., deformable mirrors, wavefront sensors, advanced tracking and compensation algorithms) begin to develop a fieldable, sub-scale tactical beam-control system.			
(U)	In FY 2005: Using successful pieces from individual applied research projects; such as deformable mirrors, wavefront sensors, advanced tracking and compensation algorithms; continue to develop a fieldable, sub-scale tactical beam-control system.	0.000	0.800	0.800
(U)				
(U)	MAJOR THRUST: Develop free electron laser (FEL) technologies that scale to high power and permit FELs to be fielded on military platforms.			
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Begin designing and planning tests of a scalable FEL that can be operated on a military platform (e.g., a ship).			
(U)	In FY 2005: Continue designing and planning tests of a scalable FEL that can be operated on a military platform (e.g., a ship).			
(U)				
(U)	MAJOR THRUST: Develop chemical laser advanced technologies and concepts that allow higher performance and more supportable chemical lasers.	0.000	1.800	0.800
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Begin development of an integrated closed-cycle chemical laser device of high power, to include realistic capability to regenerate spent laser fuels.			
(U)	In FY 2005: Demonstrate an integrated closed-cycle chemical laser device of high power, to include realistic capability to regenerate spent laser fuels.			
(U)	Total Cost	0.000	10.818	8.547

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603924F High Energy Laser Advanced Technology Program**	PROJECT NUMBER AND TITLE **5095 High Energy Laser Advanced Technology Program**

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

		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U)	PE 0602500F, Multi-Disciplinary Space Technology.									
(U)	PE 0602890F, High Energy Laser Research.									
(U)	PE 0603444F, Maui Space Surveillance System.									
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.									
(U)	PE 0603605F, Advanced Weapons Technology.									
(U)	PE 0601108F, High Energy Laser Research Initiatives.									
(U)	PE 0603883C, Ballistic Missile Defense Boost Phase Segment.									
(U)	PE 0602605F, Directed Energy Technology.									
(U)	PE 0602307A, Advanced Weapons Technology.									
(U)	PE 0602114N, Power Projection Applied Research.									
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603924F High Energy Laser Advanced Technology Program**	PROJECT NUMBER AND TITLE **5095 High Energy Laser Advanced Technology Program**

Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2004

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0804757F JOINT NATIONAL TRAINING CENTER

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.000	2.915	2.939	2.908	3.003	2.997	3.085	Continuing	TBD
5124 Training Transformation	0.000	2.915	2.939	2.908	3.003	2.997	3.085	Continuing	TBD

In FY04 84757F, Joint National Training Capability, was a new PE and included new start efforts.

(U) A. Mission Description and Budget Item Justification

Supports the SECDEF's Transformation in Training/Joint National Training Capability (JNTC). Develops capabilities that integrate live, virtual, and constructive elements into a seamless joint training environment. Using a scientific and phased approach, researches new technologies and methods that provide a crucial technology-based foundation supporting all JNTC operations.

This program is in budget activity 3 - Advanced Technology Demonstration because it supports rapid transformation of Department of Defense training into a Joint National Training Capability.

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	0.000	2.940	2.947
(U)	Current PBR/President's Budget	0.000	2.915	2.939
(U)	Total Adjustments	0.000	-0.025	
(U)	Congressional Program Reductions	0.000		
	Congressional Rescissions	0.000	-0.025	
	Congressional Increases	0.000		
	Reprogrammings	0.000		
	SBIR/STTR Transfer	0.000		

(U) Significant Program Changes:

Exhibit R-2a, RDT&E Project Justification

DATE
February 2004

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0804757F JOINT NATIONAL TRAINING CENTER**	**5124 Training Transformation**

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
5124 Training Transformation	0.000	2.915	2.939	2.908	3.003	2.997	3.085	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) **A. Mission Description and Budget Item Justification**

Supports the SECDEF's Transformation in Training/Joint National Training Capability (JNTC). Develops capabilities that integrate live, virtual, and constructive elements into a seamless joint training environment. Using a scientific and phased approach, researches new technologies and methods that provide a crucial technology-based foundation supporting all JNTC operations.

This program is in budget activity 3 - Advanced Technology Demonstration because it supports rapid transformation of Department of Defense training into a Joint National Training Capability.

(U) **B. Accomplishments/Planned Program ($ in Millions)**	FY 2003	FY 2004	FY 2005
(U) Begin Close Combat Tactical Trainer Upgrades for Tactical Air Control Party (TACP) Training	0.000	0.840	0.000
(U) Begin/Continue Air Force Modeling and Simulation Tool Kit (AFMSTT) Air Warfare Simulation (AWSIM) Upgrades	0.000	0.865	0.875
(U) Begin/Continue Test & Evaluation Network Architecture (TENA)	0.000	0.500	0.875
(U) Begin Tactical Air Data Info Link (TADIL) Joint Fix (J Fix)	0.000	0.023	0.000
(U) Begin High Level Architecture (HLA) Transfer	0.000	0.040	0.000
(U) Begin TADIL - J Link-16 Capability	0.000	0.182	0.000
(U) Begin/Continue Theater Battle Management Communications System (TBMCS)	0.000	0.227	0.939
(U) Begin/Continue basic operating support, system acquisition, engineering support and development studies/efforts		0.238	0.250
(U) Total Cost	0.000	2.915	2.939

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0604735F, Combat Training Ranges	15.244	24.077	18.714	17.490	17.935	18.454	18.732	Continuing	TBD
(U) PE 0207429F, Combat Training Range Equipment	49.834	94.329	32.189	34.667	35.564	37.109	37.772	Continuing	TBD

(U) **D. Acquisition Strategy**

The acquisition strategy will be competitive, with cost plus fixed fee and firm fixed price contracts.