DEPARTMENT OF THE AIR FORCE

FISCAL YEAR (FY) 2006/2007 BUDGET ESTIMATES

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

DESCRIPTIVE SUMMARIES, VOLUME I

SCIENTIFIC AND TECHNOLOGY BUDGET ACTIVITIES 1 - 3

FEBRUARY 2005

Fiscal Year 2006 Budget Estimates
RDT&E Descriptive Summaries, Volume I
Scientific and Technology Budget Activities 1 - 3
February 2005

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 2006 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 2006 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.

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ALPHABETICAL LISTING

PROGRAM ELEMENT COMPARISON SUMMARY

PROGRAM ELEMENT (By BUDGET ACTIVITY)

BUDGET ACTIVITY #1: BASIC RESEARCH (Volume 1)		REMARKS
None		
BUDGET ACTIVITY #2: APPLIED RESEARCH (Volume 1)		
0602201F	Aerospace Vehicle Technologies	In FY 2006 and out, Project 2403, increased funding is due to increased emphasis being placed on incorporating data from air vehicle monitoring components into flight control.
0602202F	Human Effectiveness Applied Research	In FY 2006, Deployment and Sustainment efforts will move from Project 1710 to Project 7184.
0602204F	Aerospace Sensors	In FY 2006, efforts in Project 5016 will transfer to Project 2002 within this PE. Also in FY 2006, efforts in Project 5017 will transfer to Project 7622 within this PE.
0602500F	Multi-Disciplinary Space Technology	In FY 2006, Project 5082, efforts in Project 5081 move to this project and the Air Force increased emphasis on developing optical networks for space-based applications.
0602601F	Space Technology	In FY 2006, Project 4846, decrease in funding is due to higher Air Force priorities.
0602602F	Conventional Munitions	In FY 2006, funding increased to support added emphasis on Battlefield Air Operations efforts.
0602702F	Command Control and Communications	In FY 2006 and out, increased funding reflects increased emphasis on developing high payoff applications of information technologies to meet C3 needs. In FY 2006, efforts in Project 4917 move into Project 4594, Project 4519, and Project 5581 in this PE.
0602805F	Dual Use Science and Technology Program	In FY 2006, this PE will be cancelled as a result of higher Air Force priorities.
BUDGET ACTIVITY #3: ADVANCED TECHNOLOGY DEVELOPMENT (Volume 1)		
0603203F	Advanced Aerospace Sensors	In FY 2006, efforts in Project 5019 will transfer to Project 665A within this PE.
0603211F	Aerospace Technology Dev/Demo	In FY 2006, efforts from Project 486U transfer into Project 4920 within this PE.
0603216F	Aerospace Propulsion and Power Technology	In FY 2006-2007, Project 4921, a portion of the funding in this project was shifted to Project 5098 in this PE.
0603216F	Aerospace Propulsion and Power Technology	In FY 2006-2007, Project 5098, funds were shifted to accelerate the Air Force scramjet flight demonstration efforts. In 2007, funding increases to support ground demonstrations and fabricate test vehicles for out-year flight demonstrations.

0603231F	Crew Systems and Personnel Protection Technology	In FY 2006, Helmet-Mounted Sensory Technologies and Logistics Readiness and Sustainment efforts will move from Projects 3257 and 4923, respectively, to Project 2830.
0603400F	Joint Unmanned Combat Air Systems (J-UCAS)	In FY 2006, the Joint Unmanned Combat Air Systems (J-UCAS) program was transferred from the Defense Advanced Research Projects Agency (DARPA) to be a joint program led by the Air Force with Navy representation. The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PE 0603400D8Z to PE 0603400F.
0603789F	C3I Advanced Development	In FY 2006, Project 4872, increased funding in FY 2006 and out reflects increased emphasis on developing high payoff information distribution and effects-based planning technologies. In FY 2006, efforts from Project 4925 moves to this Project.
0804757F	Joint National Training Center	In FY 2006 and beyond, this PE transfers to BA07. All FY06 and beyond funding is identified in the same PE84757F but in BA07.

BUDGET ACTIVITY #4: ADVANCED COMPONENT DEVELOPMENT AND PROTOTYPE (Volume 2)

0603851F	Intercontinental Ballistic Missile	In FY 2006 and beyond, Project 1024 ICBM Command & Control (C2) Applications is discontinued. In FY 2006 and FY2007, Project 4209 Long Range Planning includes concept refinement and pre-Milestone A activities for follow on Land-Based Strategic Deterrent capability. In FY 2006 and FY 2007 project includes concept refinement and pre-Milestone A activities for follow on Land-Based Strategic Deterrent (LBSD) capability."
0604400F	Joint Unmanned Combat Air Systems (J-UCAS)	In FY 2006 the Joint Unmanned Combat Air Systems (J-UCAS) program was transferred from the Defense Advanced Research Projects Agency (DARPA) to be a joint program led by the Air Force with Navy representation. The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PE 0604400D8Z to PE 0604400F.

BUDGET ACTIVITY #5: SYSTEM DEVELOPMENT AND DEMONSTRATION (SDD) (Volume 2)

0207256F	Unmanned Combat Air Vehicle Joint Program Office	In FY 2006, the Joint Unmanned Combat Air Systems (J-UCAS) program was transferred from the Defense Advanced Research Projects Agency (DARPA) to be a joint program led by the Air Force with Navy representation. The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PEs 0603400D8Z and 0604400D8Z to PEs 0603400F and 0604400F, respectively.

0207434F	Link-16 Support and Sustainment	In FY 2006, Project #655049 funding will merge with Project #655050 since Project #655049 efforts include the development and deployment of Tactical Data Links, which is accomplished in Project #655050. This will result in the elimination of Project #655049
0207443F	Family of Interoperable Operational Pictures (FIOP)	In FY06, Family of Interoperable Operational Pictures (FIOP) has been terminated. The Air Force will leverage the Single Integrated Air Picture (SIAP) systems engineering process and the Joint Capabilities Integration and Development System (JCIDS) process to determine and implement the Common Operational Picture (COP) standard to inform the next development milestone for the Joint Command and Control program of record. In FY07, Project #655187, Single Integrated Air Picture (SIAP) funding will transfer to a new PE and Project number.
0207450F	E-10 Squadrons	In FY 2006, this PE was renamed E-10 Squadrons (formerly Multi-sensor Command and Control Aircraft [MC2A]). The name was changed to directly associate the PE title with the E-10A, the approved Mission Design Series (MDS) designation for the MC2A. In FY 2006, Project Number 5131, MC2A Airframe, was changed to Airframe since the term MC2A was no longer being used to identify the aircraft and the new PE title already referenced the aircraft type. In FY 2006, Project Number 5132, MC2A Sensors, was changed to Sensors since the term MC2A was no longer being used to identify the aircraft and the new PE title already referenced the aircraft type.
0604240F	B-2 Advanced Technology Bomber	In FY 2006: B-2 Advanced Technology Bomber adds the Proximity Sensor Logic Unit (PSLU) and Oxygen Generation and Distribution System (OGADS) new start programs. In FY 2006: The FY03 National Defense Authorization Act (NDAA) language directed T&E centers to charge only direct costs beginning in FY06; this resulted in a zero-balance transfer (ZBT) of funding over the FYDP from the customer accounts (for indirect test costs) to T&E support, PE 65807F.
0604270F	Electronic Warfare Development	In FY 2006, Project 8462, Airborne Electronic Attack transfers from Project 658462 (formerly called Airborne Electronic Attack) to PE 0604429F, Airborne Electronic Attack, Project 655192, Network and System-of-Systems Development and Project 655193, B-52 Stand-off Jammer. Project 658462 continues to develop the Miniature Air Launched Decoy (MALD).
0604429F	Airborne Electronic Attack	In FY 2006, this is a new PE. In FY 2006, Project 655192, Network and System-of-Systems Development and Project 655193, B-52 Stand-Off Jammer, efforts were transferred from PE 0604270F, Electronic Warfare Development, Project 658462, Airborne Electronic Attack, in order to continue development of critical electronic attack capabilities.

0604604F	Submunitions	In FY 2006, the FY03 National Defense Authorization Act language directed Test & Evaluation (T&E) centers to charge only direct costs beginning in FY06. This resulted in a zero balance transfer (ZBT) of funding over the FYDP from the customer accounts (for indirect test costs) to T&E support, PE 65807F. For this PE, the T&E funding alignment begins in FY08.
0604617F	Agile Combat Support	In FY 2006, Project 2895, Civil Engineering Readiness (CE), includes new start efforts.
0604731F	Unmanned Combat Air Vehicle (UCAV)	In FY 2006 the Joint Unmanned Combat Air Systems (J-UCAS) program was transferred from the Defense Advanced Research Projects Agency (DARPA) to be a joint program led by the Air Force with Navy representation. The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PEs 0603400D8Z and 0604400D8Z to PEs 0603400F and 0604400F, respectively.

BUDGET ACTIVITY #6: RDT&E MANAGEMENT SUPPORT (Volume 2)

0604759F	Major T&E Investment	In FY 2006, Project 4597, Air Force Test Investments, includes new start efforts
0605807F	Test and Evaluation Support	In FY 2006, Project 6606TS, Test and Evaluation Support, includes a new start effort

BUDGET ACTIVITY #7: OPERATIONAL SYSTEM DEVELOPMENT (Volume 3)

0207601F	USAF Modeling and Simulation	In FY 2006, PE 0207601F, United States Air Force (USAF) Modeling & Simulation (M&S) was aligned to better support customer needs into four thrusts. This resulted in project 4567, being renamed from the Joint Synthetic Battlespace (JSB) Environment to M&S Foundations (MSF); project 4991, being renamed from the Joint Distributed Engineering Plant to Accelerated Acquisitions (AA); project 5004, being renamed from Joint Model Transition to New and Emerging Warfighting Capabilities (NEWC), and project 5135, being renamed from Distributed Mission Operations to Warfighter Readiness (WR). The four thrusts enable the communities of interest to focus and prioritize the PE's capabilities.
0304260F	Airborne SIGINT Enterprise (JMIP)	In FY 2006, this is a new PE, but this effort is not a new start. This PE combines SIGINT development efforts previously being accomplished in multiple USAF PEs. The funds in this PE came from USAF SIGINT RDT&E efforts previously resident in three other PEs: Global Hawk (0305220F); U-2 (0305202F): and Airborne Reconnaissance Systems (0305206F) Project 4882 Compass Bright. The funds were then redistributed (with inflation adjustment) among all seven ASE BPACs based on new development priorities established by the USAF SIGINT Capabilities Working Group in order to build a total capability. Global Hawk SIGINT RDT&E funds were the Joint SIGINT Avionics Family (JSAF) funds that were placed in that PE when JSAF was terminated in 2001. These funds made up all of the dedicated SIGINT RDT&E funds in the USAF. This program element will participate in the development, testing, and implementation of international standards (to include NATO standardization agreements) to ensure joint, allied, and coalition interoperability.

0305206F	Airborne Reconnaissance Systems (JMIP)	In FY 2006-2009, Project Number 674882, Compass Bright, efforts will be transferred from PE0305206F, Airborne Reconnaissance Systems, to PE 0304260F, Airborne SIGINT Enterprice, Project 675185, in order to consolidate this SIGINT development effort with other AF SIGINT development efforts. In FY 2006, Project Number 675038, Network Centric Collaborative Targeting ACTD completes.
0305220F	Global Hawk UAV (JMIP)	In FY 2006, Signals Intelligence (SIGINT) development and integration funding for all platforms, including Global Hawk, transfers to the Airborne SIGINT Enterprise PE 0304260F.
0305221F	Network-Centric Collaborative Target (TIARA)	In FY 2006, Proj 675197, Network Centric Collaborative Targeting (NCCT) (TIARA), efforts were transferred from PE 0305206F, Airborne Reconnaissance Systems, Proj 675038, NCCT in order to transition NCCT capabilities from an Advanced Concept & Technology Demonstration to operational system fielding.
0708610F	Logistics Information Technology (LOGIT)	In FY 2006, Project 5208, Expeditionary Combat Support System (ECSS), efforts were transferred from PE0708611F, Support Systems Development, Project 4654, Integrated Maintenance Data System and Project 5044, Log Application Integrated Logistics System - Supply, in order to support the Enterprise Resource Planning (ERP) technical solution (named ECSS) and provide enhanced visibility and management oversight.
0708611F	Support Systems Development	In FY 2006, Project 4654, Integrated Maintenance Data System and Project 5044, Log Application Integrated Logistics System - Supply efforts were transferred to PE 0708610F, Logistics Information Technology, Project 5208, Expeditionary Combat Support System (ECSS), in order to support the Enterprise Resource Planning (ERP) technical solution (named ECSS) and provide enhanced visibility and management oversight. The small amount of funds remaining for projects 4654 (FY 2006, 2010, and 2011) and 5044 (FY 2007, 2008, 2009 and 2011) is due to a database error and will be corrected during the FY 2007 budget cycle.
0804757F	Joint National Training Center	FY 2006 includes new start efforts. This PE is also in BA03 for FY04 and FY05 efforts and will move to BA07 for FY06 and out efforts.
0901202F	Joint Personnel Recovery Agency	In FY 2006, this is a new PE.
0901220F	Personnel Administration	In FY 2006, PE 0901220F, Personnel Administration, includes new start RDT&E efforts.

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
0101314F	Night Fist

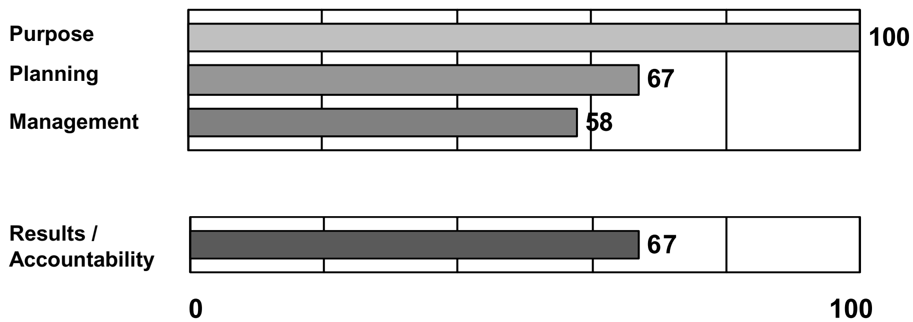
Program: *DoD Applied Research Program*

Rating: *Moderately Effective*

Program Type: *Research and Development*

Agency: *Department of Defense--Military*

Bureau:



Key Performance Measures from Latest PART

Measure	Year	Target	Actual
Long-term Efficiency Measure: Reduce by half within three years, grant and contract award funding not (1) resulting from needs identified by military or technical experts within the Services or Agencies and (2) awarded through the merit-review process. Currently about $1.0 B/yr.	2006	<$800 M	
	2007	<$500 M	
	2008	<$500 M	
Annual Measure: Percentage of ambitiously chosen Defense Technology Objectives (DTO) targets achieved.	2005	70%	
	2006	70%	
	2007	70%	
	2008	70%	
Annual Measure: Portion of external technology area review panels that are fully independent (all external reviewers).	2006	100%	
	2007	100%	
	2008	100%	

Program Summary:

The Department of Defense's Applied Research program supports systematic, scientific study to gain understanding necessary to determine how the Department's military mission can be accomplished more effectively or more efficiently. Applied research often takes the results of basic research investments and carries them forward to determine the operational parameters of potential technologies and evaluate the practicality of applying those technologies to military needs.

The assessment of the Applied Research program found that:

- The program purpose and design are clear. The Department has built methodical processes for setting program goals and for reviewing progress. The program is designed to ensure that warfighters have superior and affordable technology to support their missions and to provide revolutionary war-winning capabilities.
- Reviews of the program by external review panels are not independent of program officials.
- A large part of the program is executed either without the benefit of military or scientific expertise in choosing the funded work or without allowing the applications process to be open to all capable researchers. Earmarking of projects in the program has increased in the recent past and has led to these problems.

In response to these findings, the Administration will:

1. Continue to ensure that adequate funding exists to carry promising basic research results into the realm of applied research.
2. Change the expert evaluation process to use fully independent review panels in assessing the performance of the program.
3. 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)

2004 Actual	2005 Estimate	2006 Estimate
4,350	4,850	4,139

Program: *Basic Research*

Agency: *Department of Defense--Military*

Bureau: *Research, Development, Test, and Evaluation*

Rating: *Effective*

Program Type: *Research and Development*

Last Assessed: *2 years ago*

Key Performance Measures from Latest PART	Year	Target	Actual
Annual Measure: 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&later	100%	100%
Annual Measure: 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%	

Update on Follow-up Actions:

Recommended Follow-up Actions	Status
Continue to emphasize the use of independent review panels in assessing the performance of the program.	Completed
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.	Action taken, but not completed

Program Funding Level (in millions of dollars)

2004 Actual	2005 Estimate	2006 Estimate
1,358	1,513	1,319

Program: *DoD Small Business Innovation Research/Technology*

Agency: *Department of Defense--Military*

Bureau: *Research & Development*

Rating: *Results Not Demonstrated*

Program Type: *Research and Development*

Last Assessed: *1 year ago*

Key Performance Measures from Latest PART	*Year*	*Target*	*Actual*
Long-term Measure: Revise the Commercialization Achievement Index (CAI) to eliminate counting of investments as commercialization no later than three years after receiving the first Phase II support. After that, count competitive sales receipts only.	2004	All	
Long-term Measure: Stop funding companies with more than 5 current or past Phase II awards in the last 5 years if the company is in the bottom quartile in the CAI.	2005	All	
Long-term Efficiency Measure: Emphasize commercialization so overall competitively awarded sales to the government (direct or indirect) from resulting products is at least equal to new R&D investment (Phases I-III), as a portfolio of prior 3-8 year investments (rolling average).	2005	TBD	
	2006	TBD	
	2007	TBD	
	2008	TBD	

Recommended Follow-up Actions	*Status*
Change the way companies' past performance is assessed to ensure that it more closely matches the intent of the law.	No action taken
Look for ways to budget explicitly for the program's administrative costs.	No action taken
Seek to get highly successful awardees to enter the mainstream of Defense contracting.	No action taken
Tighten eligibility requirements for accepting proposals from companies and individuals that repeatedly fail to sell resulting products in the marketplace.	No action taken

Update on Follow-up Actions:

The Department of Defense's program management is working with the Military Services and Defense Agencies to determine how to make the changes noted above. The Department is expected to reach agreement on how to implement the changes by the end of 2005.

Program Funding Level (in millions of dollars)

2004 Actual	2005 Estimate	2006 Estimate
1,100	1,133	1,500

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PE NUMBER: 0601102F
PE TITLE: Defense Research Sciences

Exhibit R-2, RDT&E Budget Item Justification

DATE **February 2005**

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601102F Defense Research Sciences

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	210.206	252.113	223.894	245.595	235.963	252.810	257.004	262.005	Continuing	TBD
2301	Physics	25.952	26.009	23.788	27.134	24.377	24.543	24.821	26.414	Continuing	TBD
2302	Solid Mechanics and Structures	11.461	13.159	14.343	16.859	15.446	15.709	16.063	16.388	Continuing	TBD
2303	Chemistry	27.508	30.818	30.116	31.654	29.115	29.115	29.219	29.190	Continuing	TBD
2304	Mathematics and Computing Sciences	28.837	25.437	27.190	30.856	30.509	29.143	29.698	30.203	Continuing	TBD
2305	Electronics	24.654	25.943	28.999	33.367	32.662	36.033	36.686	37.268	Continuing	TBD
2306	Materials	14.803	18.057	18.010	20.017	19.705	20.099	20.456	20.774	Continuing	TBD
2307	Fluid Mechanics	12.676	33.603	11.066	11.901	11.521	11.754	11.985	12.191	Continuing	TBD
2308	Propulsion	15.418	16.715	17.043	18.064	17.783	18.184	18.528	18.839	Continuing	TBD
2311	Space and Information Sciences	20.064	29.895	25.329	26.645	25.107	24.973	25.433	25.849	Continuing	TBD
2312	Biological Sciences	9.130	9.546	9.827	9.886	10.342	10.604	10.803	10.983	Continuing	TBD
2313	Human Performance	12.471	10.503	10.385	10.641	10.488	14.494	14.784	15.044	Continuing	TBD
4113	External Research Programs Interface	7.232	12.428	7.798	8.571	8.908	18.159	18.528	18.862	Continuing	TBD

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 2005, Congress added $2.1 million for Microwave Vacuum Electronic Power Research Initiative, $0.5 million for Non-Lethal Stunning/Immobilizing Weapons, $1.8 million for Corrosion Protection of Aluminum Alloys used in Aircraft, $1.0 million for Quantum Gate, $2.3 million for Nanomaterials Research, Nanomanufacturing for Military Applications, $21.0 million for National Aerospace Leadership Initiative (transferred from PE 0603211F), $2.0 million for National Hypersonic Research Center, $1.0 million for J-P Coal Based Jet Fuel (transferred from PE 0603789F), $2.0 million for Chabot Space and Science Center, $1.0 million for Demonstrating Space Research and Applications, $2.5 million for Network, Information, and Space Security, and $4.9 million for Minority Leaders (transferred from PE 0602204F). 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.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	212.897	217.304	230.536	256.246
(U)	Current PBR/President's Budget	210.206	252.113	223.894	245.595
(U)	Total Adjustments	-2.691	34.809		
(U)	Congressional Program Reductions		-5.050		
	Congressional Rescissions		-2.241		
	Congressional Increases		42.100		
	Reprogrammings	0.600			
	SBIR/STTR Transfer	-3.291			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2005

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2301 Physics	25.952	26.009	23.788	27.134	24.377	24.543	24.821	26.414	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

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

Physics basic research seeks to enable revolutionary advances in and expand the fundamental knowledge supporting laser technologies, sensing, and imaging capabilities, communications and navigational systems, fuels and explosives, and directed energy weapons that are critical to the Air Force. 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 physics.

	FY 2004	FY 2005	FY 2006	FY 2007
(U) B. Accomplishments/Planned Program ($ in Millions)				
(U) MAJOR THRUST: Investigate regulated, broad-spectrum, variable-energy lasers, laser arrays, and multi-aperture adaptive optics.	10.119	8.223	8.317	9.357

(U) In FY 2004: Expanded studies of high power fiber lasers, in particular those using novel material combinations, which support large-core, single-mode fibers. Investigated direct and nonlinear optical methods for combining beams of fiber lasers to achieve power levels needed for multiple directed energy applications. Researched converting wavelengths of high-power laser arrays to values needed for space applications and aircraft protection. Expanded studies of large, lightweight adaptive optics and large aperture telescopes for very high-resolution space surveillance and imaging applications. Extended studies of large aperture adaptive telescopes for very high-resolution deep space imaging. Studied new optical techniques to achieve very large aperture, very wide-band phased array radars in space. Studied 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 applications for infrared countermeasures.

(U) In FY 2006: Continue investigating physical properties of lasers to enable, monitor, and regulate tunable, wide wavelength band lasers. Continue investigating novel tomographic and optical techniques tied to large, multi-aperture, adaptive telescopes and radars. Explore use of directed energy beams for direct-write materials-processing techniques that offer new microelectronics and micromechanics fabrication and packaging capabilities. Continue to examine laser applications for infrared countermeasures.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2301 Physics**

(U)	In FY 2007: Further investigate novel laser materials and configurations to enable efficient, high power, and widely wavelength tunable lasers. Investigate arrays of micro-discharges for laser devices and pumps, as well as other intense light source applications. Further explore use of directed energy beams for direct-write materials-processing techniques that offer new microelectronics and micromechanics fabrication and packaging capabilities. Continue to explore laser 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 efforts were moved to the "atoms, molecules, and particles" Major Thrust in this Project.	8.232	0.000	0.000	0.000
(U)	In FY 2004: Enhanced 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. Expanded research into the physics of 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 to facilitate creation of more compact, lighter weight, portable pulsed power systems in order to power future directed energy weapons. Expanded the understanding of short-pulse intense electric fields' effects on cells and organelles.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Explore high-energy electro-energetic device concepts and 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. Note: In FY 2005, the "high-energy electro-energetics" efforts described earlier in this Project were moved to this Major Thrust.	1.276	11.164	11.332	13.120
(U)	In FY 2004: Expanded investigations into the fundamental interplay between atoms and strong electromagnetic fields to identify potentially new classes of lasers. Continued measuring ultraviolet emission cross-sections from electron impact. Explored uses for laser-cooled and trapped atoms.				
(U)	In FY 2005: Continue to characterize interactions of atoms and molecules in strong electromagnetic fields for laser applications. Examine techniques for precision measurement of atomic and molecular properties, atomic collision processes, and fundamental interactions between atoms, molecules, ions, and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2301 Physics**

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.

(U) In FY 2006: Continue to characterize interactions of atoms and molecules in strong electromagnetic fields. Continue to examine techniques for precision measurement of atomic and molecular properties, atomic collision processes, and fundamental interactions between atoms, molecules, ions, and radiation. Continue exploring dynamic molecular interactions in combustion and high energy density propellants. Continue studies on the stunning effects of short-pulse high intensity electric fields. Continue explorations of high power, high frequency device concepts and studies of new compact pulsed power technologies. Explore use of electron beam generated microwave for, high-bandwidth communications, advanced long-distance covert surveillance, electronic countermeasures, and directed energy weapons. Expand studies of new technologies for generating very high current-density electron beams under high vacuum conditions for new generations of high power microwave weapons concepts. Use atomic physics to study overlap research areas between atomic physics and condensed matter physics (e.g., the study of many body phenomena).

(U) In FY 2007: Continue characterizing the interactions of atoms and molecules in strong electromagnetic fields. Continue to examine techniques for precision measurement of atomic and molecular properties, atomic collision processes, and fundamental interactions between atoms, molecules, ions, and radiation. Continue exploring dynamic molecular interactions in combustion and high energy density propellants. Continue studies on the stunning effects of short-pulse high intensity electric fields. Continue explorations of high power, high frequency device concepts and studies of new compact pulsed power technologies. Continue to explore the use of electron beam generated microwave for high-bandwidth communications, advanced long-distance covert surveillance, electronic countermeasures, and directed energy weapons. Investigate ultra-high current density cathode concepts. Continue study of overlap research areas between atomic physics and condensed matter physics. Resolve basic scientific issues blocking realization of electromagnetic launch concepts.

(U)

(U)	MAJOR THRUST: Advance technologies for space sensors, imaging, identification, and tracking methods, and effective space situational awareness.	3.200	4.045	4.139	4.657

(U) In FY 2004: Conducted research on the interaction of systems and sensors with atmospheric and space environments. Developed models to predict the atmospheric effects on laser propagation. Investigated

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	means to expand models of sensor performance to incorporate measurements of terrestrial and space backgrounds and radiation. Examined methods of using holographic techniques for dynamic correction of distortion and aberration in space surveillance telescopes. Studied methods to enhance hyperspectral imagery using polarization and hypertemporal information.				
(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)	In FY 2006: Continue studying fundamental issues of atmospheric and space environments concerning remote sensing, including propagation, image formation, and image recovery processes. Continue to identify, characterize, and model parameters enabling remote sensing, locating, and precision tracking of objects, particularly from space and of space objects from the ground.				
(U)	In FY 2007: Continue studying fundamental issues of atmospheric and space environments concerning remote sensing, including propagation, image formation, and image recovery processes. Continue to identify, characterize, and model parameters enabling remote sensing, locating, and precision tracking of objects, particularly from space and of space objects from the ground.				
(U)					
(U)	CONGRESSIONAL ADD: Center for Astronomical Active Optics.	0.977	0.000	0.000	0.000
(U)	In FY 2004: Studied 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: National Fotonics Research Center.	1.660	0.000	0.000	0.000
(U)	In FY 2004: Supported fundamental research at the National Photonics Research Center.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Non-lethal Stunning/Immobilizing Weapons Research.	0.488	0.495	0.000	0.000
(U)	In FY 2004: Conducted fundamental scientific investigations in non-lethal stunning and immobilizing weapons research.				
(U)	In FY 2005: Continue accelerated efforts in conducting fundamental scientific investigations in				

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	non-lethal stunning and immobilizing weapons research.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Microwave Vacuum Electronics Power Research Initiative	0.000	2.082	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Re-establish a joint industry-university program for research into Microwave Vacuum Engineering (MVE) and High Power Microwave (HPM) technology.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	25.952	26.009	23.788	27.134

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2302 Solid Mechanics and Structures**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2302 Solid Mechanics and Structures	11.461	13.159	14.343	16.859	15.446	15.709	16.063	16.388	Continuing	TBD
Quantity of RDT&E Articles	0	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. Note: In FY 2005, efforts described later in this Project were moved to this Major Thrust.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Explore the integration of advanced materials (including nano-materials) and devices into turbine engines, air vehicles, space systems, and other weapon systems, and develop new mechanics criteria for system integration. Note: In FY 2005, efforts described later in this Project were moved to this Major Thrust.	2.370	6.240	7.088	7.957

(U) In FY 2004: Enhanced research in the 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 enhance design of multi-functional materials and structures. Developed methods to combine multi-scale modeling and information technology to design new materials and structures. Examined 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.

(U) In FY 2006: Continue research in the areas of diagnostics, prognostics, self-healing, micro-/nano-mechanics, autonomics, and thermal management to enable safer and more durable aerospace structures with improved performance characteristics. Continue research on the autonomics to include the integration of energy harvesting/storage functions into load-bearing structures. Support research to develop the fundamental knowledge required to design and manufacture multifunctional aerospace material systems and devices and to predict their performance and structural integrity. Develop and

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	exploit methods that combine information technology and modeling in the design of new material systems and devices at multiple scales.				
(U)	In FY 2007: Further develop the fundamental knowledge required to design and manufacture multi-functional aerospace material systems and devices and to predict their performance and structural integrity. Expand research in the areas of diagnostics, prognostics, self-healing, micro-/nano-mechanics, autonomics, thermal management, atomic-scale modeling, and energy harvesting to enable safer and more durable aerospace structures with improved performance characteristics. Continue developing and exploiting methods that combine information technology and modeling in the design of new material systems and devices at multiple scales				
(U)					
(U)	MAJOR THRUST: Analyze and model structural fatigue and loss of integrity to mitigate their detrimental impact to Air Force weapon systems. Note: In FY 2005, these efforts were moved to the "structural fatigue and mechanics" Major Thrust in this Project.	4.921	0.000	0.000	0.000
(U)	In FY 2004: Investigated the structural and material aspects of high-cycle metal fatigue and other aging mechanisms. Explored metal fatigue-generation caused by the vibration of compressor and turbine blades. Expanded and enhanced fundamental computer simulations to predict structural response to assorted stimuli. Explored material science research to identify and mitigate material degeneration and degradation. Developed novel system techniques to analyze vehicle integrity.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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). Note: In FY 2005, these efforts were moved to the "structural fatigue and mechanics" Major Thrust in this Project.	4.170	0.000	0.000	0.000
(U)	In FY 2004: Expanded models to predict the interaction between structural motion and high-speed aerodynamics characteristic of UAVs. Further probed the behavior of distributed sensor and actuator systems of aircraft. 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 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2302 Solid Mechanics and Structures**

(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 UAVs.	0.000	6.919	7.255	8.902
(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 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)	In FY 2006: Explore methods for constructing and modeling morphing structures that broaden system operating capabilities. Develop novel actuation devices and materials for applications such as micro-UAV aircraft and space structures. Continue to investigate metal fatigue-generation caused by the vibration of compressors and turbine blades. Develop structural health monitoring techniques and systems. Continue to explore the mechanical and dynamic behavior of micro/nano-scale structures. Explore the exploitation of nonlinear phenomena, such as structural deformation and aero-elastic effects, for novel structural applications.				
(U)	In FY 2007: Continue to explore novel methods for constructing and modeling morphing structures that broaden system operating capabilities. Continue development of novel actuation devices and materials for applications such as micro-UAV aircraft and space structures. Continue to investigate metal fatigue-generation caused by the vibration of compressors and turbine blades. Continue development of structural health monitoring techniques and systems and exploration of mechanical and dynamic behavior of micro/nano-scale structures. Continue exploration of exploitation of nonlinear phenomena, such as structural deformation and aero-elastic effects, for novel structural applications.				
(U)	Total Cost	11.461	13.159	14.343	16.859

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 0602102F, Materials.

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

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

(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 2005**

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2303 Chemistry	27.508	30.818	30.116	31.654	29.115	29.115	29.219	29.190	Continuing	TBD
Quantity of RDT&E Articles	0	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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Research and characterize molecular dynamics, reaction mechanics/interactions, and theoretical chemistry to model, predict, control, and exploit atomic and molecular energetics for advanced fuels, munitions, and countermeasure techniques.	11.468	13.264	13.418	14.347
(U) In FY 2004: Completed modeling efforts of the chemical interactions between air and space systems and the space environment. Explored 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. Developed and validated theoretical methods to predict and design the behavior and properties of nano-structures. Probed 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. Studied the fundamental behavior of new fuels in hydrocarbon-fueled scramjets and combined-cycle engines. Enhanced models of chemically reacting flows associated with hypersonic vehicles. Researched new chemical sources of electronic excited states needed to fuel chemical laser systems. Optimized properties of potential fuels to increase the mass of space payloads and satellite lifetimes.				
(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,				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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advancing high-energy, high density fuels and materials, enhancing space lift, and extending time-on-orbit/station.

(U) In FY 2006: Utilize theoretical chemistry to predict promising new chemicals of interests to the Air Force and to guide their efficient synthesis. Enhance efforts to develop higher performance, less sensitive nanoscale energetic materials for applications in munitions and propellants. Support research to understand, predict, and control the reactivity and flow of energy in molecules to improve exhaust signature detection and control capabilities, and to develop new high-energy, high density chemicals for propellants and propulsion systems, to develop new high-energy chemical laser systems.

(U) In FY 2007: Continue to utilize theoretical chemistry to predict promising new chemicals of interests to the Air Force and to guide their efficient synthesis. Continue to support research to understand, predict, and control the reactivity and flow of energy in molecules to improve exhaust signature detection and control capabilities, to develop new high-energy, high density chemicals for propellants and propulsion systems, and to develop new high-energy chemical laser systems. Continue efforts to develop higher performance, less sensitive nanoscale energetic materials for applications in munitions and propellants.

(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.	9.137	8.737	9.637	9.988

(U) In FY 2004: Developed organic molecules with high optical nonlinearities for protection against laser threats. Explored 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. Researched 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. Focus on enhancing optical nonlinearity of organic molecules for laser protection applications.

(U) In FY 2006: Continue to focus on enhancing optical nonlinearity for laser protection applications. Exploit nanotechnological techniques to develop compact solar arrays, fuels cells, and power storage systems to provide lightweight power sources for space assets. Exploit photorefractive polymer as a medium for wavefront correction in optical communication and imaging.

(U) In FY 2007: Continue to utilize nanotechnology to enhance chemical and physical properties of polymers. Exploit photorefractive polymer as a medium for wavefront correction in optical communication and imaging. Continue to explore flexible structures that can provide functions such as

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	sensing, power generation and storage, electronics, and other functionalities for smart skin and multi-functional structures.				
(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.	5.926	7.032	7.061	7.319
(U)	In FY 2004: Improved theoretical and predictive methods for surface and interfacial chemical processes. Explored the chemical and physical properties of novel lubricants. Assembled novel multi-functional coatings for the corrosion protection of aging aircraft. Developed low-friction, long-life, multi-functional surface structures and coatings. Probed nano-scale surface structures with enhanced energy densities for better weapon system energy storage and delivery. Studied 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. Investigate 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)	In FY 2006: Develop theoretical and predictive methods for the fundamental understanding of the structure and reactivity of surfaces and how surfaces interact with their environment at the interface. Investigate phenomena at surface interfaces, including thin film and alloy growth, friction and wear, lubrication, corrosion and degradation, sensing, electrochemical energy storage, and electrochemically induced reaction products and kinetics. Continue to create and characterize novel multi-functional surface structures, coatings, covers, and lubricants. Continue to investigate nano-scale surface structures and systems for electronic, power, and sensing applications.				
(U)	In FY 2007: Continue developing theoretical and predictive methods for the fundamental understanding of the structure and reactivity of surfaces and how surface interact with their environment at the interface. Continue to investigate phenomena at surface interfaces, including thin film and alloy growth, friction and wear, lubrication, corrosion and degradation, sensing, electrochemical energy storage, and electrochemically induced reaction products and kinetics. Continue to create and characterize novel multi-functional surface structures, coatings, covers, and lubricants. Continue to investigate nano-scale surface structures and systems for electronic, power, and sensing applications.				
(U)					
(U)	CONGRESSIONAL ADD: Corrosion Protection of Aluminum Alloys Used in Aircraft.	0.977	1.785	0.000	0.000
(U)	In FY 2004: Advanced fundamental scientific research to enable, enhance, and exploit corrosion				

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protection of aluminum alloys used in air and space vehicles.

(U) In FY 2005: Conduct research to enable, enhance, and exploit environmentally benign cost-effective coating systems for the protection and prevention of corrosion of aluminum alloys used in air and space vehicles.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	27.508	30.818	30.116	31.654

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0602203F, Aerospace Propulsion.										
(U)	PE 0602500F, Multi-Disciplinary Space Technology.										
(U)	PE 0602601F, Space Technology.										
(U)	PE 0602602F, Conventional Munitions.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematics and Computing Sciences**	

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2304	Mathematics and Computing Sciences	28.837	25.437	27.190	30.856	30.509	29.143	29.698	30.203	Continuing	TBD
	Quantity of RDT&E Articles	0	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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Perform dynamics and control research to develop innovative techniques for design and analysis of control systems enhancing capabilities and performance of advanced air and space systems.	6.387	7.735	8.256	9.543

(U) In FY 2004: Researched cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned aerial vehicles (UAVs), and constellations of small satellites. Developed 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. Explored advances in image processing and sensors applicable to advanced UAV controllers, smart munitions, and non-destructive vehicle testing. Enhanced designs of computational models to analyze natural processes for adaptation to air and space systems. Adapted 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 sensor technologies for use in UAV controllers, smart munitions, and non-destructive vehicle testing. Investigate the adaptation of bio-inspired sensing systems, controls, and computational methods.

(U) In FY 2006: Further explore cooperative control in dynamic, uncertain, adversarial environments with

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	applications to swarms of smart munitions, UAVs, and constellations of small satellites. Continue examining control methodologies to improve non-equilibrium behavior of complex, unsteady fluid systems with applications for combustion, materials processing, and agile autonomous flight. Improve image processing and sensor technologies for use in UAV controllers, smart munitions, and non-destructive vehicle testing. Continue to investigate the adaptation of bio-inspired sensing systems, controls, and computational methods.				
(U)	In FY 2007: Advance techniques for design and analysis of cooperative control systems in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, UAVs, and constellations of small satellites. Continue developing control methodologies to improve non-equilibrium behavior of complex, unsteady fluid systems with applications for combustion, materials processing, and agile autonomous flight. Refine image processing and sensor technologies for use in UAV controllers, smart munitions, and non-destructive vehicle testing. Investigate methods for design and analysis of bio-inspired sensing systems, controls, and computational systems.				
(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: In FY 2005, these efforts were moved to Project 2311 in this Program Element.	2.465	0.000	0.000	0.000
(U)	In FY 2004: Investigated expanding the capability of critical mobile, networked communications through mathematical innovations in signal processing. Explored hybrid radio frequency and optical phenomenology to achieve robust wireless communication. Further delineated the domain of applicability of self-learning and heuristic methods such as super-resolution imaging. Examined the fundamental principles of stochastic and probabilistic analysis to actuate proof-of-concept surveillance/reconnaissance and targeting systems. Examined revolutionary technologies that attain ultra-fast, reliable information exchange. Employed 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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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	6.164	0.000	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2304 Mathematics and Computing Sciences**

	reasoning, intelligence/information assurance, and information fusion. Note: In FY 2005, these efforts were moved to Project 2311 in this Program Element.				
(U)	In FY 2004: Researched 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 developed computational techniques/software for information fusion at the situation refinement and impact assessment levels to provide decision support. Constructed 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. Designed, implemented, and tested quantum computing algorithms and architectures enabling fast, accurate solutions of complex fluid dynamics problems eliminating the need for multiple design iterations and prototype testing. Developed scalable quantum computers for automatic target recognition and target characterization.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Research physical mathematics, applied analysis, and electromagnetics.	6.119	8.257	8.846	10.011
(U)	In FY 2004: Researched developing accurate models of physical phenomena that enhance the fidelity of simulations and predictability of devices. Further investigated the properties of coherently propagating ultra-short laser pulses through the air and their exploitation in areas such as electronic warfare, laser-guided munitions, and irradiation of chemical/biological clouds. Developed algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media. Completed formulating optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluated novel 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 microdetonators. Enhanced 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)	In FY 2006: Develop more accurate models of physical phenomena to enhance the fidelity simulations.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	Investigate properties of coherently propagating ultra-short laser pulses through the atmosphere. Develop algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media. Study the dynamics of transonic/supersonic/hypersonic platforms. Study the design of reconfigurable warheads reconfiguration through suitable placement and of micro-detonators. Improve methods for recognizing and tracking targets and for penetrating coverings or other dispersive media that obscure targets.				
(U)	In FY 2007: Continue to develop more accurate models of physical phenomena to enhance the fidelity simulations. Continue to investigate properties of coherently propagating ultra-short laser pulses through the atmosphere. Continue to develop algorithms to simulate nonlinear optical effects within fiber lasers and nonlinear optical media. Study the dynamics of transonic/supersonic/hypersonic platforms. Further study the design reconfigurable warheads reconfiguration through suitable placement and of micro-detonators. Continue to improve methods for recognizing and tracking targets and for penetrating coverings or other dispersive media that obscure targets.				
(U)					
(U)	MAJOR THRUST: Investigate optimization and discrete mathematics to validate and further advance mathematical methods, algorithms, and models. Note: In FY 2005, these efforts were moved to the "computational and discrete mathematics research" Major Thrust in this Project.	4.314	0.000	0.000	0.000
(U)	In FY 2004: Enhanced research for solving complex problems in system diagnostics/prognostics, air mobility contingencies, and strategic/tactical planning for battlespace information management. Further evaluated anytime algorithms -- those that produce a feasible, but not necessarily optimal, solution. Examined 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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Perform computational mathematics research to develop unique modeling and simulation capabilities to improve designs of advanced Air Force systems. Note: In FY 2005, these efforts were moved to the "computational and discrete mathematics research" Major Thrusts in this Project.	3.388	0.000	0.000	0.000
(U)	In FY 2004: Initiated 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. Developed algorithms for unsteady reactive flow, munitions penetration				

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	and fragmentation, and plasma dynamics for directed energy weapons. Computed the simulation uncertainty in nonlinear models of aerodynamic flows and structural failure predictions.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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	9.445	10.088	11.302
(U)	In FY 2004: Not Applicable.				
(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)	In FY 2006: Continue to solve complex problems in system diagnostics/prognostics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Develop innovative methods and algorithms that will improve modeling and simulation capabilities. Continue to 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. Develop mathematical method for solving large or complex problems in logistics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Continue computing the simulation uncertainty in non-linear models of aerodynamic flows and structural failure predictions.				
(U)	In FY 2007: Continue to solve complex problems in system diagnostics/prognostics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Continue to develop innovative methods and algorithms that will improve modeling and simulation capabilities. Continue to 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 to develop				

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mathematical method for solving large or complex problems in logistics, air mobility contingencies, target tracking, and strategic/tactical planning for battlespace information management. Continue computing the simulation uncertainty in non-linear models of aerodynamic flows and structural failure predictions.

(U)	Total Cost	28.837	25.437	27.190	30.856

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

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

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

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2305	Electronics	24.654	25.943	28.999	33.367	32.662	36.033	36.686	37.268	Continuing	TBD
	Quantity of RDT&E Articles	0	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 2004	FY 2005	FY 2006	FY 2007
(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.	8.295	6.573	6.647	7.727

(U) In FY 2004: Probed intense radio frequency (RF) pulse effects on electronic circuits and systems. Designed, fabricated, and evaluated wide bandgap semiconductor materials to achieve a unique combination of high RF power output, high efficiency, low noise, robustness, and radiation hardness. Evaluated efforts to identify electronic approaches to increasing spacecraft survivability. Enhanced 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. Explored design and potential applications of small satellites (1kg to 100 kg) for rapid access to space and flexible mission capabilities. Researched scientific barriers to component miniaturization, nano-propulsion and power, smart skins, radiation hardening, and quantum effect electronics. Supported joint Air Force-NASA 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 to achieve a unique combination of 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	nano-satellite projects.				
(U)	In FY 2006: Conclude major effort to understand RF pulse effects on electronic circuits. Launch new university center of excellence on radiation effects on electronic materials and devices. Transition the results from basic research efforts to baseline gallium nitride bulk material. Closely review and re-vector, where necessary, the new university nanosatellites projects.				
(U)	In FY 2007: Launch major new initiative in materials and devices for reconfigurable electronics. Conclude research efforts on wide bandgap gallium nitride materials and devices. Link university nanosatellite projects to key DoD and commercial space interests. Organize and conduct a major review on progress and plans toward reconfigurable electronics.				
(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. Note: In FY 2005, these efforts were moved to the "quantum and optoelectronic materials" Major Thrust in this Project.	7.460	0.000	0.000	0.000
(U)	In FY 2004: Pursued 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. Enhanced nano-fabrication technology for unique optoelectronic materials. Assessed basic electronic mechanisms to improve the efficiency and reduce the cooling requirements of lasers and detectors. Evaluated fast multi-band detectors for battlespace characterization. Identified new materials for high efficiency photovoltaic devices, room temperature ferromagnets, and compact, high-power semiconductor lasers.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: In FY 2005, these efforts were moved to the "quantum and optoelectronic materials" Major Thrust in this Project.	2.248	0.000	0.000	0.000
(U)	In FY 2004: Explored ultracompact, micro-photonic, and nano-photonic structures and chip scale optical networks. Expanded investigations of robust monolithic and miniature tetrahertz frequency devices for security, remote sensing, optical communications, and optical signal processing. Initiated terahertz quantum cascade laser research.				
(U)	In FY 2005: Not Applicable.				

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(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Examine optoelectronic memory and persistent spectral hole-burning approaches for enhanced data storage and processing to enable superior strategic awareness. Note: In FY 2005, these efforts were moved to the "quantum and optoelectronic materials" Major Thrust in this Project.	1.503	0.000	0.000	0.000
(U)	In FY 2004: Investigated methods for constructing page-oriented or holographic memory configurations in two- or three-dimensions. Explored methods of buffering, storing, and retrieving data at rates and quantities anticipated for multi-spectral devices. Investigated 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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Investigate quantum and optoelectronic materials and devices, memory, and information processing, as well as nano-science for wide-field spectral sensors and critical, high-speed communication systems in order to achieve communications and spectral dominance of the battlespace to include surveillance, target tracking, and target signature identification. Note: Prior to FY 2005, these activities were covered under other Major Thrusts in this Project.	0.000	13.323	13.070	14.722
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Explore unique nonlinear optical and laser materials and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Explore new concepts, improve efficiencies, 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.				
(U)	In FY 2006: Investigate nonlinear optical and laser materials, devices, and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Explore nanoelectronics, nanophotonics, and other advanced optoelectronic and electronic materials and devices for lower power consumption, high-efficiency lasers wavelength-diverse, high sensitivity detectors. Study advanced optical memory technologies for enhanced data storage. Continue to probe robust monolithic and				

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	miniature terahertz frequency spectrum devices and quantum cascade lasers. Continue to investigate communication network technologies, room temperature ferromagnetic materials, and the interaction of system electronics and sensors with atmospheric and space environments.				
(U)	In FY 2007: Further investigate nonlinear optical and laser materials, devices, and fabrication processes for radiation protection, cloaking and tracking, and target signature identification. Further explore nanoelectronics, nanophotonics, and other advanced optoelectronic and electronic materials and devices for lower power consumption, high-efficiency lasers wavelength-diverse, high sensitivity detectors. Continue to study advanced optical memory technologies for enhanced data storage. Investigate technologies for robust monolithic and miniature terahertz frequency spectrum devices and quantum cascade lasers. Continue to investigate communication network technologies, room temperature ferromagnetic materials, and the interaction of system electronics and sensors with atmospheric and space environments.				
(U)					
(U)	MAJOR THRUST: Exploit advances in nanotechnology to support multi-spectral detection technology and chip scale optical networks. Note: This effort has been broken out from other areas to reflect the increased emphasis being placed on nanotechnology in support of future military capabilities.	0.000	0.000	4.000	5.281
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Explore techniques to control growth of self-assembled quantum structures and connections to these structures for multi-spectral image processing. Develop guided wave and free space optoelectronic device technology and methods for their integration to enable chip scale optical networks that will overcome interconnect problems for military platform networks due to future high-speed information processors. Explore nanophotonic concepts for information processing components and systems.				
(U)	In FY 2007: Further explore techniques to control growth of self-assembled quantum structures and connections to these structures for multi-spectral image processing. Continue developing nanoelectronics and nanophotonics for guided wave and free space optoelectronic device technology and method for their integration to enable chip scale optical networks that will overcome future interconnect problems.				
(U)					
(U)	MAJOR THRUST: Investigate quantum electronic solids phenomena to explore superconducting, magnetic, and nanoscopic materials to produce superconducting tapes for compact power generators and magnets, and for advanced sensing, communications, and signal processing and ultra-dense memory.	3.781	5.056	5.282	5.637
(U)	In FY 2004: Examined superconducting quantum systems for adaptation to quantum computing and				

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encryption. Conducted research on improving high-current, high-temperature superconducting cables and tapes for enhanced power generation and storage on directed energy weapons and space platforms. Furthered 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) In FY 2006: Further examine superconducting quantum computing systems and encryption techniques. Continue to examine methodologies to fabricate high current, high-temperature superconducting materials for enhanced power generation and storage devices. Continue to develop high-temperature magnetic materials for power devices, switches, and bearings in aircraft electrical systems.

(U) In FY 2007: Further examine superconducting quantum computing systems and encryption techniques. Exploit methodologies to fabricate high current, high-temperature superconducting materials for enhanced power generation and storage devices. Continue to develop high-temperature magnetic materials for power devices, switches, and bearings in aircraft electrical systems.

(U)

(U)	CONGRESSIONAL ADD: Thin Film Magnetic Materials.	1.367	0.000	0.000	0.000
(U)	In FY 2004: Studied the fundamental scientific phenomena associated with thin film magnetic materials.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Quantum Gate (SASC Title was "Advanced Research in Quantum Info Tech").	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct basic research in quantum information technology. This research is similar to that conducted with a FY 2004 Congressional add reflected in Project 2311 of this Program Element.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	24.654	25.943	28.999	33.367

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2306 Materials**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2306 Materials	14.803	18.057	18.010	20.017	19.705	20.099	20.456	20.774	Continuing	TBD
Quantity of RDT&E Articles	0	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>	FY 2004	FY 2005	FY 2006	FY 2007
(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. Note: In FY 2005, all non-metallic efforts were combined into a single Major Thrust later in this Project.	4.915	0.000	0.000	0.000
(U) In FY 2004: Optimized the thermal and mechanical stability of oxide composites for aircraft and jet engine blade applications. Extended research on ultra-high temperature ceramic materials for space propulsion and structural systems. Researched the design and optimization of multi-functional ceramic materials to enable structurally enhanced smart systems.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(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. Note: In FY 2005, all non-metallic efforts were combined into a single Major Thrust later in this Project.	2.235	0.000	0.000	0.000
(U) In FY 2004: Further probed the effects of cyclic thermal loads down to cryogenic temperatures on polymer matrix composites in order to increase durability in liquid fuel tank materials. Researched into fiber sizing techniques in glass fiber reinforced structures to minimize the degradation of mechanical and electromagnetic properties due to moisture.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				

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(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Perform non-metallic, ceramic, and hybrid materials research to identify and to design new materials and composites with very-high (>1400F) and ultra-high (>2500F) temperature applications. Create inorganic matrix composites, functional materials (including adhesives/epoxies), and hybrid carbon materials to increase the strength, application, and life span of air and space structural materials. Note: Prior to FY 2005, these efforts were covered under other Major Thrusts earlier in this Project.	0.000	6.439	7.889	9.535
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Optimize the thermal and mechanical stability of oxide ceramic 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 nonoxide ceramic materials. Examine innovative concepts for developing higher temperature and more damage-tolerant organic, inorganic, and polymer matrix composites.				
(U)	In FY 2006: Continue optimizing the thermal and mechanical stability of oxide composites for aircraft and engine applications. Identify new approaches to designing multi-functional structural ceramics materials to enable structurally enhanced smart systems. Investigate high-temperature resistant and lightweight non-oxide ceramic materials. Research on high temperature polymer matrix composites in terms of their durability in harsh environments and its processibility in fabricating high performance structural components. Develop nanomaterials and nanocomposites that will enable reduced system weight and/or size, increased operational lifetime, multi-functional performance of load-bearing aerospace structures.				
(U)	In FY 2007: Continue optimizing the thermal and mechanical stability of oxide ceramic composites for aircraft and engine applications. Exploit new approaches to designing multi-functional structural ceramics materials to enable structurally enhanced smart systems. Continue to investigate high-temperature resistant and lightweight nonoxide ceramic materials. Further examine innovative concepts for developing higher temperature and more damage-tolerant organic, inorganic, and polymer matrix composites. Further develop nanomaterials and nanocomposites that will enable reduced system weight and/or size, increased operational lifetime, multi-functional performance of load-bearing aerospace structures.				
(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.	7.653	9.338	10.121	10.482

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U) In FY 2004: Expanded 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. Developed advanced alloys for multi-functional space systems. Explored scientific bases for computational design to reduce new material experimentation development costs. Developed new models to reduce new material maturity time and to minimize associated costs. Developed 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 time, assess/validate materials design codes, seek integration with design processes, and minimize costs.

(U) In FY 2006: Study lightweight structural materials, refractory metals, intermetallic alloys, amorphous alloys and their composites, and micro-laminated materials for sustainable use in aerospace applications. Develop and verify physics-based, quantitative, predictive models that relate processing, chemistry, and structure with properties and performance of metallic materials.

(U) In FY 2007: Continue studying lightweight structural materials, refractory metals, intermetallic alloys, amorphous alloys and their composites, and micro-laminated materials for sustainable use in aerospace applications. Further develop and verify physics-based, quantitative, predictive models that relate processing, chemistry, and structure with properties and performance of metallic materials.

(U)

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	CONGRESSIONAL ADD: Nanomaterials Research, Nanomanufacturing for Military Applications.	0.000	2.280	0.000	0.000

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Conduct basic research in nanomaterials and nanomanufacturing for potential military application.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	14.803	18.057	18.010	20.017

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602102F, Materials.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2306 Materials**

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

(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 2005**

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2307 Fluid Mechanics	12.676	33.603	11.066	11.901	11.521	11.754	11.985	12.191	Continuing	TBD
Quantity of RDT&E Articles	0	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 perform fundamental experimental investigations and to formulate advanced computational methods for the simulation and study of complex flows, prediction of real gas effects in high-speed flight, and control and prediction of turbulence in flight vehicles and propulsion systems. Primary areas of research investigated by this project are unsteady aerodynamics, supersonic and hypersonic aerodynamics, turbulence, and rotating and internal flows characteristic of turbomachinery flows.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Characterize the critical phenomena in unsteady aerodynamic flows and expand fundamental knowledge of high-speed airflows to optimize air vehicle designs that will revolutionize future weapon systems. Note: In FY 2005, these efforts moved to the "supersonic, hypersonic, unsteady aerodynamics" Major Thrust later in this Project	2.690	0.000	0.000	0.000
(U) In FY 2004: Developed numerical tools and validated the experimental database to determine the effect of unsteady, vortex-dominated flows on the control and flight performance of UAVs. Investigated aero/structure interactions associated with rapid maneuver UAVs. Evaluated tools for the accurate prediction of highly separated flow over complex air vehicle and weapon systems.				
(U) In FY 2005: Not Applicable..				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(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. Note: In FY 2005, these efforts moved to the "supersonic, hypersonic, unsteady aerodynamics" Major Thrust later in this Project.	3.094	0.000	0.000	0.000
(U) In FY 2004: Examined advanced flow control concepts for shock-dominated flows. Pursued aerothermal numerical simulation capabilities to quantify heat transfer and unsteadiness for flight vehicles.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2307 Fluid Mechanics**

(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: Prior to FY 2005, these efforts were covered under other Major Thrusts earlier in this Project.	0.000	4.862	5.040	5.417
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Explore methods to optimize unsteady, vortex-dominated flows and rapid maneuver control on UAVs. Characterize and model hypersonic flows to include boundary layer phenomena, engine inlets, and plasma aerodynamics. Model aerothermal and local shock phenomena in hypersonic flows, control concepts, and performance optimization.				
(U)	In FY 2006: Further explore methods to optimize unsteady, vortex-dominated flows, and rapid maneuver controls on UAVs. Continue to model and validate unsteady hypersonic flow simulation tools to include boundary layer effects, engine inlets, and plasma aerodynamics. Continue to model aerothermal and local shock phenomena in hypersonic flows, with emphasis on control concepts and performance optimization. Explore control strategies for mitigating excessive heat transfer and unsteadiness in hypersonic flows and for abating the effects of highly separated flows.				
(U)	In FY 2007: Exploit methods to optimize unsteady, vortex-dominated flows, and rapid maneuver controls on UAVs. Validate and refine models for unsteady aerodynamics of complex, hypersonic flows to include boundary layer effects, engine inlets, and plasma aerodynamics. Continue to model aerothermal and local shock phenomena in hypersonic flows, control concepts, and performance optimization. Develop control strategy models for mitigating excessive heat transfer and unsteadiness in hypersonic flows and for abating the effects of highly separated flows.				
(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. Note: In FY 2005, these efforts moved to the "turbulence and rotating flows" Major Thrust later in this Project.	2.750	0.000	0.000	0.000
(U)	In FY 2004: Developed approaches for modeling unsteady flow control inputs on aircraft wings and jet engines. Utilized reduced order models for turbulent flow control applications and affordable engineering predictive models for the air vehicle design process. Evaluated promising flow control actuation concepts on realistic geometries in wind tunnel tests. Furthered investigations into flow control-coupling mechanisms in turbulent flows to enable agile flight vehicles.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2307 Fluid Mechanics**

(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Study complex rotating and internal flows characteristic of turbomachinery and jet engine applications. Note: In FY 2005, these efforts moved to the "turbulence and rotating flows" Major Thrust later in this Project	2.190	0.000	0.000	0.000
(U)	In FY 2004: Explored 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. Used large eddy simulation techniques to explore heat transfer and fluid flow coupling in turbine engine flow fields. Investigated detailed flow interactions using flow control measurement and actuation devices for use in harsh environments.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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, with an emphasis on flow control approaches. Note: Prior to FY 2005, these efforts were covered under other Major Thrusts earlier in this Project.	0.000	5.944	6.026	6.484
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Evaluate 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. Apply control approaches to flow interactions using measurement and actuation devices compatible with harsh environments.				
(U)	In FY 2006: Validate studies of advanced flow control coupling mechanisms in complex, turbulent flows. Validate large eddy simulation techniques to probe heat transfer and fluid flow coupling. Continue to model unsteady flow control inputs on wings and jet engines to include reduced order, closed-loop flow control demonstrations. Further explore and develop models for aerodynamic mistuning mechanisms in multiple blade row interactions tied to high cycle fatigue failures. Further develop control approaches for flow interactions using flow control measurement and actuation devices for harsh environments.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2307 Fluid Mechanics**

(U)	In FY 2007: Further evaluate validation studies of advanced flow control coupling mechanisms in complex, turbulent flows, including transient phenomena and time accurate simulation techniques. Further develop large eddy simulation techniques to include heat transfer and fluid flow coupling in preliminary simulations of film cooling flows. Develop predictive tools for unsteady flow control inputs on wings and jet engines. Evaluate coupling between aerodynamic and structural mistuning mechanisms in multiple blade row interactions tied to high cycle fatigue failures. Develop predictive tools for flow control in harsh environments.				
(U)					
(U)	CONGRESSIONAL ADD: National Hypersonic Research Center.	1.952	1.982	0.000	0.000
(U)	In FY 2004: Conduct fundamental scientific and engineering research studies at the National Hypersonics Research Center.				
(U)	In FY 2005: Conduct fundamental scientific and engineering research studies at the National Hypersonics Research Center.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: National Aerospace Leadership Initiative.	0.000	20.815	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Establish a broad based agenda to reinvigorate America's aerospace research and development and maintain America's competitive leadership in aviation.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	12.676	33.603	11.066	11.901

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0602201F, Aerospace Flight Dynamics.										
(U)	PE 0602203F, Aerospace Propulsion.										
(U)	PE 0603211F, Aerospace										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)**

Structures.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2308 Propulsion	15.418	16.715	17.043	18.064	17.783	18.184	18.528	18.839	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

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) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Research and model space propulsion and power in the areas of chemistry, electronics, miniaturization, and contamination/signature. Note: In FY 2005, the plasma efforts in this Major Thrust moved to the "combustion, propulsion, and diagnostics" Major Thrust in this Project.	6.577	7.923	8.478	8.988

(U) In FY 2004: Studied 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. Furthered research into new engine concepts such as pulsed detonation engines, hybrid rockets, and combined cycle engines. Advanced supercritical combustion models and leverage computational capabilities that will enhance the design of new hydrocarbon, cryogenic, and monopropellant-fueled engines. Completed research of plasma turbulence and its effects on the transport coefficients in order to develop a new class of more versatile plasma thrusters. Researched high altitude signature characterization and spacecraft cross-contamination, especially in the presence of multiple thrusters and satellites. Examined magnetohydrodynamic (MHD) flow control to optimize propulsion system flow path performance in scramjets. Investigated lightweight super conducting magnet capability for onboard flight-rated systems needed to achieve MHD flow control of advanced engines. Investigated 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, 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2308 Propulsion**

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.

(U) In FY 2006: Continue studies in plasma-based, charged droplet-based, and beamed-energy thrusters. Continue studies of pulsed detonation rocket engines and other new engine concepts. Evaluate methods to predict and suppress combustion instabilities. Investigate high altitude plumes signature and contamination. Examine MHD flow control to optimize scramjet flow path performance. Continue to investigate lightweight superconducting magnet capability for MHD flow control of advanced engines.

(U) In FY 2007: Continue studies in plasma-based, charged droplet-based, and beamed-energy thrusters. Continue studying pulsed detonation rocket engines and other new engine concepts. Evaluate methods to predict and suppress combustion instabilities. Continue to investigate high altitude plumes signature and contamination. Further examine MHD flow control to optimize scramjet flow path performance. Continue to investigate lightweight superconducting magnet capability for MHD flow control of advanced engines.

(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.	6.352	7.801	8.565	9.076

(U) In FY 2004: Improved laser diagnostic measurement capabilities with expanded agility over limited wavelength ranges for time-resolved characterization of reacting flows. Developed detailed mechanisms for hydrocarbon fuel combustion at elevated pressures. Explored 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) In FY 2006: Continue improving laser diagnostic measurement capabilities in the characterization of turbulent reacting flows. Probe deeper into molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions. Further 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2308 Propulsion**

		FY 2004	FY 2005	FY 2006	FY 2007
	aerodynamic characteristics and propulsive efficiencies. Continue to investigate fuels and propellants that are more energetic, environmentally benign, and less sensitive to accidental detonations.				
(U)	In FY 2007: Continue improving laser diagnostic measurement capabilities in the characterization of turbulent reacting flows. Continue to probe deeper into molecular transport effects causing and enhancing thermal destabilization of hydrocarbon fuels under supercritical thermodynamic conditions. Further incorporate prediction methodologies, which are both quantitatively accurate and computationally tractable, into turbulent combustion models. Further enhance scientific bases for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies. Continue to investigate fuels and propellants that are more energetic, environmentally benign, and less sensitive to accidental detonations.				
(U)					
(U)	CONGRESSIONAL ADD: Coal-derived Jet Fuels.	2.489	0.991	0.000	0.000
(U)	In FY 2004: Researched producing coal-based jet fuels in increasingly larger quantities through refinery trials. Evaluated refinery-produced fuels for large-scale combustion and thermal stability.				
(U)	In FY 2005: Research to produce coal-based jet fuels in increasingly larger quantities through refinery trials. Evaluate refinery-produced fuels for large-scale combustion and thermal stability for use in advanced high-performance engines.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	15.418	16.715	17.043	18.064

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0602203F, Aerospace Propulsion.										
(U)	PE 0602500F, Multi-Disciplinary Space Technology.										
(U)	PE 0602601F, Space Technology.										
(U)	PE 0603211F, Aerospace										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2308 Propulsion**

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

Structures.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE
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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**2311 Space and Information Sciences**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2311 Space and Information Sciences	20.064	29.895	25.329	26.645	25.107	24.973	25.433	25.849	Continuing	TBD
Quantity of RDT&E Articles	0	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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Analyze solar physics and weather to develop techniques for improved space observations and protection of Air Force space assets and operations. Note: In FY 2005, these efforts were moved to "Space Environment Research" Major Thrust later in this Project.	3.554	0.000	0.000	0.000
(U)	In FY 2004: Exploited solar physics models to develop techniques for protecting assets against high-energy plasma ejections. Supported cutting-edge instrumentation development for ground-based solar telescopes. Investigated 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. Defined 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.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Research magnetosphere and ionosphere effects to enhance global surveillance, geolocation, and communication. Note: In FY 2005, these efforts were moved to "Space Environment Research" Major Thrust later in this Project.	3.554	0.000	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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 2004: Expanded deployment of research sensors to observe ionospheric scintillation and worldwide plasma turbulence radio disruptions. Supported scientific analyses of space-based and ground-based data assimilation techniques to modernize ionospheric and space weather forecasting. Designed and examined observational equipment globally to improve capability to observe atmospheric gravity wave interactions with radars, advance electro-optical instrumentation, and light detection and ranging techniques. Exploited 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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Research, characterize, and model space debris to protect Air Force space assets. Note: In FY 2005, these efforts were moved to the "Space Environment Research" Major Thrust later in this Project.	4.261	0.000	0.000	0.000
(U)	In FY 2004: Cataloged and tracked the populations of Near Space/Earth Objects and space debris particles derived from comets and asteroids. Advanced multi-conjugate adaptive optics for unparalleled resolution of small, dim, deep space targets. Furthered developments in astronomical detection and tracking algorithms to enhance space awareness and control capabilities. Expanded development of future space radar surveillance systems using nanotechnology and advanced signal processing algorithms.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: In FY 2005, these efforts were moved to "Space Environment Research" Major Thrust later in this Project.	2.932	0.000	0.000	0.000
(U)	In FY 2004: Created new space environment models and enhanced current theories using data from the Air Force's Communications/Navigation Outage Forecasting System and Solar Mass Ejection Imager (C/NOFS-SMEI) satellite missions. Investigated the theoretical underpinnings of active and passive space environment remediation techniques. Stimulated novel efforts to advance design, study, and development of new sensor technologies to observe cosmic rays and energetic charged particles from deep space in order to better quantify risks to Air Force systems. Researched simulation and				

visualization techniques to simplify complex data analysis and ensure future strategic awareness.
(U) In FY 2005: Not Applicable.
(U) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.
(U)

(U) MAJOR THRUST: Research space environment to improve solar plasma theories and modeling in the areas of solar phenomena, space weather, magneto/ionosphere effects, space debris, adaptive optics for improved space observation, better space-based communications, and the quantifying of risks to space systems. Note: Prior to FY 2005, these efforts were part of other Major Thrusts earlier in this Project.	0.000	8.463	8.664	9.034

(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 C/NOFS-SMEI 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 multi-conjugate 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.
(U) In FY 2006: Explore advanced modeling algorithms to take advantage of increased computer power and speed. Seek improved plasma models to enhance understanding of basic plasma theory. Seek fundamental processes of energetic particle scattering in the near Earth environment to lay groundwork for protection of space assets. Continue investigating solar processes and energetic events, the solar wind, and fundamental processes in the magnetosphere, ionosphere, and thermosphere. Seek understanding of fundamental processes controlling space plasma to improve ability to forecast near Earth space environment. Continue to exploit data from DoD surveillance assets in conjunction with data from C/NOFS-SMEI satellites to improve remote sensing of interplanetary space. Continue developing ground-based optical telescope technologies to include adaptive optics, photon detection, spectral resolution, nanotechnology, advanced signal-processing algorithms, and developing space-based sensor technology. Continue to exploit developments in all-sky imaging and multi-conjugate adaptive optics to obtain visible and infrared observations of ionospheric plasma phenomena, optical clutter, and small, dim, deep space targets.
(U) In FY 2007: Expand development of ground-based optical telescope technologies (i.e., adaptive optics, photon detection, spectral resolution, nanotechnology, and advanced signal-processing algorithms) to include radio telescopes. Continue developing space-based sensor technology. Explore the solar interior

as a complex system through advanced modeling techniques. Continue to explore advanced modeling algorithms to take advantage of increased computer power and speed, and to seek improved plasma models to enhance understanding of basic plasma theory. Develop understanding of fundamental processes of energetic particle scattering in the near Earth environment to support protection of space assets. Continue investigating solar processes and energetic events, the solar wind, and fundamental processes in the magnetosphere, ionosphere, and thermosphere. Seek understanding of fundamental processes controlling space plasma to improve ability to forecast near Earth space environment. Further exploit data from DoD surveillance and the C/NOFS-SMEI satellites to improve remote sensing of interplanetary space. Further employ all-sky imaging to study of ionospheric plasma phenomena.

(U)					
(U)	MAJOR THRUST: Investigate innovative technologies for space-based communication capabilities to ensure continued Air Force space dominance.	0.980	1.000	1.000	1.000
(U)	In FY 2004: Researched innovative methods for optical communications. Began probing novel techniques for potential bandwidth efficient modulation to enhance satellite communications. Started 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. Continue to explore the basic mechanisms of dual polarization antennas for space applications.				
(U)	In FY 2006: Widen consideration of innovative methods for optical communications. Continue to probe novel techniques for potential bandwidth efficient modulation to enhance satellite communications. Continue to explore the basic mechanisms of dual polarization antennas for space applications.				
(U)	In FY 2007: Further examine innovative methods for optical communications such as partial coherence, polarization modulation, and liquid crystal spatial modification techniques. Continue to 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 efforts were covered under Project 2304 in this Program Element.	0.000	4.211	4.306	4.786
(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)	In FY 2006: Further develop data fusion science to enable rapid data conversion across multiple bands into graphical and conceptualized information. Continue to promote methodologies to evaluate the performance of new wireless mobile, networked communications systems. Further assess technical alternatives on the overall feasibility of super-resolution millimeter and search and rescue imagery. Continue to solidify the hybrid radio-frequency/free-space optical paradigm and refine the parameters of other innovative technologies to attain ultra-fast, reliable information exchange. Further develop ultra-wide band transmission technology for hyperspectral and other diverse data.				
(U)	In FY 2007: Further develop data fusion science to enable rapid data conversion across multiple bands into graphical and conceptualized information. Continue to promote methodologies to evaluate the performance of new wireless mobile, networked communications systems. Develop technology for super-resolution millimeter and search and rescue imagery. Further solidify the hybrid radio-frequency/free-space optical paradigm and refine the parameters of other innovative technologies to attain ultra-fast, reliable information exchange. Further develop ultra-wide band transmission technology for hyperspectral and other diverse data.				
(U)					
(U)	MAJOR THRUST: Conduct research in complex systems and algorithms for highly flexible, reliable, secure, and rich information systems supporting battlefield commanders using artificial intelligence, information warfare techniques, intelligent agents, knowledge bases, distributed systems, machine learning, uncertainty reasoning, information assurance, and information fusion. Note: Prior to FY 2005, these efforts were covered under Project 2304 in this Program Element.	0.000	10.770	11.359	11.825
(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 and command and control. Design, implement, and evaluate quantum-computing architectures for fast, accurate solutions of complex fluid dynamics.				
(U)	In FY 2006: Develop information operations science techniques to proactively protect information intensive systems and networks. Further develop information fusion science to provide deep, adaptive, expert decision support. Exploit quantum and bio-computing techniques and algorithms to allow enhanced tracking, recognition, and characterization to improve situational awareness, command and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2311 Space and Information Sciences**

	control, and security. Begin to investigate first principles of software system architectures.				
(U)	In FY 2007: Continue to develop information operations science techniques to proactively protect information intensive systems and networks. Further develop information fusion science to provide deep, adaptive, expert decision support. Exploit quantum and bio-computing techniques and algorithms to allow enhanced tracking, recognition, and characterization to improve situational awareness, command and control, and security. Continue to investigate first principles of software system architectures including characteristic property metrics and begin development of automatic software architecture analysis tools.				
(U)					
(U)	CONGRESSIONAL ADD: Quantum Information Technology.	1.074	0.000	0.000	0.000
(U)	In FY 2004: Conducted fundamental scientific research associated with quantum information technologies.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Information Security and Cyber Counter Terrorism.	1.757	0.000	0.000	0.000
(U)	In FY 2004: Conducted fundamental scientific studies related to information security and cyber counter terrorism.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Chabot Space and Science Center.	1.952	1.982	0.000	0.000
(U)	In FY 2004: Supported the development of astronomical and scientific research and education capabilities at the Chabot Space and Science Center.				
(U)	In FY 2005: Increase the fundamental understanding of the upper atmosphere, as well as education outreach projects to support space science education programs designed to train the next generation of scientists and engineers.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Demonstrating Space Research and Applications	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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: Support educational programming and exhibits that demonstrate the application of defense technology and research.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Network Information and Space Security.	0.000	2.478	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct fundamental multi-disciplinary scientific research associated with network information and space security efforts.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	20.064	29.895	25.329	26.645

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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 Development Space Technology.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2312 Biological Sciences	9.130	9.546	9.827	9.886	10.342	10.604	10.803	10.983	Continuing	TBD
Quantity of RDT&E Articles	0	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 biomineralization. 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Characterize, understand, predict, control, and engineer biomolecular responses induced in organisms by chemical and physical agents of Air Force significance, such as jet fuels, nano-energetic materials, and directed energy. Identify, characterize, and engineer novel enzymatic properties that enable inexpensive and safe manufacture of unique, improved, or hard-to-make aerospace materials. Note: In FY 2004, "biocatalysis and bioenzymatic" efforts were moved from another Major Thrust later in this Project to this Major Thrust.	6.806	5.568	5.633	5.646
(U) In FY 2004: Pursued 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. Extended 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. Extended sensitive genomics and proteomics profiling techniques to studies investigating the cellular and extra cellular effects of chronic and acute low-level exposures of animals to laser and microwave systems.				
(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				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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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) In FY 2006: Refine biokinetics models used to predict the fuel constituent levels in tissues following dermal and pulmonary exposures to fuel mixtures. Continue developing and begin applying methodologies for profiling and modeling the biomolecular responses induced by the interactions of directed energy and nano-energetic materials with biological systems. Begin developing and utilizing biocatalysis techniques for use in genetically engineering photosynthetic microbes to generate fuel-cell hydrogen from water. Begin exploring the dose ranges and kinetics associated with the positive stimulatory or "hormetic" responses of biological systems exposed to very low-levels of known toxic substances and hazardous radiation.

(U) In FY 2007: Experimentally validate biokinetics models used to predict the fuel constituent levels in tissues following dermal and pulmonary exposures to fuel mixtures. Continue profiling and modeling the biomolecular responses induced by the interactions of directed energy and nano-energetic materials with biological systems. Continue utilizing biocatalysis techniques and genetic engineering principles to elicit the water-based generation of fuel-cell hydrogen by photosynthetic microbes. Begin investigating the biomolecular profiles for underlying mechanisms associated with the positive stimulatory or "hormetic" responses of biological systems exposed to very low-levels of known toxic substances and hazardous radiation.

(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.	2.324	3.978	4.194	4.240

(U) In FY 2004: Modeled 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. Enhanced adapting characteristics of microbial and protein-based biosystems for applications to military sensor systems. Explored mimicking natural materials, using organisms as factories of new materials, or taking existing biomaterials and processing them into Air Force useful materials. Studied 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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and biointerfacial sciences to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications.

(U) In FY 2006: Investigate, evaluate, model, and mimic biological processes and designs for future applications in near ambient temperature sensing devices. Probe and manipulate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems. Continue to exploit biomaterial and biointerfacial sciences to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications.

(U) In FY 2007: Continue to investigate, evaluate, model, and mimic biological processes and designs for future applications in near ambient temperature sensing devices. Further probe and manipulate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems. Continue to exploit biomaterial and biointerfacial sciences to synthesize novel materials, evaluate biosensors, and elucidate bionanotechnology applications.

(U) Total Cost	9.130	9.546	9.827	9.886

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2313 Human Performance**	

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2313	Human Performance	12.471	10.503	10.385	10.641	10.488	14.494	14.784	15.044	Continuing	TBD
	Quantity of RDT&E Articles	0	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 2004	FY 2005	FY 2006	FY 2007
(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.	3.414	4.763	5.227	5.382
(U)	In FY 2004: Investigated and modeled theories of sensory and perceptual systems. Evaluated theories and models of perception and cognition for more accurate simulation and improved fusion of sensor data. Examined visual information processing techniques to improve methods for evaluating display designs, enhancing the capability for collaboration, and improving the movement and sharing of information. Used performance metrics to critically test theories of sensory integration to understand complex images. Probed intrinsic differences in humans that make some individuals highly resistant to, and others 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.				
(U)	In FY 2006: Continue to conduct empirical research with mathematical and computational modeling in spatial audition, speech perception, and hearing protection. Further assess multi-sensory integration methods and novel biological sensing mechanisms. Continue to probe biophysical mechanisms				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2313 Human Performance**

responsible for fatigue. Evaluate models of sleep/wake dynamics to predict specific consequences in the performance of an individual warfighter. Study the effects of ultrashort laser pulse on the eye (laser flash blindness).

(U) In FY 2007: Continue empirical research with mathematical and computational modeling in spatial audition, speech perception, and hearing protection. Exploit multi-sensory integration methods and novel biological sensing mechanisms. Continue to probe biophysical mechanisms responsible for fatigue. Further evaluate models of sleep/wake dynamics to predict specific consequences in the performance of an individual warfighter. Further study of the effects of ultrashort laser pulse on the eye (laser flash blindness).

(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.	4.631	5.740	5.158	5.259

(U) In FY 2004: Extended 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. Tested 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) In FY 2006: Develop quantitative models and methods for improved understanding of individual and team information processing and decision making. Assess mechanisms affecting training effectiveness for individuals and teams. Continue modeling relationships between individual skill differences and interactions with envisioned training. Continue to explore measures to avert/mitigate human error and optimize decision making under conditions of uncertainty and information overload.

(U) In FY 2007: Refine quantitative models and methods for an improved understanding of individual and team information processing and decision-making. Continue to assess mechanisms affecting training effectiveness for individuals and teams. Continue modeling relationships between individual skill differences and interactions with envisioned training. Continue exploring measures to avert/mitigate human error and optimize decision making under conditions of uncertainty and information overload.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **2313 Human Performance**

(U)	MAJOR THRUST: Study and test behavioral and physiological theories of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance. Note: In FY 2005, these efforts were moved to the "cognition and perception" Major Thrust earlier in this Project.	4.426	0.000	0.000	0.000
(U)	In FY 2004: Modeled relationships between individual skill differences and interactions with envisioned training techniques. Studied 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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	12.471	10.503	10.385	10.641

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602202F, Human 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 2005**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
01 Basic Research	**0601102F Defense Research Sciences**	**4113 External Research Programs Interface**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4113	External Research Programs Interface	7.232	12.428	7.798	8.571	8.908	18.159	18.528	18.862	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The primary elements in this project are to facilitate interactions between the international and domestic research communities and Air Force researchers and to support and develop scientists and engineers with an awareness of Air Force basic research priorities. These professional interactions and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities to the research community as a whole, and attract talented scientists and engineers to address Air Force needs. International interactions facilitate future interoperability of coalition systems and foster relationships with future coalition partners. This project also seeks to enhance educational interactions with historically black colleges and universities, Hispanic serving institutions, and other minority institutions.

(U)	**B. Accomplishments/Planned Program ($ in Millions)**	FY 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Support the Air Force Research Laboratory international strategy mission. Note: In FY 2005, these efforts were moved to the "international science and technology" Major Thrust later in this Project.	2.559	0.000	0.000	0.000
(U)	In FY 2004: 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 Department of Defense (DoD) organizations.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Support 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. Note: In FY 2005, these efforts were moved to the "international science and technology" Major Thrust later in this Project.	2.620	0.000	0.000	0.000
(U)	In FY 2004: Enabled on-site coordination with international research organizations and supported international visits of high-level DoD delegations. Sustained and funded Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **4113 External Research Programs Interface**

(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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 efforts were part of other Major Thrusts earlier in this Project.	0.000	3.994	4.115	4.520
(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 U.S. 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)	In FY 2006: Provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Capitalize on foreign investments by influencing and acquiring world-class scientific research. Establish and maintain access to technical briefs and publications on unique foreign research and research capabilities. 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)	In FY 2007: Continue to provide centralized cooperation expertise and support international technology liaison missions in order to identify and maintain awareness of foreign science and technology developments. Capitalize on foreign investments by influencing and acquiring world-class scientific research. Establish and maintain access to technical briefs and publications on unique foreign research and research capabilities. Support international visits of high-level DoD delegations and provide primary interface to coordinate international participation among DoD organizations. Assist 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.	2.053	3.577	3.683	4.051
(U)	In FY 2004: Supported scientist and engineering research programs at U.S. colleges and universities,				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **01 Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT NUMBER AND TITLE **4113 External Research Programs Interface**

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 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) In FY 2006: 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) In FY 2007: 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)					
(U)	CONGRESSIONAL ADD: Minority LEADERS.	0.000	4.857	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct research in the areas of both materials and aerospace sensors.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	7.232	12.428	7.798	8.571

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0601103D, University Research Initiative.										
(U) PE 0602102F, Materials.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U) C. Other Program Funding Summary ($ in Millions)

(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.

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Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601103F University Research Initiatives

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	103.981	118.985	105.029	106.353	106.333	115.421	118.103	120.114	Continuing	TBD
5094 University Research Initiatives	103.981	118.985	105.029	106.353	106.333	115.421	118.103	120.114	Continuing	TBD

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. Note: In FY 2005, Congress added $1.1 million for 21st Century Information Operations Workforce; $1.5 million for Agile Response Chameleon Coatings; $3.0 million for Bio/Nanotechnology Infrastructure and Technology Oriented Research; $1.0 million for Griffith Observatory Programming; $1.6 million for Information Security Solutions; $2.5 million for Science, Math and Research for Transformation (SMART) Defense Scholarship Pilot Program (subsequently transferred to an OSD PE); and $1.0 million for The Logistics Institute. 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 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	106.313	115.865	110.092	110.273
(U) Current PBR/President's Budget	103.981	118.985	105.029	106.353
(U) Total Adjustments	-2.332	3.120		
(U) Congressional Program Reductions		-5.000		
Congressional Rescissions		-1.080		
Congressional Increases		11.700		
Reprogrammings	-0.020	-2.500		
SBIR/STTR Transfer	-2.312			

(U) Significant Program Changes:
Not Applicable.

C. Performance Metrics
(U) Under Development.

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

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5094	University Research Initiatives	103.981	118.985	105.029	106.353	106.333	115.421	118.103	120.114	Continuing	TBD
	Quantity of RDT&E Articles	0	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. Note: In FY 2005, Congress added $1.1 million for 21st Century Information Operations Workforce; $1.5 million for Agile Response Chameleon Coatings; $3.0 million for Bio/Nanotechnology Infrastructure and Technology Oriented Research; $1.0 million for Griffith Observatory Programming; $1.6 million for Information Security Solutions; $2.5 million for Science, Math and Research for Transformation (SMART) Defense Scholarship Pilot Program (subsequently transferred to an OSD PE); and $1.0 million for The Logistics Institute. 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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Promote fundamental, multi- and interdisciplinary science and engineering research projects. Topics will be selected in scientific research areas related to transformational and high priority technologies, such as nanotechnology, sensor networks, intelligence information fusion, smart materials and structures, efficient energy and power conversion, high energy materials for propulsion and control, and enhancing human performance.	51.577	61.693	57.291	54.758
(U)	In FY 2004: Issued competitive research awards to universities focused on enabling Air Force-related technologies usually not achievable through single investigator awards. Funded 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. Continue funding of multi-disciplinary programs begun in prior years.				
(U)	In FY 2006: Fund competitive research awards at U.S. universities to focus on underpinning Air Force-related technologies usually not achievable through typical single investigator awards. Support superior academic research the Presidential Early Career Award for Scientists and Engineers (PECASE). Continue funding of multi-disciplinary programs begun in prior years.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	In FY 2007: Continue funding competitive research awards at U.S. universities to focus on underpinning Air Force-related technologies usually not achievable through typical single investigator awards. Support superior academic research the PECASE. 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. National Defense Science and Engineering Graduate Program (NDSEG) Fellowships are awarded under a joint tri-Service and Office of the Director of Defense Research and Engineering competition.	34.652	35.151	35.499	40.161
(U)	In FY 2004: Awarded approximately 170 highly competitive NDSEG fellowships. Supported competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Promoted and advanced recognition of superior academic research under Federal programs such as the PECASE. Funded awards made under prior year Department of Defense programs.				
(U)	In FY 2005: Award highly competitive NDSEG fellowships. 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 PECASE. Continue funding for awards made under prior year Department of Defense programs.				
(U)	In FY 2006: Award highly competitive NDSEG fellowships. Support competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. Continue funding for awards made under prior year Department of Defense programs. (Note: In FY 2006, PECASE efforts will be move to the multi- and interdisciplinary science and engineering research since this Major Thrust is not an educational effort.)				
(U)	In FY 2007: Award highly competitive NDSEG fellowships. Support competitive awards for graduate and undergraduate research experiences including those established under the Awards to Stimulate and Support Undergraduate Research Education program. 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.	15.806	13.021	12.239	11.434
(U)	In FY 2004: Conducted the competition for U.S. universities to establish unique capability, high technology instrumentation and infrastructure under the Defense University Research Instrumentation				

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	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)	In FY 2006: 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)	In FY 2007: 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.	0.973	0.000	0.000	0.000
(U)	In FY 2004: Conducted fundamental multidisciplinary scientific research associated with network and information efforts.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Kelly Material Science and Engineering Laboratory.	0.973	0.000	0.000	0.000
(U)	In FY 2004: Conducted fundamental multidisciplinary scientific research at Kelly Material Science and Engineering Laboratory.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: 21st Century Information Operation Workforce.	0.000	1.091	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: To support an Information Operations curriculum to educate graduates and undergraduates in the field of intelligence.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Agile Response Chameleon Coating.	0.000	1.486	0.000	0.000
(U)	In FY 2004: Not Applicable.				

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(U)	In FY 2005: Conduct meta-materials research into aircraft coating systems that allow for stealth capabilities and advanced sensing capabilities.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Bio/Nanotechnology Infrastucture and Technology Oriented Research.	0.000	2.974	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: To conduct functionalized carbon nanotubes research and determine the feasibility of transferring information on the surface of photosensitive proteins at the single-molecule level.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Griffith Observatory Programming.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: To support educational programming and exhibits which demonstrate the application of defense technology and research at Griffith Observatory Planetarium.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Information Security Solution.	0.000	1.587	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct research to the security issues in information technology architectures and components.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: The Logistics Institute.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: To continue the research and support of the Air Force crew systems personnel protection program.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	103.981	118.985	105.029	106.353

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:
PE 0601102F, Defense Research Sciences.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2005**

BUDGET ACTIVITY
01 Basic Research

PE NUMBER AND TITLE
0601108F High Energy Laser Research Initiatives

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	11.611	12.223	11.894	12.263	12.339	13.374	13.685	13.917	Continuing	TBD
5097	High Energy Laser Research Initiatves	11.611	12.223	11.894	12.263	12.339	13.374	13.685	13.917	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 Joint Technology Office.

(U) A. Mission Description and Budget Item Justification

This program funds basic research aimed at developing fundamental scientific knowledge to support future Department of Defense (DoD) High Energy Laser (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 Joint Technology Office. 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 DoD 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	11.961	12.331	12.467	12.716
(U)	Current PBR/President's Budget	11.611	12.223	11.894	12.263
(U)	Total Adjustments	-0.350	-0.108		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.108		
	Congressional Increases				
	Reprogrammings				
	SBIR/STTR Transfer	-0.350			

(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 High Energy Laser (HEL) Joint Technology Office (JTO).

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C. Performance Metrics
Under Development.

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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5097	High Energy Laser Research Initiatves	11.611	12.223	11.894	12.263	12.339	13.374	13.685	13.917	Continuing	TBD
	Quantity of RDT&E Articles	0	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 Department of Defense (DoD) High Energy Laser (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 Joint Technology Office. 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 DoD 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 2004	FY 2005	FY 2006	FY 2007
(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, platform integration, and man-machine interface.	3.038	2.713	2.743	2.773

(U) In FY 2004: Conducted research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with 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%, materials that can operate 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 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with 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%, materials that can operate 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

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receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with 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 30%, materials that can operate 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, areas begun during FY 2002 will continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including laser materials with large fluorescence lifetime and cross-section, laser materials with 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 30%, materials that can operate 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, areas begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(U)

(U) MAJOR THRUST: Conduct fundamental research in high-power, lightweight optics.	1.606	1.795	1.584	1.719

(U) In FY 2004: Conducted research in areas of interest including basic materials and fabrication techniques, large optics lightweight structure and deployment concepts, high energy laser (HEL) optical coatings, multipurpose materials. (e.g., wave front 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 continued 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., wave front 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. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including basic materials and fabrication techniques,

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large optics lightweight structure and deployment concepts, high energy laser (HEL) optical coatings, multipurpose materials (e.g., wave front 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. Investigate 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, areas begun during FY 2002 will continue to receive funding along with FY 2005 awards.

(U) In FY 2007: 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., wave front 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. Investigate 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, areas begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(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.	0.680	1.110	1.122	1.135

(U) In FY 2004: Conducted research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continued to receive funding.

(U) In FY 2005: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the

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presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Research focuses on new methods for wave front 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, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Conduct research in areas of interest including improved theoretical and computer-based analysis of propagation effects, advanced wave front sensing and reconstruction (especially in the presence of thermal blooming), and the effects of extended reference sources used for wave front correction. Research focuses on new methods for wave front 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, areas that were begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(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.	0.792	1.426	1.209	1.341

(U) In FY 2004: Conducted 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. Measured chemical kinetics for an all gas phase chemical laser and studied plasma physics of an electrically driven oxygen iodine laser system. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continued 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 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, areas that were begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: 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 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 will continue to receive funding along with FY 2005 awards.

(U) In FY 2007: 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 system. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.

(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.	2.655	1.480	1.496	1.513

(U) In FY 2004: Conducted 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 begun during FY 2002 continued 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 begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: 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, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: 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

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	program, areas that were begun during FY 2002 will be completed. FY 2005 awards will continue to receive funding. Conduct proposal call for FY 2007 new starts.				
(U)					
(U)	MAJOR THRUST: Conduct fundamental research in modeling and simulation for high energy lasers (HEL).	1.140	1.479	1.496	1.513
(U)	In FY 2004: Continued 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 high energy laser systems' military utility in a broad range of missions. 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 continued to receive funding.				
(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. 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. Conduct FY 2005 proposal call for multidisciplinary research program.				
(U)	In FY 2006: 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. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.				
(U)	In FY 2007: Conduct research in areas of modeling and simulation to achieve a balance between high-fidelity technical analyses, engineering trade that allow analyses of a wide range of systems, and analyses of HEL system's military utility in a broad range of missions. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards. Conduct proposal call for FY 2007 new starts.				
(U)					
(U)	MAJOR THRUST: Conduct fundamental research in beam control component technology to improve high energy laser (HEL) systems.	1.700	2.220	2.244	2.269
(U)	In FY 2004: Continued to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles, and technology to fabricate conformal HEL windows for tactical air vehicles. Developed wavefront sensors that are insensitive to high scintillation environments and prepare to benchmark performance in a simulated high scintillation environment. Established a government optical				

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metrology capability to precisely measure adsorption and reflectivity of optical coatings. Developed methods for discrimination, pointing, and tracking in high clutter using three-dimensional imaging. Continued to develop characterizations that concentrate on understanding atmospheric limitations in low-altitude tactical scenarios in order to increase the lethal range. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continued to receive funding.

(U) In FY 2005: Continue to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles, and 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. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 will continue to receive funding. Conduct FY 2005 proposal call for multidisciplinary research program.

(U) In FY 2006: Continue to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles. Develop technology to fabricate conformal HEL windows for tactical air vehicles. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards.

(U) In FY 2007: Continue to develop beam control technology to improve HEL system performance. Provide critical technology options for use in tactical scenarios on tactical platforms such as aircraft, ground vehicles. Develop technology to fabricate conformal HEL windows for tactical air vehicles. Pursuant to the nature of the university-led multidisciplinary research initiative program, areas that were begun during FY 2002 continue to receive funding along with FY 2005 awards. Conduct proposal call for FY 2007 new starts.

(U)	Total Cost	11.611	12.223	11.894	12.263

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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.										
(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.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) **D. Acquisition Strategy**

Not Applicable.

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Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2005**

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602102F Materials

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	107.233	119.498	74.156	78.620	80.183	79.534	80.086	80.579	Continuing	TBD
4347	Materials for Structures, Propulsion, and Subsystems	62.966	72.909	42.499	46.522	47.696	45.328	45.561	45.757	Continuing	TBD
4348	Materials for Electronics, Optics, and Survivability	18.905	22.141	12.139	12.405	12.534	13.216	13.365	13.509	Continuing	TBD
4349	Materials Technology for Sustainment	15.893	17.667	17.060	17.190	17.421	18.311	18.450	18.575	Continuing	TBD
4915	Deployed Air Base Technology	9.469	6.781	2.458	2.503	2.532	2.679	2.710	2.738	Continuing	TBD

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

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 fire fighting capabilities. Note: In FY 2005, Congress added $1.0 million for Computational Tools for Materials Development, $2.6 million for Advanced Wide Bandgap Materials for RF [Radio Frequency] Technology, $1.7 million for Advanced Silicon Carbide Device Technology, $2.0 million for Domestic Titanium Powder Manufacturing Initiative, $1.0 million for Cost-Effective Composite Materials for Manned and Unmanned Flight Structures, $2.4 million for Blast Resistant Barriers for Homeland Defense, $2.1 million for Advanced Magnetic Random Access Memory Modules, $1.0 million for Optimal Design of Materials Processes, $2.8 million for Wright Brothers Institute - Nanostructured Materials for Advanced Air Force Systems, $2.5 million for Titanium Matrix Composites, $3.6 million for Nanostructured Materials for Advanced Air Systems, $2.5 million for Gallium Nitrate RF Power Technology, $2.1 million for Thermal Sprays for Structural Protection, $2.5 million for ONAMI [Oregon Nanoscience and Microtechnologies Institute] Safer Nanomaterials and Nanomanufacturing, $1.0 million for Non-Linear Optical Materials, $1.0 million for Durable Hybrid Coatings for Aircraft Systems, $1.1 million for Material Science Laboratory, $3.5 million for Advanced Manufacturing Technologies for Metals, Composites (UMR), and $10.5 million for Strategic Partnership for Research in Nanotechnology. 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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**

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

	FY 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	109.222	73.660	71.548	77.516
(U) Current PBR/President's Budget	107.233	119.498	74.156	78.620
(U) Total Adjustments	-1.989	45.838		
(U) Congressional Program Reductions				
Congressional Rescissions		-1.062		
Congressional Increases		46.900		
Reprogrammings				
SBIR/STTR Transfer	-1.989			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4347	Materials for Structures, Propulsion, and Subsystems	62.966	72.909	42.499	46.522	47.696	45.328	45.561	45.757	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	4.635	4.991	4.138	3.620

(U) In FY 2004: Designed new advanced ceramics and ceramic composites with improved durability and fracture resistance for aircraft applications. Developed advanced analytical techniques to predict the life of advanced ceramic composites containing stress concentration sites. Developed advanced analytical models to design integrally woven, actively cooled ceramic composite structures for advanced combustor applications. Designed 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 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 the robustness of these state-of-the-art ceramic composites in severe environments.

(U) In FY 2006: Design, fabricate, and test advanced ceramic composite coupons and sub-elements for demonstration of durability. Expand the ceramic composite life prediction model to account for complex component shapes and apply to complex turbine component shapes. Develop material/component

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	acceptance criteria. Validate advanced weaving and design methodology of integrally cooled ceramic composites by designing, fabricating, and testing an annular trapped vortex combustor. Scale up advanced fiber-matrix interface coating concepts and apply to state-of-the-art ceramic composites.				
(U)	In FY 2007: Demonstrate advanced ceramic composite performance through testing under real and simulated engine service life conditions. Incorporate environmental degradation analysis into the ceramic composite life prediction model to address time dependent degradation associated with environmental exposure and validate the model. Demonstrate the severe environment durability of advanced ceramic composite systems with advanced interfaces via mechanical testing.				
(U)					
(U)	MAJOR THRUST: Develop materials processing technologies involving process models, advanced control methods, and advanced non-invasive sensors. Note: In FY 2005, this effort was incorporated into the next major thrust.	2.425	0.000	0.000	0.000
(U)	In FY 2004: Evaluated the use of evanescent microwave sensors for evaluating laser damage and subsurface corrosion. Established baseline parameters for selected techniques for generating large-scale dynamic and phase behavior simulations for nanomaterial process design. Investigated process control of optical deposition for scale-up and stress control of optical and multi-functional coatings for transfer to industry. Initiated studies of processing relationships to produce variation in composites. Investigated nucleation and growth mechanism for single wall carbon nanotubes in order to optimize manufacturing ability.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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: This effort includes Congressional Add funding of $15.2 million in FY 2004 and $13.0 million in FY 2005 ($2.5 million for ONAMI Safer Nanomaterials and Nanomanufacturing and $10.5 million for Strategic Partnership for Research in Nanotechnology).	17.698	16.449	3.906	4.233
(U)	In FY 2004: Tested clay-infiltrated nanostructured polymeric materials for impermeability of gas and fluids. Developed rapid fabrication of nanoscale three-dimensional structures for Air Force conducting, structural, and electromechanical applications. Tested hybrid thin wires under rigorous environmental conditions and extreme mechanical stresses. Scaled up and completed advanced evaluation of two photon absorbing (TPA) polymer materials for night vision goggle protection. Developed the curing				

process for and initiated testing of composites containing advanced resins. Developed 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 lightning strike protection. Show the feasibility of lightweight radio frequency polymer substrates for reduced aperture size, conformal radar, and antenna systems.

(U) In FY 2006: Continue to develop techniques and materials for nanoscale architectures to address advanced Air Force conducting, structural, and electromechanical applications. Develop second-generation TPA materials for night vision goggle and optical limiting applications. Investigate use of photonic crystals to enhance second- and third-order nonlinear optical properties for use in optical limiting applications. Demonstrate improved life for Air Force aircraft tires by incorporation of nanostructured polymeric materials. Validate aromatic hyperbranched polymers as viscosity-lowering additives for structural component manufacture via solvent-free processes. Investigate microfabrication of organic-inorganic nanophotonic structures that have the potential to impact Air Force electromagnetic applications for reduced aperture size, conformal radar, and antenna systems. Begin development of adaptive (shape memory and actuator) materials based on polymer nanocomposites for adaptive aircraft structures, wings, fins, antennas, and mirrors. Scale up improved polymer proton exchange membranes for high efficiency, long life, lightweight, fuel cell applications. Demonstrate polymer photovoltaic materials for high efficiency, long life, lightweight, solar cell applications.

(U) In FY 2007: Continue to develop techniques and materials for nanoscale architectures to address advanced Air Force conducting, structural, and electromechanical applications. Continue to develop second-generation TPA materials for night vision goggle and optical limiting applications. Demonstrate optical limiting with improvements in nonlinear optical properties using photonic crystals. Demonstrate improved life nanostructured aircraft tires. Demonstrate aromatic hyperbranched polymers as rheology-modifying additives for structural component manufacture via resin transfer molding processes. Demonstrate organic-inorganic nanostructured materials for Air Force electromagnetic applications. Continue development of adaptive (shape memory and actuator) materials based on polymer nanocomposites for adaptive aircraft structures, wings, fins, antennas, and mirrors. Demonstrate polymer proton exchange membranes for Air Force fuel cell applications. Demonstrate polymer photovoltaic materials for high efficiency, long life, lightweight, solar cell applications.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

(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: This effort includes Congressional Add funding of $5.5 million in FY 2004 and $8.5 million in FY 2005 ($1.0 million for Cost-Effective Composite Materials for Manned and Unmanned Flight Structures, $1.1 million for Materials Science Laboratory, $3.6 million for Nanostructured Materials for Advanced Air Systems, and $2.8 million for Wright Brothers Institute - Nanostructured Materials for Advanced Air Force Systems).	12.930	17.998	10.014	11.075
(U)	In FY 2004: Continued 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. Validated materials, processing, and fabrication scale-up of high-temperature organic matrix composites for turbine engines, aircraft and high-speed vehicle applications. Evaluated nanomaterials technologies for multifunctional properties required by military aircraft and satellites. Evaluated innovative carbon materials, such as carbon foams, and processing techniques for aircraft thermal management applications.				
(U)	In FY 2005: Develop 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-speed vehicle applications. 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 for thermal management applications.				
(U)	In FY 2006: Continue development of life prediction capabilities for high temperature turbine engine and airframe hot structures. Demonstrate high temperature organic matrix composites onto relevant DoD platforms. Investigate and assess future requirements for material development as applied to next generation high-speed vehicle applications. Continue development of materials and processes for nanotailored composites with multifunctional capabilities. Initiate nanomaterial modeling efforts. Continue demonstration of novel materials and processes that enhance the reliability and performance of thermal management subsystems.				
(U)	In FY 2007: Demonstrate tools and methodologies required for life prediction of materials in high temperature turbine engine and airframe structures environments. Continue demonstration of high temperature organic matrix composites onto relevant DoD platforms. Initiate new material development and affordable processing for space and high-speed vehicle applications. Continue development of new materials and processes for nanotailored composites with multifunctional capabilities. Continue nanomaterial modeling and technology efforts. Continue development and demonstration of advanced				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

	material concepts and processes for thermal management applications.				
(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: This effort includes Congressional Add funding of $1.2 million in FY 2004 and $1.0 million in FY 2005 for Durable Hybrid Coatings for Aircraft Systems.	7.948	9.035	9.282	10.052
(U)	In FY 2004: Formulated the most promising electrically conductive elastomers for specific electrostatic discharge control gap treatments. Continued to develop advanced analytical techniques to predict the optical properties of specialty coatings. Developed non-chromate surface treatments with advanced performance coatings for aircraft corrosion protection systems. Developed environmentally friendly corrosion protection systems with a 30-year life expectancy. Evaluated nanostructured multifunctional coatings to control friction and wear in extreme environments. Refined candidate surface treatments for friction, stiction, and wear control in micro-devices.				
(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. Continue to develop 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 multifunctional coatings to control friction and wear in extreme environments. Fabricate and test surface treatments for friction, stiction, and wear control in micro-devices.				
(U)	In FY 2006: Evaluate candidate materials for use in electrostatic discharge control gap treatments. Validate the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Demonstrate non-chromate surface treatments via flight test. Continue to develop environmentally friendly corrosion protection systems with a 30-year life expectancy. Continue to develop nanostructured multifunctional coatings to control friction and wear in extreme environments. Continue testing of surface treatments for friction, stiction, and wear control in micro devices.				
(U)	In FY 2007: Demonstrate candidate gap treatment materials on air vehicles. Complete validation of the advanced analytical models that will be used to predict the optical properties of specialty coatings based on measured data. Continue to demonstrate and validate the non-chromate surface treatments for aircraft corrosion protection systems. Formulate chrome-free primer for corrosion protection systems with a 30-year life expectancy. Validate multifunctional coatings on engineering components. Downselect surface treatment candidates for further development for friction, stiction, and wear control in micro devices.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

(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: This effort includes Congressional Add funding of $3.9 million in FY 2004 and $10.0 million in FY 2005 ($3.5 million for Advanced Manufacturing Technologies for Metals, Composites (UMR), $2.0 million for Domestic Titanium Powder Manufacturing Initiative, $2.5 million for Titanium Matrix Composites, $1.0 million for Computational Tools for Materials Development, and $1.0 million for Optimal Design of Materials Processes).	17.330	24.436	15.159	17.542
(U)	In FY 2004: Initiated development of new life prediction technologies for improving aircraft turbine engine rotor durability in thermal-mechanical fatigue design systems. Continued to develop and analyze second-generation high-temperature structural materials that are nickel- and molybdenum-based for turbine engine applications. Developed computational methods for modeling mechanical properties of metals and alloys and validated these tools so that they can be used to reduce the amount of proof testing required to release metals for final component production. Identified 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. Initiate concept identification of advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. 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)	In FY 2006: Demonstrate reliable life extension capability for turbine engine rotors. Explore materials-damage predictive approaches for engine health determination and life extension capability. Explore advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Explore computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems. Continue the identification of processes and protocols for unitized manufacturing of aerospace components.				
(U)	In FY 2007: Develop materials-damage predictive approaches for engine health determination and life extension capability. Continue exploration of advanced metallic materials for enhanced performance propulsion for air platforms with an emphasis on higher temperature capability. Develop computational methods supporting development and processing to reduce costs to accelerate insertion of advanced metals into Air Force systems. Demonstrate processes and protocols for unitized manufacturing of				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4347 Materials for Structures, Propulsion, and Subsystems**

aerospace components.

(U)	Total Cost	62.966	72.909	42.499	46.522

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0603112F, Advanced Materials for Weapon Systems.										
(U)	PE 0603211F, Aerospace Technology Dev/Demo.										
(U)	PE 0603202F, Aerospace Propulsion Subsystems Integration.										
(U)	PE 0603216F, Aerospace Propulsion and Power Technology.										
(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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4348 Materials for Electronics, Optics, and Survivability**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4348	Materials for Electronics, Optics, and Survivability	18.905	22.141	12.139	12.405	12.534	13.216	13.365	13.509	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	0.464	0.500	0.658	0.663

(U) In FY 2004: Validated the military utility of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Exploited validated processing techniques to develop enhanced IR detector materials performance and improve military utility. Demonstrated the process control required for growth of complex IR detector materials that require control on an atomic level to structure their detection properties. Investigated 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.

(U) In FY 2006: Provide prototype growth, characterization, and analyses of potential IR materials systems to determine unique properties of interest to Air Force users. Develop the process control to enable ordered growth of two-dimensional, abrupt compositional interfaces in multiple wavelength materials. Validate the optical properties of advanced IR materials by optical characterization and evaluation of complex IR detector materials that have been produced by atomic level control. Explore methods of controlling materials composition, shape, and size on a nano-scale level and validate by structural

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4348 Materials for Electronics, Optics, and Survivability**

	characterization.				
(U)	In FY 2007: Validate optical, structural, and electronic properties of innovative IR materials to determine their ability to provide unique IR detection properties of interest to the Air Force. Characterize and evaluate the utility of single element multispectral IR materials with responses to more than two discrete wavelengths. Investigate the potential for three-dimensional material growth to exploit unique detection properties of complex IR materials. Validate promising materials growth technologies for nano-scale IR detection materials.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate materials technologies to enhance the safety and survivability of aircrews and related assets. Note: This effort includes Congressional Add funding of $1.0 million in FY 2005 for Non-Linear Optical Materials.	4.836	6.747	4.920	5.033
(U)	In FY 2004: Investigated growth and processing techniques for nonlinear optical crystals including surface coatings and nanostructuring for generating radiation with significantly higher energy per pulse for future infrared countermeasures (IRCM). Optimized the performance of promising nonlinear absorbing materials in candidate host materials and tested 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 for generating radiation at significantly higher energies. 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 and viewing systems.				
(U)	In FY 2006: Continue to characterize the performance of optimized nonlinear absorbing materials into device concepts for eye and sensor system protection.				
(U)	In FY 2007: Incorporate optimized nonlinear optical limiter materials for damage protection of eyes and sensor systems.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate 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: This effort includes Congressional Add funding of $4.3 million in FY 2004 and $8.9 million in FY 2005 ($2.6 million for Advanced Wide Bandgap Materials, $2.5 million for Gallium Nitrate RF Power Technology, $1.7 million for Advanced Silicon Carbide Device Technology, and $2.1 million for Advanced Magnetic Random Access Memory Modules).	8.150	13.052	4.760	4.866
(U)	In FY 2004: Continued 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. Continued development and testing of materials and processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Completed 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. Explored 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) In FY 2006: Demonstrate scale-up of materials and materials processes for power control systems, advanced radar, and electronic countermeasures. Continue development of advanced materials and materials process technologies to enable airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft, and an order of magnitude improvement in speed for Air Force sensor and communication systems. Demonstrate scale-up of materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Continue development of advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Continue development of materials and materials process technologies for Terahertz components supporting order of magnitude improvement in speed for Air Force sensor and communication systems. Identify most promising materials approaches for application to initial prototype evaluation.

(U) In FY 2007: Demonstrate capabilities of advanced materials and materials process technologies to

	enable airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Validate and demonstrate selected materials and materials process technologies for use in Terahertz components. Continue to demonstrate scale-up of materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Demonstrate capabilities of advanced materials and materials process technologies to provide improvements and additional capabilities relative to baseline materials/processes for ultra-lightweight, ultra-high-power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft. Validate and demonstrate selected materials and materials process technologies for use in Terahertz components, supporting high speed communications and advanced sensors.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensors and viewing systems. Note: This effort includes Congressional Add funding of $3.8 million in FY 2004.	5.455	1.842	1.801	1.843
(U)	In FY 2004: Validated the performance of liquid crystal materials employed in autonomous tunable filters. Fabricated laboratory samples of high optical density, multiple-wavelength switchable filter stacks.				
(U)	In FY 2005: Design a representative brassboard protection system using liquid crystal-based tunable filters. Characterize the optical performance of high optical density, multiple-wavelength switchable filter stacks.				
(U)	In FY 2006: Develop photorefractive materials for passive protection applications and develop device concepts that utilize photorefractive materials. Optimize the performance of high optical density, multiple-wavelength switchable filter technology for Air Force applications.				
(U)	In FY 2007: Optimize photorefractive materials properties for Air Force passive protection applications. Incorporate switchable filter technology into device concepts for eye and sensor system protection.				
(U)	Total Cost	18.905	22.141	12.139	12.405

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities: PE 0603112F, Advanced										
(U)	Materials for Weapon Systems.										
(U)	PE 0602202F, Human										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602102F Materials**	**4349 Materials Technology for Sustainment**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4349	Materials Technology for Sustainment	15.893	17.667	17.060	17.190	17.421	18.311	18.450	18.575	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	3.320	3.759	3.747	3.837
(U)	In FY 2004: Improved methods to inspect and maintain the integrity of aging aerospace structures and propulsion systems. Developed electromagnetic methods to rapidly detect and characterize multi-site damage and cracks in large-area, aging structures. Developed 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 technology concepts for measuring complex electromagnetic material properties beneath dielectric tiles in LO applications. Developed 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 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 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)	In FY 2006: Demonstrate electromagnetic technology to detect and characterize multi-site damage and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4349 Materials Technology for Sustainment**

	cracks in large area, aging structures. Develop computer simulations and models of NDI/E technique response to enable rapid assessment of multiple NDI/E technologies for depot level inspections. Initiate efforts to explore and develop NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Evaluate feasibility of advanced LO NDI/E methods and systems for use in battle damage assessment and for inspection following battle damage repair. Transition sensor technology for measuring complex electromagnetic material properties beneath dielectric tiles.				
(U)	In FY 2007: Continue to develop computer simulations and models of NDI/E technique response to enable rapid assessment of multiple NDI/E technologies for depot level inspections. Develop NDI/E technologies for inspection of thick (multi-layer) aging aircraft structures with complex geometries. Develop advanced LO NDI/E methods and systems for use in battle damage assessment and for inspection following battle damage repair.				
(U)					
(U)	MAJOR THRUST: Develop enabling technologies to reduce the Air Force LO maintenance burden.	3.693	4.007	4.068	3.991
(U)	In FY 2004: Completed development of NDI/E point inspection device capability. Developed 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, radar absorbing material (RAM) repair materials, RAM removal equipment, radar absorbing structure (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)	In FY 2006: Develop multispectral/multipurpose tool for inspection of LO systems on aircraft. Investigate program for improved maintainability of advanced LO materials and designs including conductive outer-mold-line, applique, door edges and seals, multifunctional systems, and embedded LO NDI/E.				
(U)	In FY 2007: Design prototype multispectral/multipurpose tool for inspection of LO systems on aircraft. Develop technologies for improved maintainability of advanced LO materials and designs including conductive outer-mold-line, applique, door edges and seals, multifunctional systems, and embedded LO NDI/E.				
(U)					
(U)	MAJOR THRUST: Develop support capabilities, information, and processes to resolve materials problems and provide electronic and structural failure analysis of components.	3.610	4.001	4.110	4.141
(U)	In FY 2004: Continued performing failure analysis and materials investigations for field, acquisition, and depot organizations. Developed electrostatic discharge protection technologies for emerging				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4349 Materials Technology for Sustainment**

avionics subsystems. Developed new test methodologies for analyzing structural failures of replacement materials for aging Air Force systems. Investigated 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. Continue to develop electrostatic discharge protection technologies for emerging avionics subsystems. 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) In FY 2006: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Demonstrate electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Evaluate new test methodologies for analyzing structural failures of emerging materials for Air Force systems. Evaluate wiring materials technologies to replace aging wiring systems and new wiring technologies for emerging weapons systems.

(U) In FY 2007: Continue performing failure analysis and materials investigations for field, acquisition, and depot organizations. Continue demonstration of electrostatic discharge protection technologies and procedures for emerging avionics subsystems. Validate new test methodologies for analyzing structural failures of emerging materials for Air Force systems. Evaluate/validate wiring materials technologies to replace aging wiring systems and new wiring technologies for emerging weapons systems.

(U)

(U) MAJOR THRUST: Develop support capabilities, information, and processes to resolve problems with materials in the repair of aircraft structures and to reduce aircraft corrosion.	5.270	5.900	5.135	5.221

(U) In FY 2004: Developed and evaluated methodologies to determine corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Identified 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. Develop specification for laser additive manufacturing of non flight critical parts. Demonstrate effectiveness of low plasticity burnishing of landing gear components. Assess effectiveness of corrosive preventative compounds for various Air Force applications.

(U) In FY 2006: Apply methodologies to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Continue to evaluate methodologies to test failure limits for MEMS structures and subsystems. Evaluate effects of defects in laser additive manufactured parts.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4349 Materials Technology for Sustainment**

(U) In FY 2007: Continue to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Continue to evaluate methodologies to test failure limits for MEMS structures and subsystems. Validate effects of defects in laser additive manufactured parts.

(U)	Total Cost	15.893	17.667	17.060	17.190

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 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 2005

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4915 Deployed Air Base Technology	9.469	6.781	2.458	2.503	2.532	2.679	2.710	2.738	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops new deployable airbase technologies to reduce airlift and manpower requirements, setup times, and sustainment costs, and to improve protection and survivability of deployed Air Expeditionary Force (AEF) warfighters. Affordable, efficient technologies are developed for base infrastructure, fire fighting, and force protection to improve deployed operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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: This effort includes Congressional Add funding of $1.2 million in FY 2004.	2.201	1.143	1.279	1.302
(U) In FY 2004: Matured deployable fuel cell power system to advanced technology development. Continued development of high-efficiency, solid state solar cell technology. Initiated 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. Initiated research on polymer-clay stabilization technology for rapid airfield expansion that will reduce the time required to prepare aircraft operating surfaces at contingency bases. Initiated research on catalysis and degradation of Air Force materials that will provide cleaner and lower cost advanced materials.				
(U) In FY 2005: Develop high-efficiency, solid state solar cell technology. Develop advanced heat and mass transfer technologies and thin film catalytic technologies to improve deployed energy system performance. Develop an advanced work-recovery rotary expansion device to improve deployed air conditioning performance. Develop polymer-clay stabilization agents for rapid airfield expansion that will reduce time to prepare aircraft operating surfaces. Evaluate catalysis and degradation technologies to provide cleaner, lower cost advanced materials.				
(U) In FY 2006: Investigate fabrication techniques to integrate solid state solar cell technology into deployable shelter fabrics. Continue to develop advanced heat and mass transfer technologies and thin film catalysis for logistic fuel processing planar technology. Continue to develop an advanced work-recovery rotary expansion device to improve deployed air conditioning performance. Demonstrate polymer-clay stabilization agents for rapid airfield expansion. Refine ground penetrating radar interpretation capability to improve man-portable rapid airfield assessment. Develop biomaterials that produce similar effects as chemical catalysts for improved reactive production of aerospace materials.				
(U) In FY 2007: Develop high-efficiency solar shelter fabrics. Continue development of advanced heat and mass transfer technologies and demonstrate logistic fuel processing planar technology. Investigate				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT NUMBER AND TITLE **4915 Deployed Air Base Technology**

behavior of soil and stabilizer interaction with airfield matting and begin model development. Develop non-radar wave methods of nondestructive inspection of airfield surface anomalies. Synthesize polymer materials using biocatalysts and reagents for producing reduced cost, tailored characteristics in aerospace materials.

(U)

(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop affordable technologies to provide force protection and survivability to Air Expeditionary Force (AEF) deployed warfighters and infrastructure. Note: This effort includes Congressional Add funding of $6.4 million in FY 2004 and $4.5 million in FY 2005 ($2.4 million for Blast Resistant Barriers for Homeland Defense and $2.1 million for Thermal Sprays for Structural Protection).	7.268	5.638	1.179	1.201

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

(U) In FY 2005: Develop more effective fire fighting agents and application methodologies for protection of warfighters. Develop technologies for increased firefighter situational awareness, improved synergy, and greater on-site duration. Initiate research on resilient infrastructure technologies for more effective protection of structures and inhabitants. Characterize ballistic and fragmentation aspects of improvise explosive device threats for development of protective measures. Characterize the atmospheric and surface action and interaction of asymmetric threat agents for protection of aerospace warfighters and equipment.

(U) In FY 2006: Develop fire fighting agents with increased versatility by combining agents and application methodologies. Continue developing technologies for increased fire fighter situational awareness, improved synergy, and greater on-site duration. Continue research on resilient infrastructure technologies for more effective protection of structures and inhabitants. Develop technologies to protect against the ballistic and fragmentation effects of improvised explosive device threats and characterize high energy weapons threats. Model atmospheric and surface phenomenon of in-theater chemicals and asymmetric threats for tailored response protection.

(U) In FY 2007: Demonstrate emerging fire suppression technologies for integrated crash/rescue capability. Integrate individual fire fighter effectiveness technologies for a combined technology demonstration. Demonstrate resilient structural materials and methodologies for improved protection of structures and inhabitants. Continue developing technologies to protect against the ballistic and fragmentation effects of improvised explosive device threats, and initiate protective material development against high energy threats. Develop characterization data for atmospheric models for protection of deployed warfighters from asymmetric threats.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT NUMBER AND TITLE 4915 Deployed Air Base Technology

(U) Total Cost	9.469	6.781	2.458	2.503

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0603112F, Advanced Materials for Weapon Systems.										
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

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PE NUMBER: 0602201F
PE TITLE: Aerospace Vehicle Technologies

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602201F Aerospace Vehicle Technologies

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	64.700	76.401	96.679	104.229	96.987	102.672	104.208	105.648	Continuing	TBD
2401	Structures	26.541	32.542	41.005	44.258	37.002	41.284	41.885	42.446	Continuing	TBD
2403	Flight Controls and Pilot-Vehicle Interface	15.079	17.785	28.805	31.694	26.933	28.734	29.175	29.588	Continuing	TBD
2404	Aeromechanics and Integration	23.080	26.074	26.869	28.277	33.052	32.654	33.148	33.614	Continuing	TBD

(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. Advanced structures concepts are explored and developed to exploit new materials, fabrication processes, and design techniques. Flight control technologies are developed and simulated for aerospace vehicles. Advanced aerodynamic vehicle configurations are developed and analyzed through simulations, experiments, and multi-disciplinary analysis. Resulting technologies reduce life cycle costs and improve the performance of existing and future manned and unmanned aerospace vehicles. Note: In FY 2005, Congress added $1.3 million for the Intelligent Flight Control Simulation Research Laboratory and $1.1 million for the Unique Stealth Unmanned Air Vehicle Houck Aircraft Design program. 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	64.311	74.679	103.895	111.893
(U)	Current PBR/President's Budget	64.700	76.401	96.679	104.229
(U)	Total Adjustments	0.389	1.722		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.678		
	Congressional Increases		2.400		
	Reprogrammings	0.400			
	SBIR/STTR Transfer	-0.011			

(U) Significant Program Changes:

Not Applicable.

(U) C. Performance Metrics

Under Development

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2401 Structures	26.541	32.542	41.005	44.258	37.002	41.284	41.885	42.446	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops advanced structures concepts to exploit new materials and fabrication processes and investigates new structural concepts and design techniques. New structural concepts include incorporating subsystem hardware items (e.g., antennas, sensors, directed energy weapon components, and integrated energy storage) and adaptive mechanisms into the actual aircraft structures and/or skin of the aircraft. Resulting technologies strengthen and extend the life of current and future manned and unmanned aerospace vehicle structures, while providing increased capabilities. 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop an economic service life analysis capability comprised of analysis tools, methodologies, and structural health monitoring schemes. Note: Decrease in FY 2006 and out is due to reduction of related sustainment efforts in PE 0603211F.	5.122	6.281	2.344	1.880

(U) In FY 2004: Developed economic service life analysis and structural design tools for current and future aircraft, enhancing capabilities, component replacement, and technology direction. Developed unitized structural concepts and multi-disciplinary methodologies that enhance affordability and decrease vulnerability for current and future aerospace vehicles. Completed 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 multi-disciplinary methodologies that enhance affordability and decrease vulnerability for current and future aerospace vehicles.

(U) In FY 2006: Continue to 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 into life prediction and failure analysis. Continue to refine failure criteria tools for advanced high temperature aircraft components and concepts.

(U) In FY 2007: Continue development of structural health management schemes for structures susceptible

	to damage. Continue 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 into life prediction and failure analysis. Continue to develop failure criteria tools for advanced high temperature aircraft components and concepts.				
(U)					
(U)	MAJOR THRUST: Develop methodologies to allow for analytical airworthiness certification that will reduce the cost and time involved in actual full-scale testing of components and aircraft prior to obtaining airworthiness certification.	5.308	6.508	7.236	6.959
(U)	In FY 2004: Developed analytical certification methodologies for the incorporation of advanced methods, concepts, diagnostic techniques, and manufacturing technologies into legacy aircraft components and airframe design. Improved the airworthiness certification process for aircraft subject to dynamics loads 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 airworthiness certification process for aircraft subject to dynamic loads and with high fidelity.				
(U)	In FY 2006: Continue development of medium- and high-fidelity, and real-time analytical certification methodologies that improve airworthiness certification process and reduce development and testing for aircraft and components subject to dynamics loads.				
(U)	In FY 2007: Continue development of analytical certification methodologies that incorporate advanced methods, concepts, diagnostic techniques, and manufacturing technologies into legacy aircraft components and airframe design. Complete development of medium- and high-fidelity, and real-time analytical certification methodologies that improve airworthiness certification process and reduce development and testing for aircraft and components subject to dynamics loads.				
(U)					
(U)	MAJOR THRUST: Develop design methods to capitalize on new materials and integration of various subsystem hardware items (e.g., antennas, sensors, direct energy weapon components, and integrated energy storage) and adaptive mechanisms into the actual aircraft structures and/or skin of the aircraft. Note: In FY 2006 and out, funding increased due to initiation of full-scale feasibility determination of air vehicle monitoring in advanced structures. Efforts in this thrust are integrated with efforts in Project 2403 for advanced flight controls, components, and integrated vehicle health monitoring.	4.379	5.369	14.025	18.864
(U)	In FY 2004: Developed 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. Continued the development of concepts that include adaptive structures,				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2401 Structures**

subsystem hardware, and antenna integration into a load-bearing structure to create multi-function 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 multi-function or ultra-lightweight concepts.

(U) In FY 2006: Continue development and initiate evaluation and assessment of 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 and performance of future systems. Initiate the development and analysis of critical subsystem hardware integration methods to enable directed energy weapons to be carried out on future air vehicles. Complete analysis and continue feasibility determination of energy storage concepts that are integrated into load-bearing structures. Continue the development and initiate evaluation, assessment, and ground evaluation of adaptive structures and antenna integration concepts into load-bearing structures to create multi-function or ultra-lightweight concepts.

(U) In FY 2007: Continue the development, evaluation, and assessment of 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 and performance of future systems. Continue the development, evaluation, assessment, and ground testing of adaptive structures, subsystem hardware, and antenna integration into load-bearing structures to create multi-function or ultra-lightweight concepts. Complete feasibility determination efforts of energy storage concepts that are integrated into load-bearing structures. Complete the development and analysis, and initiate evaluation and testing of critical subsystem hardware integration methods that enable directed energy weapons to be carried out on future air vehicles. Initiate development, analysis, and evaluation of innovative technologies that integrate active aeroelastic design concepts, adaptive structures, and aerodynamic flow control technologies to enable viable long-range and long endurance air vehicle 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. Note: In FY 2005 and out, funding increased due to increased emphasis placed on air vehicle structures for high-speed vehicles.	11.732	14.384	17.400	16.555

(U) In FY 2004: Developed technologies that incorporate advanced materials, as well as passive and active cooling to withstand extreme flight environments. Completed the development of assessment methodologies for air vehicle assessment.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2401 Structures**

(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; joining concepts; and tanks.

(U) In FY 2006: Refine the development of technologies that incorporate advanced materials and design concepts for the creation of an integrated air vehicle structure that can withstand extreme flight environments. Technologies will improve durability of existing and future aerospace vehicle structures resulting in reduced cost and increased life. Continue the development of concepts germane to advanced, all weather, durable, thermal protection systems; attachment techniques; vehicle health management; joining concepts; and tanks.

(U) In FY 2007: Further develop technologies that incorporate advanced materials and design concepts for the creation of an integrated air vehicle structure that can withstand extreme flight environments. Technologies will improve durability of existing and future aerospace vehicle structures resulting in reduced cost and increased life. Complete development of concepts germane to advanced, all weather, durable, thermal protections systems; attachment techniques; vehicle health management; hot primary structures; hybrid structures; joining concepts; and tanks.

(U)

(U) Total Cost	26.541	32.542	41.005	44.258

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602102F, Materials.										
(U) PE 0602500F - Multi-Disciplinary Space Technology.										
(U) PE 0603112F, Advanced Materials for Weapon Systems.										
(U) PE 0603211F, Aerospace Technology Dev/Demo.										
(U) PE 0604015F, Next Generation Bomber.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2401 Structures**

(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 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2403	Flight Controls and Pilot-Vehicle Interface	15.079	17.785	28.805	31.694	26.933	28.734	29.175	29.588	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006 and out, increased funding is due to increased emphasis being placed on incorporating data from air vehicle monitoring components into flight control.

(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 2004	FY 2005	FY 2006	FY 2007
(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. Note: Increased funding in FY 2006 and out, is due to increased emphasis being placed on incorporating data from air vehicle monitoring components into the flight control systems.	5.483	7.108	13.730	15.912

(U) In FY 2004: Developed and assessed advanced control mechanization to provide highly reliable operations for manned and unmanned systems at reduced size, weight, and cost. Developed demonstrations of validation and verification techniques for complex, adaptive, and autonomous control software. Defined 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 evaluation of sensing and associated interpretation techniques for unmanned system situational awareness in airspace operations. Continue to enhance real-time fault 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) In FY 2006: Further the development and assessment of advanced control mechanization technologies to

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**

provide highly reliable operations for manned and unmanned systems under adverse environments at significantly reduced size, weight, and cost. Develop high-density optical component technologies for adverse environments that reduce subsystem size, weight, and cost while considering maintainability. Design systems for safety-critical control using high-density optical components. Continue to develop and assess tools and processes for the affordable validation and verification of complex, adaptive, and autonomous control software. Develop technologies and analysis tools to extend design-time verification and validation of intelligent, autonomous, and reconfigurable control systems for enhanced assurance. Continue the evaluation of sensing and associated interpretation techniques for unmanned system situational awareness in airspace operations. Continue to enhance real-time fault compensation for aerospace vehicles using integrated health management. Continue the development and evaluation of novel flight control effectors for distributed actuation and morphing aerospace vehicles.

(U) In FY 2007: Further the development and assessment of advanced control mechanization technologies to provide highly reliable operations for manned and unmanned systems under adverse environments at significantly reduced size, weight, and cost. Develop high-density optical component technologies for adverse environments that reduce subsystem size, weight, and cost while considering maintainability. Design systems for safety-critical control using high-density optical components. Continue to develop and assess tools and processes for the affordable validation and verification of complex, adaptive, and autonomous control software. Refine technologies and analysis tools for reconfigurable control systems. Complete the evaluation of sensing and associated interpretation techniques for unmanned system situational awareness in aerospace operations. Refine technologies that permit integrated vehicle health management.

(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. Note: In FY 2006 and out, increased funding is due to increased emphasis being placed on developing flight controls for small air platforms operating in an urban environment.	3.990	3.646	6.530	9.422

(U) In FY 2004: Developed and assessed novel control automation techniques and algorithms to enable safe and interoperable application of unmanned vehicle systems. Investigated feasibility of biology inspired control techniques to simplify unmanned systems autonomy implementations. Continued to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle packages. Developed 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**

	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)	In FY 2006: Assess novel control automation techniques and adaptive algorithms to enable safe and interoperable application of manned and unmanned aerospace systems. Continue to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle flight formations.				
(U)	In FY 2007: Continue to develop and assess novel control automation techniques and adaptive algorithms to enable safe and interoperable application of manned and unmanned aerospace systems. Continue to enhance reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle flight formations. Initiate development and assessment of cooperative control techniques for close-in surveillance of urban environments. Initiate control and situational awareness requirements development for interoperability of unmanned vehicles in terminal area and ground operations.				
(U)					
(U)	MAJOR THRUST: Develop tools and methods for capitalizing on simulation-based research and development of future aircraft. Note: In FY 2006 and out, funding increased to expand simulation efforts.	4.427	5.743	8.545	6.360
(U)	In FY 2004: 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. Conducted simulation assessments of advanced unmanned aerospace vehicles concepts. Enhanced simulation and analysis capabilities through incorporation of cost models to determine the affordability of new technologies. Refined the development capability to virtually simulate future strike aircraft. Formulated and simulated 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.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2403 Flight Controls and Pilot-Vehicle Interface**

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	In FY 2006: Conduct assessments of advanced manned and unmanned aerospace concepts in simulated future environments. Conduct analysis of future strike concepts in a 2020+ virtual environment. Continue analysis of long endurance intelligence, surveillance, and reconnaissance platforms in a network centric environment. Continue to support simulation activities for advanced transports and future tankers. Support the analysis of new concepts in hostile urban environments and missions requiring aircraft-like access to space.				
(U)	In FY 2007: Complete assessments of advanced manned and unmanned aerospace concepts in simulated future environments. Complete analysis of long endurance intelligence, surveillance, and reconnaissance platforms in a network centric environment. Conduct technology trade studies for next generation theater transports. Conduct the analysis of new concepts in access to space missions. Conduct analyses of new concepts in hostile urban environments.				
(U)					
(U)	CONGRESSIONAL ADD: Intelligent Flight Control Simulation Research.	1.179	1.288	0.000	0.000
(U)	In FY 2004: Continued Congressionally-directed effort for intelligent flight control simulation research laboratory.				
(U)	In FY 2005: Continued Congressionally-directed effort for intelligent flight control simulation research laboratory.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	15.079	17.785	28.805	31.694

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602202F, Human Effectiveness Applied Research.										
(U)	PE 0602204F, Aerospace Sensors.										
(U)	PE 0602500F - Multi-Disciplinary Space Technology.										
(U)	PE 0603211F, Aerospace										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

(U) Technology Dev/Demo. PE 0604015F, 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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2404 Aeromechanics and Integration	23.080	26.074	26.869	28.277	33.052	32.654	33.148	33.614	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 multi-disciplinary advances in airframe, propulsion, 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop aerodynamic prediction efforts centered on expanding the design capabilities of manned and unmanned air vehicles. Note: In FY 2006, efforts for both manned and unmanned air vehicles were combined in this Major Thrust.	4.028	2.571	3.532	3.275

(U) In FY 2004: Developed and assessed aeronautical technologies that enable broad use of unmanned air vehicles in future missions to reduce life cycle costs and decrease human risk. Developed signature compatible, high lift wings for long-duration surveillance missions. Developed technology to improve engine nozzle design for increased survivability. Performed mission assessment and developed low-cost unmanned air vehicle concept to perform tactical surveillance. Applied 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) In FY 2006: 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. Evaluate the application of flow control techniques to complex air vehicle designs to achieve reduced drag and improved propulsion system performance. Continue to develop technologies for improved weapon delivery and propulsion system performance in unmanned air vehicles.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2404 Aeromechanics and Integration**

(U) In FY 2007: 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. Initiate development and evaluation of flow control techniques to complex air vehicle designs to achieve reduced drag and improved propulsion system performance on low speed vehicles. Continue to develop technologies for improved weapon delivery and propulsion system performance in unmanned air vehicles.					
(U)					
(U) MAJOR THRUST: Develop aerodynamic prediction efforts centered on expanding the design capabilities of manned air vehicles. Note: This effort was completed in FY 2004.	3.916	0.000	0.000	0.000	
(U) In FY 2004: Developed design tools that permit quicker and more affordable certification of aerodynamic enhancements to extend the operational life of the current fleet. Enhancement of computer design and analysis code that reduced the need for expensive flight-testing, including completion of a robust unstructured mesh generation and adoption framework.					
(U) In FY 2005: Not Applicable.					
(U) In FY 2006: Not Applicable.					
(U) In FY 2007: Not Applicable.					
(U)					
(U) MAJOR THRUST: Develop new and improved concepts, designs, and analysis of technologies to enable revolutionary capabilities for sustained high-speed flight and re-useable high altitude aerospace vehicle efforts. Note: In FY 2004, the funding for this effort was zeroed to support increased emphasis that was placed on DDR&E's National Aerospace Initiative. In FY 2005, reuseable, high altitude aircraft efforts were broken out for increased visibility between high-speed and reuseable, high altitude aircraft efforts. In FY 2006 and out, increased emphasis has been placed on assessing the next generation long-range, high-speed air vehicle concepts.	0.000	8.815	13.460	15.901	
(U) In FY 2004: Not Applicable.					
(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) In FY 2006: Continue development and assessment of aerospace technologies that enable sustained high-speed flight to permit global reach. Continue development of integrated airframe propulsion design concepts for high-speed aerospace vehicles. Conduct computational aerodynamic analysis and sub-scale					

aerodynamic testing of advanced inlet boundary layer flow control techniques, secondary flow devices, and high-speed inlet apertures. Conduct computational aerodynamic analysis of high performance vectoring exhaust nozzles. Continue development of analytic methods for modeling the plasma flow field over high-speed vehicles to significantly reduce drag. Conduct computational aerodynamic analysis of high efficiency wing-body aero configurations including advanced flight control techniques.

(U) In FY 2007: Continue development and assessment of aerospace technologies that enable sustained high-speed flight to permit global reach. Continue development of integrated airframe propulsion design concepts for high-speed aerospace vehicles. Conduct sub-scale aerodynamic testing of integrated inlet concepts on high efficiency aero configurations for system level performance validation. Develop and analyze thermally integrated structures for lightweight integrated exhaust systems and airframes. Conduct high fidelity aerodynamic testing of advance control techniques for low speed and high-speed operation. Develop analytical stability and control simulations to verify system level operability. Complete development of analytic methods for modeling the plasma flow field over high-speed vehicles to significantly reduce drag

(U)

(U) MAJOR THRUST: Develop new and improved concepts, designs, and analysis of technologies to enable revolutionary capabilities for re-useable, high altitude aircraft . Note: In FY 2004, the funding for this effort was zeroed to support increased emphasis that was placed on DDR&E's National Aerospace Initiative. In FY 2005, the reuseable, high altitude aircraft efforts previously described in the above related Major Thrust area were broken out to allow for increased visibility between high-speed and reuseable, high altitude aircraft efforts. The FY 2006 and FY 2007 efforts will be leveraging the results of the high-speed Major Thrust area previously listed above.	0.000	7.245	3.738	1.501

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Develop and assess aerospace technologies that enable high-speed flight to permit reuseable, high altitude aircraft operations. Continue development of computational, multi-disciplinary, 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) In FY 2006: Continue development and assessment of aerospace technologies that enable high-speed flight to permit reuseable, high altitude aircraft. Continue development and initiate evaluation of computational, multi-disciplinary, experimental, and analytical tools to simulate and control the flow fields around advanced concepts for ultra-high-speed aerospace vehicles in extreme flight environments. Continue and evaluate development of techniques to evaluate transatmospheric vehicle aerodynamic

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2404 Aeromechanics and Integration**

	configurations to validate aero thermodynamic predictions and analysis techniques.				
(U)	In FY 2007: Develop and assess aerospace technologies that enable reuseable, high altitude aircraft. Complete development and evaluation of computational, multi-disciplinary, 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. Complete development of 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. Note: In FY 2006 and out, investment is decreasing pending further development of directed energy applications.	9.566	4.093	2.544	1.716
(U)	In FY 2004: Developed and evaluated critical aeronautical technologies to enable directed energy weapons to be carried on future air vehicles to improve combat effectiveness. Developed 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. Performed 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)	In FY 2006: Continue development and evaluation of critical aeronautical technologies that enable directed energy weapons to be carried on future air vehicles, including maneuvering fighter aircraft, to improve combat effectiveness. Complete analysis of tactical utility of 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)	In FY 2007: Complete development and evaluation of critical aeronautical technologies that enable directed energy weapons to be carried on future air vehicles, including maneuvering fighter aircraft, to improve combat effectiveness. Complete 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.	5.570	2.259	3.595	5.884

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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

(U)	In FY 2004: Developed and assessed aeronautical technologies to enable revolutionary re-fueling and transport aircraft designs for rapid global mobility. Developed technologies to enable multiple roles and missions for support aircraft. Completed innovative designs for re-fueling and transport aircraft to improve range and payload capacity. Completed 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 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)	In FY 2006: Continue to develop and assess aeronautical technologies including high lift systems, transonic, and structural designs that enable revolutionary tanker and transport aircraft designs for rapid global mobility. Continue to develop technologies that enable multiple roles and missions for delivery and support aircraft.				
(U)	In FY 2007: Further development and assessment of aeronautical technologies including high lift systems, transonic, and structural that enable revolutionary tanker and transport aircraft designs for rapid global mobility. Continue to develop technologies that enable multiple roles and missions for delivery and support aircraft.				
(U)	CONGRESSIONAL ADD: Unique Stealth Unmanned Air Vehicle Houck Aircraft Design Program.	0.000	1.091	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiated Congressionally-directed effort for unique stealth unmanned air vehicle Houck aircraft design program.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	23.080	26.074	26.869	28.277

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities: PE 0602500F -										
(U)	Multi-Disciplinary Space Technology.										
(U)	PE 0603211F, Aerospace Technology Dev/Demo.										
(U)	PE 0603500F -										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Vehicle Technologies**	PROJECT NUMBER AND TITLE **2404 Aeromechanics and Integration**

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

Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0604015F, 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.

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Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

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

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

(U) A. Mission Description and Budget Item Justification

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

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

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

(U) Significant Program Changes:

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE: **February 2005**

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

(U) A. Mission Description and Budget Item Justification

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

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

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

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

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

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	deployable visual simulation systems. Conduct engineering and human factors analyses of display devices.				
(U)	In FY 2007: Research and specify key perceptual performance parameters for deployable visual display systems including resolution, image stability, target tracking accuracy, and transport delay. Assist in the development of head-mounted and deployable display proof-of-concepts that meet these specifications. Continue research and evaluation of visual system requirements for air-to-ground and composite force training. Conduct engineering and human factors analyses of display devices.				
(U)					
(U)	MAJOR THRUST: Research and analyze tools, strategies, and performance support methods for improving combat mission training, rehearsal, and operations for aircrews and command and control forces. Research provides the combat air forces and global strike operations with the empirical data and guidelines for improving the quality and effectiveness of both air and command and control DMT and live flight training environments through the identification of competency-based training methods.	6.395	7.788	8.585	8.823
(U)	In FY 2004: Completed specifications of mission essential competencies for operators in major air operations center divisions and teams. Completed preliminary training effectiveness evaluations with the Air Force Weapons School and an operational mission training center. Developed a study plan for dynamic aerospace control training incorporating command and control, air combat, and coalition entities.				
(U)	In FY 2005: Complete guidelines for applying DMT to the Air Combat Command Ready Aircrew Program training and mission objectives based on identified competencies. Complete specification of mission essential competencies for operators in Air Operations Center (AOC) specialty teams and unique positions. Develop competency-based behavioral models and representations of select operators for use in simulation-based training systems. Complete development of specification tools for coalition training and collaborative mission planning.				
(U)	In FY 2006: Evaluate integrated learning and readiness assessment models, data, and specifications. Assess usability of exemplar DMO training scenario design tool. Explore and evaluate virtual environment training syllabi capable of tailoring to individual needs. Investigate fully immersive training environments, with realistic, interactive visual scenery that can be adapted by multiple platforms. Analyze how spin-up time after brief and extended delays can be reduced with virtual reality training.				
(U)	In FY 2007: Evaluate capability to assess proficiency within operational contexts. Identify guidelines for refresher and continuation training and rehearsal. Analyze and review instructional designs for common training requirements across airframes. Begin development of a fully immersive training environment, with realistic, interactive visual scenery, that can be adapted for multiple platforms. Develop a migration transition plan from hardware-dependent training simulators to software-dependent				

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

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

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602202F Human Effectiveness Applied Research**	**1710 Deployment and Sustainment**

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

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

(U) A. Mission Description and Budget Item Justification

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

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

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	simulation requirements and technology options for Air Force units to select the best options for using limited logistics resources in crisis action circumstances.				
(U)	In FY 2005: Examine new techniques to identify both functional and system requirements, as well as new information presentation techniques for future logistics and maintenance software tools. Continue working to define the requirements and component technologies necessary to support a more automated and responsive maintenance environment. Design foundational models for advanced simulation capabilities that optimize limited logistics resources during operations. Begin work on defining "sense-respond" capabilities which will promote effects-based logistics through a common operating picture.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop, demonstrate, and apply predictive assessment models to determine the toxicological risks to airmen if exposed to operational compounds and materials. This will improve commanders' decision-making ability to properly balance mission and force protection requirements.	1.111	0.862	0.000	0.000
(U)	In FY 2004: Investigated the use of genomics, proteomics, and metabonomics to predict toxic combinations of chemicals and to measure exposures of airmen to toxic chemicals before any adverse health effects occur. Developed simulation models to predict the effects on operational forces in different exposure situations.				
(U)	In FY 2005: Develop biotechnology procedures and computer simulation models to predict effects of toxic exposure on airmen and improve the protection of Air Force personnel. Develop and demonstrate algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bio-electromechanical capability for Air Force systems.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop nuclear magnetic resonance (NMR) technologies that will identify warfighter exposure to toxic chemicals before they result in illness or a reduction in mission performance, thus greatly improving force protection and the probability of mission success.	1.225	4.337	0.000	0.000
(U)	In FY 2004: Initiated genomic and NMR studies to identify target-organ biomarkers in body fluids of the deployed warfighter exposed to hazardous agents. Validated target-organ NMR pattern recognition algorithms for early detection of the effects of unknown hazardous agents on Air Force personnel.				
(U)	In FY 2005: Conduct genomic and NMR studies and initiate proteomic and metabolite studies to identify target-organ biomarkers in body fluids of the deployed warfighter exposed to hazardous agents.				

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	Assess target-organ response biomarker patterns for early detection of the effects of unknown hazardous agents on Air Force personnel.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Bio Medical DNA Program.	0.000	1.000	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate Congressionally-directed effort for Bio Medical DNA Program.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	8.006	9.783	0.000	0.000

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

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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602202F Human Effectiveness Applied Research**	**7184 Decision Effectiveness & Biosciences**

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

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

(U) A. Mission Description and Budget Item Justification

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

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop interface technologies that enhance human-human and human-machine collaboration in network-centric warfare environments. These technologies will enable the common operational understanding and shared, distributed decision making required on the modern battlefield.	4.428	4.949	5.038	4.992
(U) In FY 2004: Demonstrated a real-time ability to use on-line estimates of crew workload and situational awareness to adjust automation during future unmanned combat air vehicle missions. Performed laboratory demonstration of multi-sensory display concepts and technology for virtual air command in airborne early warning missions, and continue to assess the impact of near-term and far-term autonomous vehicle capability on the remote interface and decision support requirements of intelligent unmanned air vehicles. Performed research on speech signal processing and speech-based countermeasures for information operations, and explored the concept of a robust stressed-speaker identification capability.				
(U) In FY 2005: Demonstrate the feasibility of a situational awareness estimator to improve real-time task sharing during multi-platform unmanned combat air vehicle missions. Continue to explore the decision support benefits of multi-sensory controls and displays for intelligent autonomous air vehicles and for multi-mission command and control aircraft, and demonstrate a common functionality for ground control centers and for airborne control platforms. Perform laboratory simulations to determine strike chain efficiencies achievable from network-centric interfaces that span airborne controllers, unmanned				

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	vehicles, and special forces on the ground. Continue research on speech signal processing and speech-based countermeasures for information operations and demonstrate a multimedia speech extraction interface.				
(U)	In FY 2006: Begin spiral development of a laboratory prototype of a speech recognizer/synthesizer based on multilingual phoneme acoustic models designed to enhance collaboration between multinational forces. Complete development of human-machine interface style guide and begin development of a collaboration toolkit, both essential for developing effective warfighter interfaces for air battle management command and control (BMC2). Complete development of an operator cognitive state assessment package that enables real-time human-machine collaboration.				
(U)	In FY 2007: Determine the risk and benefit of adding language, accent, and domain models into the laboratory speech recognizer/synthesizer, and continue to develop advanced speech processing technology. Complete development of a collaboration toolkit for BMC2. Develop and evaluate BMC2 decision support technologies, and plan to demonstrate operational benefits in an advanced technology program.				
(U)					
(U)	MAJOR THRUST: Develop cognitive system interface technologies to achieve common understanding at all echelons of operations and to improve decision-making and predictive battlespace awareness. These technologies offer breakthrough potential for understanding and modeling human behavior, in order to assure timely and effective decisions, while also providing context-sensitive human-computer interfaces that support decision effectiveness.	3.409	2.559	3.576	3.510
(U)	In FY 2004: Performed laboratory and field evaluations of a cognitive interface and knowledge repository to support information operations in the future air operations center. Began exploration of information, display, and course-of-action aids by analyzing information needs and by developing a combat operations visualization concept. Supported the Targets Under Trees program by evaluating target nomination advances in a field exercise.				
(U)	In FY 2005: Transition to advanced development a cognitive interface and knowledge repository to support decision making in the future AOC. Continue a multi-year exploration of information, display, and course-of-action aids by demonstrating a multi-mode information interface to speed air tasking orders.				
(U)	In FY 2006: Identify and develop software design patterns that enable the standardization and reuse of human-computer interface elements in Command and Control Intelligence, Surveillance, and Reconnaissance systems. Begin to develop collaboration techniques that enable diverse users to share a common object representation of the problem domain. Perform laboratory research on the cultural and ethnic bases of human decision-making. Develop methods to represent knowledge about adversaries as a				

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	key technology in overcoming barriers that limit effects-based operations.				
(U)	In FY 2007: Continue development and begin the transition to advanced development of software design patterns that enable the standardization of human-computer interface elements in Command and Control Intelligence, Surveillance, and Reconnaissance systems. Continue to develop collaboration techniques and methods to embed them in command and control systems. Continue researching the cultural and ethnic bases of human decision making and begin to develop human performance models that reflect these differences to enable effects-based operations.				
(U)					
(U)	MAJOR THRUST: Establish the technology base for a decision support environment that enables the Joint Forces Commander (JFC), Joint Force Air Component Commander (JFACC), and command staffs to interrelate the past, present, and future battlefield mission states and to predict the intent and actions of adversaries during Joint Operations. Note: In FY 2006, this increase in funding is due to greater emphasis on commanders decision aids.	0.000	0.000	4.250	3.750
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Begin developing advanced visualization techniques that enable the uncertainty associated with information to be incorporated into the iconic or graphic portrayal scheme for command center display. Begin to develop methods to simulate enemy potential courses of action. Begin the development of "sensemaking" tools for dynamic battlefields. Begin research toward developing knowledge representation techniques to model potential adversaries and complex systems of systems. Begin research to develop an integrated set of work aids that will support a commander's decision-making in a future environment of continuous Anticipatory Planning and Operations (APO).				
(U)	In FY 2007: Continue developing advanced visualization techniques that enable the uncertainty associated with information to be incorporated into the iconic or graphic portrayal scheme for command center display. Continue to develop, and begin to transition to advanced development, needed methods to simulate enemy potential courses of action, beginning with simple models of adversary behavior. Conduct laboratory experiments to evaluate "sensemaking" tools and displays for dynamic battlefields. Continue to develop knowledge representation techniques to model potential adversaries and complex systems of systems. Continue to develop an integrated set of APO work aids to achieve persistent operational planning, persistent prediction, and focused execution even as military and broad national security objectives are dynamically changing.				
(U)					
(U)	MAJOR THRUST: Develop system control interface concepts enabling full operator exploitation of all platform capabilities. Identify the best mix of intelligent methods and traditional design to	3.187	3.661	4.664	4.873

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

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

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

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

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

(U)

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

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

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

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

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

(U)

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

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

(U) In FY 2005: Complete technology assessment of acoustic remote threat detection in perimeter defense, and explore the use of acoustic detection capabilities by special tactics forces. Demonstrate the feasibility of combining active noise reduction with three-dimensional (3-D) audio communications for a high performance (50 dB) hearing protection system. Identify a concept to validate the dynamic noise model in terms of lowering the cost of collecting acoustic data, and explore acoustic modeling for operational analysis. Begin to analyze how to minimize acoustic detection of vectored thrust aircraft. Begin to develop virtual audio interface technology using dynamic audio/visual interaction for use with HMDs.

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

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

(U)

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

(U) In FY 2004: Conducted research to develop, distribute, and synchronize knowledge, training, and decision-making among various team members, multiple support teams, and reachback locations via advanced collaboration technologies and environments in order to enhance predictive battlespace awareness. Determined feasibility and technical approach for developing adversary cultural decision models, and development of training techniques and tools for information warriors.

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

(U) In FY 2006: Conduct research to develop better visualization for spectral data exploitation and to improve predictive battlespace awareness capabilities. Continue next stage of developing proof-of-concept technologies to specify, measure, and model key parameters.

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

(U)

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

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

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

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

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

(U)

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

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

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	protection requirements. Note: In FY 2006, this effort moved from Project 1710.				
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Develop procedures and computer simulation models to predict effects of toxic compound and nanomaterial exposure on Air Expeditionary Forces and improve the protection of Air Force personnel in operational environments. Continue development and demonstration of algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bioelectromechanical capability for Air Force systems.				
(U)	In FY 2007: Apply procedures and computer simulation models to predict effects of toxic compound and nanomaterial exposure on Air Expeditionary Forces and improve the protection of Air Force personnel in operational environments. Further develop and demonstrate algorithms to describe the function of a cell-like entity with the potential for improved logic, sensor, and bioelectromechanical capability for Air Force systems.				
(U)					
(U)	MAJOR THRUST: Develop biotechnologies to identify warfighter exposures to hazardous agents before they result in illness or a reduction in mission performance, thus greatly improving force protection and the probability of mission success. Note: In FY 2006, this effort moved from Project 1710.	0.000	0.000	5.053	6.190
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Conduct genomic, proteomic and metabolite studies to identify target-organ biomarkers in body fluids of the deployed airmen exposed to hazardous agents. Assess kidney and liver organ response biomarker patterns for early detection of the effects of unknown hazardous agents on Air Force personnel.				
(U)	In FY 2007: Continue to conduct genomic, proteomic and metabolite studies to identify target-organ biomarkers in body fluids of the deployed airmen exposed to hazardous agents. Complete kidney and assess liver organ response biomarker patterns for early detection of the effects of unknown hazardous agents on Air Force personnel.				
(U)					
(U)	MAJOR THRUST: Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force operations. Note: In FY 2006, this effort moved from Project 1710.	0.000	0.000	2.003	2.006
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				

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

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

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

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602201F, Aerospace Flight Dynamics.										
(U)	PE 0602204F, Aerospace Sensors.										
(U)	PE 0602702F, Command, Control, and Communications.										
(U)	PE 0603205F, Flight Vehicle Technology.										
(U)	PE 0603231F, Crew Systems and Personnel Protection Technology.										
(U)	PE 0603245F, Flight Vehicle Technology Integration.										
(U)	PE 0604706F, Life Support Systems.										
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

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(U) **D. Acquisition Strategy**

Not Applicable.

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

(U) A. Mission Description and Budget Item Justification

This project predicts and mitigates the effects of exposure to directed energy, warfighter fatigue, altitude, and high, rapid-onset gravitational forces. The project enables the safe operational use of Air Force aerospace systems through technology developments that ameliorate/counter/exploit the biological effects of aerospace stressors, directed energy, and other threats. It addresses areas such as safety, risk assessment, mission planning, countermeasures, personnel protection, and counterproliferation research, technology development, and validation. The project also assesses the bioeffects of directed energy technologies for force protection, special operations, military operations other than war, and peacekeeping applications.

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

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

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

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

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

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

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

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

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

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

(U)

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

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

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

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

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

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

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

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

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	31.342	24.162	15.996	19.664

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602720A, Environmental Quality Technology.										
(U)	PE 0603231F, Crew Systems and Personnel Protection Technology.										
(U)	PE 0604617F, Agile Combat Support.										
(U)	PE 0604706F, Life Support Systems.										
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2005**

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602203F Aerospace Propulsion

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	126.295	132.918	107.523	115.360	111.064	116.822	118.426	119.872	Continuing	TBD
3012	Advanced Propulsion Technology	16.681	13.094	18.876	23.974	22.228	22.654	23.038	23.392	Continuing	TBD
3048	Fuels and Lubrication	17.540	16.098	14.371	16.255	12.842	13.553	13.674	13.774	Continuing	TBD
3066	Turbine Engine Technology	31.341	34.345	32.095	31.600	33.881	35.948	36.398	36.802	Continuing	TBD
3145	Aerospace Power Technology	36.155	44.152	30.134	29.025	31.144	33.201	33.724	34.203	Continuing	TBD
4847	Rocket Propulsion Technology	24.578	25.229	12.047	14.506	10.969	11.466	11.592	11.701	Continuing	TBD

(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 conversion/storage, power generation/power conditioning/distribution, 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 2005, Congress added $1.0 million for Information Assurance Initiative; $1.0 million for Intense, Ultrafast Laser Microfabrication and Diagnostics; $1.0 million for Wavelength Agile Spectral Harmonic Oxygen Sensor; $1.4 million for Hybrid Bearings; $1.0 million for Versatile Affordable Advanced Turbine Engine-Titanium Matrix Composites; $1.9 million for Center for Flow Physics and Control; $1.5 million for Cell-Level Battery Controller; $1.0 million for Lightweight Photovoltaic for Portable Power and Hydrogen Generation; $3.1 million for Hypersonics Vehicle Electric Power Systems; $6.5 million for High Powered Electrical Aircraft Capabilities; $1.9 million for Center for Security of Large-Scale Systems; $1.5 million for Remote-Base Power Demonstration; $2.8 million for Integrated Cooling and Power System with Magnetic Bearing Turbogenerator; $1.3 million for Advanced Cooling Technology for High Flux Military Diode Laser Arrays; $4.0 million for Advanced Vehicle and Propulsion Center; $6.8 million for Jet and Rocket Engine Test Site; $1.0 million for Aerospace Laboratory Equipment Upgrade; $1.0 million for Advanced Aerospace Vehicle Cooling Technologies; $0.75 million for High Regression Rate Hybrid Rocket Fuels; and $1.0 million for Engineering Research Laboratory Equipment Upgrade. 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.

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

	FY 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	126.988	92.650	109.833	119.239
(U) Current PBR/President's Budget	126.295	132.918	107.523	115.360
(U) Total Adjustments	-0.693	40.268		
(U) Congressional Program Reductions				
Congressional Rescissions		-1.182		
Congressional Increases		41.450		
Reprogrammings				
SBIR/STTR Transfer	-0.693			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**		PROJECT NUMBER AND TITLE **3012 Advanced Propulsion Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3012 Advanced Propulsion Technology	16.681	13.094	18.876	23.974	22.228	22.654	23.038	23.392	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2005, funding level was reduced as Air Force efforts shifted from variable-geometry demonstrators to Advanced Technology Development (6.3) fixed-geometry demonstrators. In FY 2006, 2007, and 2008 funding was increased to accelerate efforts to develop technologies to support an Air Force scramjet effort.

(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 provide 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 Department of Defense and NASA. Efforts include modeling, simulations, and proof of concept demonstrations of critical components; advanced component development; and ground-based demonstrations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop advanced fuel-cooled scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future warfighter needs. Note: In FY 2005, start of ground demonstrations was delayed until FY 2006 due to shift in type of demonstrator.	16.113	7.441	7.813	11.685

(U) In FY 2004: Developed flight weight engine components including flight weight fuel control valves, fuel pumps, and engine controllers. Initiated detailed analysis for mating scramjet flight engines with demonstrator vehicles. Performed trajectory optimization for flight test. Evaluated options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Verified operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation. Initiated fabrication of a flight weight ground test engine with a fuel cooled structure incorporating a variable geometry inlet. Note: In FY 2004, several of these activities were moved from PE 0602500F, Project 5027, to consolidate all 6.2 scramjet non-space unique demonstration efforts.

(U) In FY 2005: Continue flight weight engine components development including flight weight fuel control valves, fuel pumps, and engine controllers. Complete detailed analysis mating of scramjet flight engines to demonstrator vehicles. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Continue verification 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 flight weight, fuel-cooled ground test engine with a variable geometry inlet.

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(U) In FY 2006: Continue development and demonstration of flight weight engine components and a control system with closed loop controller. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, 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. Design, fabricate, and initiate ground test of a flight weight, fixed geometry inlet scramjet engine with improved operability to reduce flight test risk.

(U) In FY 2007: Continue development and demonstration of flight weight engine components and a control system with closed loop controller. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, 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 ground test of a flight weight, fixed geometry inlet scramjet engine with improved operability to reduce flight test risk.

(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. CCEs require the development and demonstration of components to integrate scramjets with high speed turbines and/or rocket engines for efficient propulsion over a broad range of Mach numbers.	0.568	0.256	1.095	2.144

(U) In FY 2004: Initiated system trade studies to determine military payoff and establish component technology goals. Initiated defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and the Defense Advanced Research Projects Agency (DARPA). Note: In FY 2004, these non-space unique activities were moved from PE 0602500F, Project 5027.

(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 DARPA.

(U) In FY 2006: 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 DARPA. Initiate development of advanced components for turbine-based and rocket-based CCEs. Initial emphasis is on

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	advanced inlets for turbine-based CCEs capable of operating for Mach 0-8. Design sub-scale inlet test article.				
(U)	In FY 2007: 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 DARPA. Continue development of advanced components for turbine-based and rocket-based CCEs. Fabricate and initiate test of advanced inlets for turbine-based CCEs capable of operating for Mach 0-Mach 8.				
(U)					
(U)	MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future missiles and for aerospace vehicles. Note: In FY 2005, these activities were moved from PE 0602500F, Project 5027 to consolidate all 6.2 scramjet development efforts.	0.000	4.406	9.968	10.145
(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 3.5 to provide robust options for CCEs. Support development of low internal drag flame stabilization devices and flight test engine components.				
(U)	In FY 2006: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Fabricate and initiate test of scramjet combustors sized for reusable applications with improved structural efficiency. Support development of low internal drag flame stabilization devices and flight test engine components.				
(U)	In FY 2007: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Complete test of scramjet combustors sized for reusable applications with improved structural efficiency. Initiate development of improved durability engine concepts. Continue development of low internal drag flame stabilization devices and flight test engine components.				
(U)					
(U)	CONGRESSIONAL ADD: Information Assurance Initiative.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Support the Air Force Research Laboratory-Propulsion Directorate Information Assurance Initiative by facilitating information technology infrastructure security upgrades in compliance with				

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	Congressional mandates.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	16.681	13.094	18.876	23.974

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0601102F, Defense Research Sciences.										
(U)	PE 0602201F, Aerospace Flight Dynamics.										
(U)	PE 0602500F, Multi-Disciplinary Space Tech.										
(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										

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(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

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3048 Fuels and Lubrication	17.540	16.098	14.371	16.255	12.842	13.553	13.674	13.774	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops improved fuels, lubricants, mechanical systems, and combustion concepts for advanced turbine engines, scramjets, pulse detonation, and combined cycle engines, and technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. 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 2004	FY 2005	FY 2006	FY 2007
(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.	1.994	1.599	1.806	2.042

(U) In FY 2004: Developed additive packages to enable JP-8 to achieve jet propulsion at thermally stable low temperatures (high altitude). Developed approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit, including thermal stability additives, fuel deoxygenation, and improved coatings. Enhanced existing fuel modeling and simulation capabilities by incorporation of more realistic additive performance models and detailed fuel chemistry.

(U) In FY 2005: Complete additive package optimization and test protocols to enable JP-8 to achieve jet propulsion at thermally stable low temperatures. Conduct lab-scale evaluation of approaches 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 incorporating more realistic additive performance models. Develop engine thermal management models.

(U) In FY 2006: Continue conducting lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative energy fuels, and improved materials and coatings. Complete initial development of engine thermal management models, aiming toward system-level models of advanced aircraft. Initiate development of laboratory-scale combustion tests for evaluating combustion performance of fuels and additives at low fuel and air temperatures.

(U) In FY 2007: Continue conducting lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative energy fuels, and improved materials and coatings. Initiate effort to validate component

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	performance models on aircraft thermal management simulator. Continue to develop approaches to assess and improve additive combustion behavior at low fuel and air temperatures. Test fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems.				
(U)					
(U)	MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature (including nano-scale additives), as well as, advanced emission diagnostic test protocols. Note: In FY 2004, the emissions and signature reduction activities became a separate effort in this Project.	1.081	0.991	1.119	1.266
(U)	In FY 2004: Developed emission reduction additives. Verified additives 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 additional additives performance in laboratory scale combustion tests. Complete development and application of advanced diagnostics for sub-micron particulate emissions.				
(U)	In FY 2006: Continue assessing novel fuel additives including nano-technologies and fuels derived from alternative energy resources to reduce emissions in laboratory scale combustion rigs. Develop higher-pressure laboratory-scale combustion tests and diagnostics for sub-micron particulate investigations.				
(U)	In FY 2007: Complete assessing novel fuel additives including nano-technologies and fuels derived from alternative energy resources to reduce emissions in laboratory scale combustion rigs. Initiate higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion.				
(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), as well as study fuel logistics vulnerabilities and develop detection and mitigation technologies.	1.118	0.991	1.119	1.266
(U)	In FY 2004: Developed improvements to existing fuel additive packages to simplify logistics and reduce cost. Conducted initial assessment of the performance of fuels from alternative sources, including Fischer-Tropsch fuels. Initiated investigation of biological contamination in fuel supply chain. Tested candidate technologies for field-fuel quality diagnostics. Investigated 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. Continue assessing performance of fuels from alternative sources, including Fischer-Tropsch fuels and bio-derived fuels. Further investigate biological contamination in fuels and the impact of fuel logistic supply chains. Develop field mitigation techniques for biological fuel contamination. Continue development of new field fuel quality diagnostics for fuel properties and bio-contamination.				

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(U)	In FY 2006: Complete assessment of fuel additives optimization for logistics footprint reduction. Continue to investigate performance of Fischer-Tropsch and other alternative fuels for aircraft and other field hardware. Complete investigation of supply chain biological contamination and the impact on fuel logistics. Initiate evaluation of nano-technology fuel sensors and biological mitigation techniques. Complete development of advanced field diagnostics techniques for fuel properties and bio-contamination.				
(U)	In FY 2007: Continue to investigate performance of Fischer-Tropsch and other alternative fuels for aircraft and other field hardware. Continue evaluation of advanced nano-technology fuel sensors, nano-technology fuel additives, and novel detection and mitigation technologies for biological growth.				
(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 boost applications.	0.508	0.496	0.560	0.633
(U)	In FY 2004: Completed preliminary development of fuel property and performance data for industry and Government use in selecting alternative hydrocarbon fuels for advanced propulsion. Investigated 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 boost applications. Test approaches to assess fuel thermal stability under high heat flux conditions relevant to advanced rockets and combined cycle engines.				
(U)	In FY 2006: Continue to assess advanced hydrocarbon propellant stability under high heat flux conditions for advanced rockets and combined cycle engines.				
(U)	In FY 2007: Continue to assess advanced hydrocarbon propellant stability under high heat flux conditions. Collect improved fuel property data for hydrocarbon propellant database.				
(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 emissions characteristics of fuels and fuel additives.	3.490	3.454	3.899	4.411
(U)	In FY 2004: Evaluated advanced combustor concepts and the inter-turbine burner combustor at conditions that simulate turbine-wake and turbine-inlet interactions. Investigated the performance of a rudimentary combined cycle pulse detonation engine (PDE). Evaluated the technical issues associated with incorporating PDE propulsion technologies into gas turbine engines. Performed experiments to validate the high-speed performance of a pure PDE. Completed 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				

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	turbine machinery. Evaluate and develop 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)	In FY 2006: Begin evaluating advanced combustion system performance at realistic operating conditions. Start investigating larger-scale inter-turbine burner concepts at relevant engine operating conditions to increase mission flexibility. Continue developing a PDE into turbine-based hybrid concept. Conduct experiments to validate chemical kinetics of practical fuels at high pressure and temperature. Perform modeling and simulation of advanced combustion systems to decrease design cycle time, optimize compact combustor, and augmentor designs, and to understand physical parameters controlling combustion processes. Evaluate and develop novel lightweight, high performance augmentor concepts.				
(U)	In FY 2007: Continue evaluating advanced combustion system performance at realistic operating conditions. Continue investigating inter-turbine burning concepts for large gas turbine engines. Continue integration of PDE into turbine-based hybrid concept. Evaluate and optimize advanced combustor, augmentor, and PDE concepts using modeling and simulation tools.				
(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.	0.961	0.496	0.560	0.635
(U)	In FY 2004: Developed approaches to improve fuel heat sink capability. Developed systems to minimize regenerative cooling heat loads absorbed by endothermic fuel systems. Developed means to improve fuel combustion performance, especially during cold start and cycle transition. Improved fuel system modeling and simulation tools to better simulate endothermic fuel behavior.				
(U)	In FY 2005: Evaluate, at a laboratory scale, 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. Complete improving fuel system modeling and simulation tools to better simulate endothermic fuel behavior.				
(U)	In FY 2006: Continue evaluating, at a laboratory scale, approaches to improve fuel heat sink and provide thermal management capability for high speed systems. Evaluate surface/catalyst effects on coke reduction to improve fuel heat sink capability and increase fuel system life. Initiate assessment of unconventional approaches to increase fuel heat sink, such as steam reforming.				
(U)	In FY 2007: Continue development of improved surfaces/catalysts to mitigate coking and thus improve fuel heat sink capability. Continue assessment of unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads, including low heat rejection structures.				
(U)					

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(U)	MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies.	0.890	0.622	0.702	0.794
(U)	In FY 2004: Investigated pollutant emission formation pathways through computational and experimental methods. Evaluated methods to reduce gaseous and particulate pollutant emission from legacy and future gas turbine engines. Investigated high intensity laser light interaction with matter for micromachining and diagnostic capabilities. Completed preliminary development and demonstration of sensors for the control of combustor performance and extension of component life.				
(U)	In FY 2005: Complete 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. Initiate investigation of the interaction of high intensity laser light with matter for micromachining and diagnostic capabilities.				
(U)	In FY 2006: Begin applying advanced laser diagnostics for accurate measurements inside advanced gas turbine combustion systems that will improve design cycle time. Develop sensor technologies for use in intelligent gas turbine engine combustion systems for enhanced operability, increased durability and performance. Continue investigation of high intensity laser light with matter for micromachining and diagnostic capabilities.				
(U)	In FY 2007: Continue application of advanced diagnostics in a relevant gas turbine combustion system environment. Apply diagnostics to sensor development and validate sensors in relevant gas turbine engine system. Conduct experiments to obtain benchmark-quality data for improvement of combustion modeling and simulation tools.				
(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, DoD, and commercial users. Generate and maintain military specifications for aviation engine lubricants, as well as continued field support activities for aviation lubrication technologies and DoD operational units.	1.896	1.923	2.171	2.455
(U)	In FY 2004: 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 man-rated, expendable, high-Mach, and unmanned air vehicle (UAV) turbine engines. Improved vapor lubricants for the expendable and small high Mach vehicles in support of a Navy demonstration, as well as follow on programs. Developed corrosion inhibition additives for improved storability of UAV engines. Transitioned some optimal ester lubricants to military and commercial turbine engines.				
(U)	In FY 2005: Expand development and test of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health				

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	monitoring. Initiate testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and UAV turbine engines. Design test approaches for optimal ester lubricant to military and commercial turbine engines. Coordinate oil research and development activities between Government, engine manufacturers, and oil companies in support of the Joint Oil Program (JOP). Engage oil companies to deliver prototype lubricants and initiate bench top evaluation. Design test approaches for JOP lubricants for use in new fighter demonstration engines.				
(U)	In FY 2006: Continue development and testing of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Continue testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and UAV turbine engines. Design test approaches for enhanced high thermal stability (HTS) oils for new, legacy, and commercial turbine engines. Focus optimal ester lubricant development on high Mach/high temperature military and commercial turbine engines. Test prototype JOP lubricants with mechanical hardware in preparation of new fighter demonstration engines.				
(U)	In FY 2007: Begin technology insertion of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring into demonstrator cores and engines. Continue testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and UAV turbine engines. Continue optimal ester lubricant development for high Mach/high temperature military and commercial turbine engines. Coordinate and support demonstration of JOP lubricants in new fighter asset engines. Deliver military specifications and test methods for DoD lubricants to support new fighter engines.				
(U)					
(U)	MAJOR THRUST: Develop and test advanced bearing technology concepts for small, intermediate, and large-sized turbine engine applications.	2.675	2.156	2.435	2.753
(U)	In FY 2004: Performed full-scale rig tests of electromagnetic rotor support and a power generation system for advanced, oil-less engines. Completed initial studies and tested airfoil shaft bearings for propulsion turbine engine application. Developed and tested affordable rotor support technology for small, intermediate, and large-sized turbine engine applications. Enhanced modeling and simulation capabilities to advance design, shorten development time, and reduce test requirements for mechanical and electromagnetic rotor support and power generation systems. Completed preliminary modeling rotordynamics of airfoil shaft bearing supported engine shafts. Conducted advanced rotor support and power generation studies and start tests for turbine and combined cycle engines. Developed the primary approach and roadmaps for the hybrid (metal/ceramic) bearing technology for the new fighter demonstrator engines. Supported industry in developing on-line engine mechanical systems diagnostics. Assisted in thermal analysis of mechanical systems for a NASA developed turbine engine.				
(U)	In FY 2005: Initiate airfoil shaft bearing tests to determine load capacity and rotor size limitations of this				

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technology. Continue development and test of affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications, specifically ultra-high temperature lubrication concepts and composite bearing cages for supersonic missile engines. Enhance modeling and simulation activities to advance design, shorten development time, and reduce test requirements for mechanical and electromagnetic rotor support and power generation systems. Conduct modeling of airfoil shaft bearings and iterate results with test activity. Support industry development of hybrid (metal/ceramic) bearing designs for new fighter engines. Note: FY 2005 combined cycle engine rotor/power efforts were delayed until FY 2007 to accelerate the new fighter bearing efforts.

(U) In FY 2006: Continue conducting airfoil shaft bearing testing in large shaft diameter sizes to determine load capacity and rotor size limitations of this technology. Continue development and test of affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications. Continue enhancement of modeling and simulation activities to advance design, shorten development time, and reduce test requirements for mechanical and electromagnetic rotor support and power generation systems. Continue modeling airfoil shaft bearings for advanced engine rotor support and power generation. Begin full-scale tests of hybrid (metal/ceramic) bearing technology for the new fighter demonstrator engines with lubricant from the JOP. Initiate study of mechanical systems thermal management concepts for turbo accelerators in combined cycle engines.

(U) In FY 2007: Continue conducting airfoil shaft bearing tests in larger shaft diameter sizes to determine load capacity and rotor size limitations of this technology. Continue development and test of affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications. Continue enhancement of modeling and simulation activities to advance design, shorten development time, and reduce test requirements for mechanical and electromagnetic rotor support and power generation systems. Improve the modeling of airfoil shaft bearings and initiate evaluation of insertion opportunities for advanced engine rotor support and power generation. Continue transition/transfer of airfoil shaft bearing technology to bearing and engine companies. Demonstrate hybrid (metal/ceramic) bearing and JOP lubricants in the new fighter demonstrator engines. Initiate programs for hardware needed for optimum thermal protection designs for high mach/high temperature turbine engines and accelerators. Expand the previous studies of advanced rotor support and power generation for turbine and combined cycle engines.

(U)

(U)	CONGRESSIONAL ADD: Pulse Detonation Engine Development and SBIR Phase III including Laser Induced Thermal Acoustics Instrument Development.	2.927	0.000	0.000	0.000

(U) In FY 2004: Completed 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. Performed design validation tests of the key components and developed engineering models

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	to guide the design. Advanced the design of a demonstration vehicle for eventual flight test of the PDE. Developed and evaluated a Laser Induced Thermal Acoustics instrument for characterization of combusting flows.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Intense, Ultrafast Laser Microfabrication and Diagnostics.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop the technology base required to reduce the development, production, and maintenance costs of advanced weapon systems through the use of intense, ultrafast lasers.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Wavelength Agile Spectral Harmonic Oxygen Sensor.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop a sensor using wavelength agile spectral harmonics to measure oxygen concentration in high-performance fuel tanks, allowing the verification and optimization of nitrogen inerting.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Hybrid Bearings. Note: Efforts expand upon activities in a FY 2004 Congressional Add in PE 0603112F, Project 3946.	0.000	1.388	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Accelerate the development of advanced hybrid bearing technology, which will provide 25 percent increase in thrust load and speed capability, increased reliability, and safety margin of aircraft turbine engines.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	17.540	16.098	14.371	16.255

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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.

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Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3066 Turbine Engine Technology	31.341	34.345	32.095	31.600	33.881	35.948	36.398	36.802	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2004, funding will be concentrated on completing the turbofan/turbojet gas generator technology efforts under the Integrated High Performance Turbine Engine Technology (IHPTET) program as it comes to completion in FY 2005. In FY 2005, the funding will be distributed to the broader turbine technology efforts as the Versatile Affordable Advanced Turbine Engine (VAATE) program ramps up.

(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 IHPTET and VAATE programs, which are joint DoD, NASA, and industry efforts to focus turbine propulsion technology on national needs. The program plan reflects the technology base support for VAATE activity applicable to global responsive strike, capable unmanned warfighting, tactical and global mobility, responsive space lift, and persistent Intelligence, Surveillance, and Reconnaissance.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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. Note: In FY 2005, funding shifts from IHPTET core engine efforts to VAATE component and technology efforts in this project. In FY 2006, efforts will further develop advanced concepts, designs, design rules, and computational tools to increase efficiency and operability, decrease weight, and improve durability of axial compressors, combustors, and high pressure turbines (HPT), as well as improve pattern factor and decrease harmful emissions of combustors, and increase HPT cooling effectiveness. These efforts enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost.	23.981	16.640	16.970	16.708
(U) In FY 2004: Completed 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. Completed preliminary full annular aerothermal tests of a trapped vortex combustor. Conducted design and began fabrication of advanced high-pressure turbine rig hardware to evaluate advanced three-dimensional effects on blade tip heat transfer for increased performance and durability. Developed advanced intentional mistuning methodology and began experimental verification on transonic rig hardware.				
(U) In FY 2005: Rig test 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. Conclude full annular aerothermal tests of a trapped vortex combustor. Rig				

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	test an integrated lightweight combustor with a ceramic matrix composite shell and advanced material panels representative of advanced combustor configurations. Complete fabrication and test 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)	In FY 2006: Develop and apply advanced modeling and simulation rules and tools for advanced components (high cycle fatigue, computational fluid dynamics, cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Incorporate advanced materials systems into innovative designs (gamma titanium aluminides, metal matrix composites, ceramics, new metallic alloys, etc.). Develop and extend analytical methods to predict integrally bladed rotor and airfoil durability, and damage tolerance. Conduct bench and rig tests of advanced components for validation, such as an advanced metal foam heat exchanger.				
(U)	In FY 2007: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Incorporate advanced materials systems into innovative designs and analyze Ceramic Matrix Composite turbine blades, turbine vanes, and turbine rear frame. Design and analyze tiled turbine airfoil technology to reduce cooling flow and increase life. Design and demonstrate a very short, high efficiency afterburner concept. Conduct rig tests and design optimization of effective, durable, radiation barrier coatings to reduce the radiant heat loads on hot section components. Design, fabricate, and rig test fan/radial compressor internal aerodynamics, large radius rotating air seals, a low profile annular combustor, and a large scale casting of fan/radial compressor.				
(U)					
(U)	MAJOR THRUST: Develop turbofan/turbojet 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. Note: In FY 2006, funding increases to support new focus to further develop advanced concepts, designs, design rules, and computational tools to increase efficiency and operability, decrease weight, and improve durability of fans, low pressure turbines (LPT), control systems, augmentors, and exhaust nozzles, as well as increase LPT cooling effectiveness, increase control systems parameters and response, and reduce augmentors observability and screech. These efforts enable aircraft engines to have higher performance, increased durability, reduced fuel consumption, and lower life cycle cost.	6.915	10.419	10.626	10.461
(U)	In FY 2004: Completed preliminary 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. Performed 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. Performed				

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initial tests of advanced control system hardware using component life models to verify real-time computational capabilities for transitioning this technology to a demonstrator engine program. Conducted base analysis and tests 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: 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. Conclude testing advanced control system hardware using component life models to verify real-time computational capabilities for transitioning this technology to a demonstrator engine program. Conclude analysis and tests of advanced, low-observable compatible augmentor designs, resulting in improved design rules and tools to improve augmentor operability and reduce screech. Note: In FY 2005, the refocusing of Air Force turbine efforts to complete the IHPTET by FY 2005 caused the advanced tandem, forward swept fan activity to be eliminated in favor of other critical elements.

(U) In FY 2006: Develop and apply advanced modeling and simulation rules and tools for advanced components (high cycle fatigue, computational fluid dynamics, cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Apply advanced materials systems to innovative designs (gamma titanium aluminides, metal matrix composites, ceramics, advanced metallic alloys, etc.). Develop new and innovative design concepts, and conduct bench and rig tests of advanced components for validation.

(U) In FY 2007: Identify and quantify sources of variability and uncertainty affecting turbine blade durability performance (oxidation, creep, thermal material fatigue, high cycle fatigue, etc.). Apply advanced materials systems to innovative designs to determine wear reduction, improve load capacity, and increase temperature capability of five centi-stokes oil and to assess aerodynamics, operability, aeromechanics, and acoustic characteristics of a counter-rotating fan-on-blade (FLADE) concept. Conduct design optimization for turbine blade microcircuit cooling. Test pilot and fuel injection concepts in a single-flameholder rig to evaluate fundamental capabilities.

(U)

(U) MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. Note: In FY 2006, funding increases to support new focus to further develop advanced concepts, designs, design rules, and computational tools for the complete range of small and mid-size turbine engine applications. These efforts enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, thereby greatly expanding the operating envelopes of missiles and unmanned vehicles.	0.294	3.313	3.378	3.327

(U) In FY 2004: Completed preliminary conceptual design and conducted configuration studies of an advanced versatile and affordable high-pressure core and engine component configurations for expendable engines using rub tolerant ceramic blades to meet the small engine performance and cost

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	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)	In FY 2006: Complete 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. Apply advanced materials systems to innovative designs and analyze a slinger-fed, dual-fuel compact recirculation combustor (CRC). Develop and apply advanced modeling and simulation rules and tools for advanced components (i.e.; high cycle fatigue (HCF), computational fluid dynamics (CFD), cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Complete detailed design, computational fluid dynamics, and perform analyses for a fuel-cooled turbine. Develop new and innovative design concepts, and conduct bench and rig tests of advanced components for validation.				
(U)	In FY 2007: Rig test a slinger-fed, dual-fuel CRC. Continue to develop and apply advanced modeling and simulation rules and tools for advanced components (Ie;high cycle fatigue, computational fluid dynamics, cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Rig test a fuel-cooled turbine. Design and analyze a five-stage forward swept compressor.				
(U)					
(U)	MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Note: In FY 2006, funding increases to support new focus to further develop advanced concepts, designs, design rules, and computational tools for the complete range of turboshaft/turboprop turbine engine applications.	0.151	1.099	1.121	1.104
(U)	In FY 2004: Began conceptual design and conducted 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)	In FY 2006: Develop and apply advanced modeling and simulation rules and tools for advanced components (i.e.; HCF, CFD, cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Complete 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. Apply advanced materials systems to design and analyze a high heat release combustor. Develop new and innovative design concepts and conduct bench and rig tests of advanced components for validation.				

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(U)	In FY 2007: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Apply advanced materials systems to innovative designs and analyze a nano-laminate thermal barrier coating. Develop new and innovative design concepts and conduct bench and rig tests of advanced components for validation such as a high heat release combustor.				
(U)					
(U)	CONGRESSIONAL ADD: VAATE-Titanium Matrix Composites.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Apply Titanium Matrix Composite materials to an advanced fan design with the goal of increasing performance and/or reducing weight.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Center for Flow Physics and Control.	0.000	1.883	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct experimental and analytical studies to determine optimal diagnostic configuration for new high-speed sensors and actuators to evaluate gaseous flow through a turbine engine. Use results to design more accurate and effective laboratory test facility for engine design.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	31.341	34.345	32.095	31.600

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related 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.										

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

(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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**		PROJECT NUMBER AND TITLE **3145 Aerospace Power Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3145 Aerospace Power Technology	36.155	44.152	30.134	29.025	31.144	33.201	33.724	34.203	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops techniques for efficient energy conversion/storage, power generation/power conditioning/distribution, 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/power conditioning/distribution and thermal management technologies 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, high power lasers, and high power microwaves for aerospace platforms. Lightweight power systems suitable for other aerospace applications are also developed.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop power generation/conditioning/distribution, energy conversion/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.	12.502	11.987	11.400	10.866
(U) In FY 2004: Tested an advanced-switched reluctance machine controller. Initiated development of lithium-based solid state electrolyte battery technology. Performed 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 through data analysis by independent model. Complete testing of an advanced switched reluctance machine controller.				
(U) In FY 2006: Develop next generation solid state lithium-based electrolyte and develop thin film cells with high voltage battery cathodes. Perform system design and analysis and develop breadboard of a high power fuel cell system for manned and unmanned vehicles.				
(U) In FY 2007: Fabricate and characterize next generation solid state lithium-based thin film cells.				
(U)				
(U) MAJOR THRUST: Develop thermal management, energy conversion/storage and power conditioning components, and subsystem technologies for aerospace applications.	2.612	2.870	4.276	4.003
(U) In FY 2004: Developed integrated vehicle health monitoring algorithms. Studied advanced packaging techniques for silicon carbide power electronics.				
(U) In FY 2005: Integrate vehicle health monitoring algorithms into power distribution unit. Fabricate and begin testing a silicon carbide packaging concept for power electronic device development.				

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(U)	In FY 2006: Complete testing a silicon carbide packaging concept for power electronic device development. Initiate efforts to scale-up sub-scale spray cooling flight tests to ten kW and expand modeling efforts to support the scale-up. Develop flight experiment for two-phase active thermal management system.				
(U)	In FY 2007: Complete scale-up, modeling efforts and flight tests of ten kW spray cooling technology.				
(U)					
(U)	MAJOR THRUST: Develop cryogenic power generation, high rate batteries, energy conversion/storage and power conditioning components, and system technologies with low volume displacement to enable delivery of high power for operation of directed energy weapons. Note: In FY 2006, increase in funding is due to fabrication and test of superconducting generator.	8.650	9.868	14.458	14.156
(U)	In FY 2004: Designed and fabricated advanced capacitors for pulsed power applications. Fabricated and began testing liquid dielectric high voltage switches. Optimized processing techniques for long length Bismuth Strontium Calcium Copper Oxide (BSCCO)/Yttrium Barium Copper Oxide (YBCO) high temperature superconducting components. Fabricated and tested small-scale, high rate lithium-ion cells.				
(U)	In FY 2005: Test advanced pulse power capacitors. Complete testing liquid dielectric high voltage switches. Test BSCCO/YBCO superconducting coils in a rotating test rig for megawatt-class power applications. Scale-up and test high rate lithium-ion (liquid) cells. Initiate preliminary design of proof-of-concept superconducting generator.				
(U)	In FY 2006: Develop conductor configuration, test, and deliver a coil of alternating current tolerant high temperature superconducting material. Initiate preliminary design of high rate lithium-ion (liquid) battery system for directed energy applications. Complete design of proof-of-concept superconducting generator and begin fabrication.				
(U)	In FY 2007: Continue design of high rate lithium-ion (liquid) battery system for directed energy applications. Complete fabrication and begin testing proof-of-concept superconducting generator.				
(U)					
(U)	CONGRESSIONAL ADD: High-Power, Advanced Low-Mass (HPALM).	2.439	0.000	0.000	0.000
(U)	In FY 2004: Designed, fabricated, and tested prototype components supporting a five 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. Investigated integration of prototype components as an initial ground demo system analysis. Conducted performance and mission analysis of a conceptual 50kW HPALM space power system based on prototype data.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				

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(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Cell-Level Battery Control. Note: In FY 2004, only for SBIR Phase 3 cell level battery controller development.	0.976	1.486	0.000	0.000
(U)	In FY 2004: Designed, fabricated, and tested initial prototype components for monitoring and controlling charge and temperature of battery energy storage systems of battery controller for lithium ion battery in man-portable systems to address cell level charge and thermal management.				
(U)	In FY 2005: Further develop and improve prototype components for monitoring and control of charge and temperature of battery energy storage systems of battery controller for lithium ion battery in man-portable systems and expand efforts to airborne systems.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Lightweight Photovoltaics for Portable Power and Hydrogen Generation. Note: In FY 2005, this was referred to as "Photovoltaic Hydrogen and Flexible Photovoltaic for Portable Power."	0.976	0.991	0.000	0.000
(U)	In FY 2004: Investigated various photovoltaic solar cells to determine performance characteristics. Designed, fabricated, tested, and integrated 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: Continue to investigate various photovoltaic solar cells to determine performance characteristics. Evaluate device designs to incorporate accomplishments from prior years. Determine designs most likely for success and produce a final design based on this determination.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Hypersonic Vehicle Electric Power System (HVEPS) Technology.	2.145	3.073	0.000	0.000
(U)	In FY 2004: Designed, fabricated, and tested a small 10-100 kilowatt (kW) demonstration magnetohydrodynamic (MHD) generator. This demonstration included the use of high temperature ceramic electrodes and modern commercial cryocoolers with superconducting magnets that were integrated, but thermally isolated from the high temperature MHD channel with active cooling.				
(U)	In FY 2005: Fabricate and test subscale 500 kW supersonic and 100 kW hypersonic MHD generators using modern commercial cryocoolers for the MHD superconducting magnets and high energy fuels to produce high temperatures and electrical conductivity in the MHD channel.				

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(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: High Powered Electrical Aircraft Capabilities (HiPEAC).	2.927	6.443	0.000	0.000
(U)	In FY 2004: Performed system analyses of high-powered electrical systems including investigation of integrated subsystems and various component technologies. Designed, fabricated, and tested 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: Identify the technologies required to satisfy the capability requirements of emerging high-powered aircraft. Complete designs, fabrication, and tests of critical technologies required for enabling new platform capabilities. Develop and build a ground-based aircraft electric power test bed to demonstrate system level and component level technologies and drive them to mature technology readiness levels.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Center for Security of Large-Scale Systems.	2.928	1.883	0.000	0.000
(U)	In FY 2004: Developed accurate, high-speed computations for the implementation of fast-acting on-line control to enhance security and survivability of military installations and applications. Developed advanced distributed heterogeneous simulation techniques and implemented their application to the security of large-scale systems (LSS). Configured and exercised predictive simulations, and developed and tested prototype hardware to verify and validate the modeling and simulation accuracy.				
(U)	In FY 2005: Improve previous and develop new accurate, high-speed computation for the implementation of fast-acting on-line control to enhance security and survivability of military platforms with specific focus on the application of advanced distributed heterogeneous simulation techniques to LSS. Expand and conduct tests of prototype hardware used to verify and validate the modeling and simulation accuracy.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Remote-Base Power Demonstration.	0.000	1.486	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop materials systems and cell-stack configurations for increasing the power density and improving start-up characteristics for a five kW Auxiliary Power Unit using advanced solid oxide				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3145 Aerospace Power Technology**

	fuel cell technology.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Integrated Cooling and Power System with Magnetic Bearing Turbogenerator.	0.000	2.776	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Analyze, model, and develop the system components comprising a complete Integrated Cooling and Power System (ICPS), integrate the Magnetic Bearing Turbo-Generator (MBTG) with these components, and perform system-level ground tests of the entire MBTG-enabled ICPS package.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Cooling Technology for High Flux Military Diode Laser Arrays.	0.000	1.289	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct scaling, reliability, and flight test experiments to advance spray-cooling concepts for high flux laser components for space and air vehicles.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	36.155	44.152	30.134	29.025

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3145 Aerospace Power Technology**

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

(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 2005
BUDGET ACTIVITY **02 Applied Research**		PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4847 Rocket Propulsion Technology	24.578	25.229	12.047	14.506	10.969	11.466	11.592	11.701	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 being accomplished in two phases and are developed to reduce the weight by 15 percent (Phase I)/20 percent (Phase II) and cost of components 25 percent (Phase I)/30 percent (Phase II) through the use of new materials, and improving designs and manufacturing techniques. Aging and surveillance efforts could improve lifetime prediction capabilities by 10 years and reduce non-destructive test costs by 50 percent. 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop missile propulsion, aging, and surveillance technology for solid rocket systems for Intercontinental Ballistic Missile to include testing missile propulsion technology and Post Boost Control Systems (PBCS). Efforts support the Technology for the Sustainment of Strategic Systems program - Phase I. Note: In FY 2005, these efforts were moved to the Advanced Technology Development efforts in PE 0603216F, Project 4922.	2.248	0.000	0.000	0.000
(U) In FY 2004: Completed risk reduction efforts supporting the Phase I missile propulsion demonstration. Completed Phase I full-scale risk reduction component development and test to support the advanced PBCS demonstration.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: 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.	10.199	9.009	10.615	7.301
(U) In FY 2004: Conducted component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Furthered development of rapid densification nozzle technology, using improved strategic propellants for future ballistic missiles to enhance performance and weight. Demonstrated low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Improved the formulation and characterization of new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion. Completed preliminary development and updates to solid rocket motor modeling and simulation tools to improve industry capability to design ballistic missile				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

	components (cases, nozzles, insulation, etc.) and motors.				
(U)	In FY 2005: Enhance component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Continue development of rapid densification nozzle technology, using improved strategic propellants for future ballistic missiles to enhance performance and weight. 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. Continue development of advanced tactical propulsion components. Note: The FY 2005 start of component development for the propulsion demonstration efforts was delayed to allow completion of modeling and simulation tools, these tools will be used in the design of the new components.				
(U)	In FY 2006: Enhance component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Continue development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Complete formulation and characterization of new propellant formulations using new fuels and oxidizers developed over the last couple of years for the next phase of advanced solid propulsion. Continue modeling and simulation tool developments for solid rocket motors to be used in developing components for the Phase II Missile Propulsion Demonstration. Continue development of advanced tactical propulsion technologies.				
(U)	In FY 2007: Initiate component development and risk reduction efforts for the Phase II Missile Propulsion demonstration. Verify development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Continue development of advanced tactical propulsion technologies. Complete modeling and simulation tool developments for solid rocket motors to be used in developing components for the Phase II Missile Propulsion Demonstration.				
(U)					
(U)	MAJOR THRUST: Develop missile propulsion technologies and aging and surveillance technologies for ballistic missile. Efforts support the Technology for the Sustainment of Strategic Systems program Phase II.	1.596	1.798	1.432	7.205
(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.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

(U)	In FY 2006: Complete analysis of existing sensor technologies for use in assessment of ballistic missile aging characteristics and status. Initiate an advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite.				
(U)	In FY 2007: Continue advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite.				
(U)					
(U)	CONGRESSIONAL ADD: Hybrid Plastics.	0.976	0.000	0.000	0.000
(U)	In FY 2004: Built 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: 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. In FY 2005, this effort was continued as a Congressional Add in PE 0602500F, Project 5026.	4.194	0.000	0.000	0.000
(U)	In FY 2004: Developed and improved modeling and simulation tools to address spacecraft component interactions and solid rocket motor component contributions and technology payoffs. Developed improvements identified from previous work for liquid engine system modeling and simulation tools.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Integrated High Payoff Rocket Propulsion Technology.	0.976	0.000	0.000	0.000
(U)	In FY 2004: Conducted 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)	In FY 2006: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Vehicle and Propulsion Center. Note: For a common Air Force Research Laboratory/Space and Missile Systems Center product center co-located with the Rocket Propulsion Laboratory.	4.389	3.965	0.000	0.000
(U)	In FY 2004: Provided technical support for the analysis of alternatives (AOA) for the following key Air Force missions: prompt global strike; land-based strategic deterrent; and operationally responsive space lift.				
(U)	In FY 2005: Continue technical support for the AOA for the following key Air Force missions: prompt global strike; land-based strategic deterrent; and operationally responsive space lift.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Jet and Rocket Engine Test Site (JRETS) testing at San Bernardino International Airport. Note: Efforts expand upon activities in a FY 2004 Congressional Add in PE 0602500F, Project 5026.	0.000	6.740	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Expand the test capabilities to include a spacecraft environmental testing capability and upgrade test capabilities at each test stand.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Aerospace Vehicle Cooling Technologies. Note: Only to conduct evaluations of aerospace vehicle cooling technologies at the JRETS rockets test stand at the San Bernardino International Airport.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Commence Congressionally-directed effort for evaluating aerospace vehicle cooling technologies.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Aerospace Lab Equipment Upgrade.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Obtain subsonic wind tunnel equipment for university educational and research purposes.				
(U)	In FY 2006: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: High Regression Rate Hybrid Rocket Fuels.	0.000	0.744	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Conduct analytical and experimental studies to evaluate the feasibility to mature high regression rate hybrid rocket fuels for use in space launch vehicles.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Engineering Research Laboratory Equipment Upgrade.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Obtain mechanical engineering equipment for university educational and research purposes.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	24.578	25.229	12.047	14.506

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0601102F, Defense Research Sciences.										
(U)	PE 0602114N, Power Projection Applied Research.										
(U)	PE 0602303A, Missile Technology.										
(U)	PE 0602500F, Multi-Disciplinary Space Tech.										
(U)	PE 0603311F, Ballistic Missile Technology.										
(U)	PE 0603401F, Advanced Spacecraft Technology.										
(U)	This project has been coordinated through the										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **4847 Rocket Propulsion Technology**

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

Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

PE NUMBER: 0602204F
PE TITLE: Aerospace Sensors

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	86.093	93.376	93.263	94.486	93.221	97.535	98.249	99.488	Continuing	TBD
2002	Electronic Component Technology	18.416	18.905	21.284	23.614	23.364	24.154	23.675	23.127	Continuing	TBD
2003	EO Sensors & Countermeasures Tech	17.961	18.097	14.377	14.734	15.049	15.943	16.125	16.302	Continuing	TBD
4916	Electromagnetic Tech	12.151	17.182	10.632	11.090	11.576	12.228	12.758	13.364	Continuing	TBD
5016	Photonic Component Technology	2.830	2.852	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5017	RF Processing for ISR Sensors	6.221	7.297	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
6095	Sensor Fusion Technology	12.013	13.129	16.308	15.600	15.693	16.107	16.321	16.533	Continuing	TBD
7622	RF Sensors & Countermeasures Tech	16.501	15.914	30.662	29.448	27.539	29.103	29.370	30.162	Continuing	TBD

Note: In FY 2006, efforts in Project 5016 will transfer to Project 2002 within this PE. Also in FY 2006, efforts in Project 5017 will transfer to Project 7622 within this PE.

(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 (EO) 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 RF sensors and electronic combat systems. Note: In FY 2005, Congress added $2.0 million for 3-D Packaging Technology for High Speed RF Communication, $1.3 million for Phased Array Antenna Control Computer, $1.6 million for Watchkeeper UWB [Ultra-Wideband] Demonstration, $3.0M for the Center for Advanced Sensor and Communications Antennas, $2.0 million for General Purpose Reconfiguration Signal Processors System, $1.0 million for Optical Signature Recognition System for Authenticity Verification, $2.0 million for Super-resolution Sensor System, $4.9 million for Minority LEADERS (transferred to PE 0601102F), $1.0 million for Compact Optical Receiver for Smart and Loitering Weapons, and $1.5 million for Stable Articulating Backbone for Ultralight Radar Project (transferred from PE 0602500F for execution in this PE). 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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	86.405	78.804	93.839	96.715
(U)	Current PBR/President's Budget	86.093	93.376	93.263	94.486
(U)	Total Adjustments	-0.312	14.572		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.828		
	Congressional Increases		15.400		
	Reprogrammings				
	SBIR/STTR Transfer	-0.312			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2002 Electronic Component Technology	18.416	18.905	21.284	23.614	23.364	24.154	23.675	23.127	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006 efforts in Project 5016 will transfer to this project.

(U) A. Mission Description and Budget Item Justification

This project focuses on generating, controlling, receiving, and processing electronic signals for RF sensor aerospace applications. The enabling technologies developed under this project will be used for intelligence, surveillance, reconnaissance (ISR), electronic warfare (EW), battlespace access, and precision engagement capabilities. The technologies developed include: exploratory device concepts, solid state power devices and amplifiers; low noise and signal control components; photonic 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; reconfigurable electronics; 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System, radar, EW, and ISR sensors. Develop advanced aperture subsystems that support affordable and scalable antenna arrays, as well as enable efficient wideband, multi-function sensors for radar, EW, and communications. Develop receiver and exciter subsystem technologies that enable compact, affordable, multi-function, multi-beam radar and EW systems.	2.889	5.050	6.635	7.602
(U) In FY 2004: Developed 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. Evaluated 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 DBF-specific GaAs RF components (ADCs, filters, mixers, etc.) with the technology upgrade plan for InP RF components into radar and EW digital receiver modules.				
(U) In FY 2006: Demonstrate low cost, lightweight subpanel for phased array radar applications.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

	Demonstrate an affordable, compact Receiver on a Chip by leveraging advances in commercial silicon germanium technology for multifunction and reconfigurable sensor systems.				
(U)	In FY 2007: Develop scalable panel demonstration with multiple panel communication and metrology. Design and demonstrate a distributed receiver/exciter architecture for advanced multifunction systems used in radar and EW sensors for ISR and battlespace access capabilities.				
(U)					
(U)	MAJOR THRUST: Develop microwave, millimeter wave, and optical components using state-of-the-art microelectronics fabrication technology for advanced RF apertures and phased array antennas used in military ISR and precision strike applications.	2.548	0.815	0.962	1.660
(U)	In FY 2004: Developed and demonstrated 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)	In FY 2006: Develop engineering model of advanced photonic modulation components for low loss signal distribution.				
(U)	In FY 2007: Demonstrate integrated photonic microsystems.				
(U)					
(U)	MAJOR THRUST: Develop integration and assembly technologies for high performance aerospace phased array sensors. Design and model photonic component technologies for RF distribution and signal processing.	2.261	1.900	2.132	3.337
(U)	In FY 2004: Developed and demonstrated 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)	In FY 2006: Design and fabricate advanced components for external and direct modulation of optical sources with high efficiency for RF photonic links used in radar and communications.				
(U)	In FY 2007: Demonstrate optical modulation technology with high linearity and dynamic range for ISR, battlespace access, and time-sensitive targeting capabilities.				
(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, and ISR sensors. Develop and integrate adaptable circuit technologies which utilize dynamic elements and low loss signal control for multi-function radar and EW sensors used for ISR and battlespace access capabilities.	3.035	4.427	6.752	7.113

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

	Develop wideband (multi-octave) component technologies for multi-function RF apertures used in radar and EW sensor systems.				
(U)	In FY 2004: Fabricated 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)	In FY 2006: Design, implement and characterize low insertion loss tunable filters for advanced RF multifunction front ends. Demonstrate RF transistors with five-fold reduction in parasitic capacitance for equivalent power output. Design and demonstrate Gallium Nitride (GaN) based field-effect devices with enhanced power handling capabilities.				
(U)	In FY 2007: Develop and demonstrate adaptable microcircuits for multi-function applications. Characterize and transition reliable wideband power amplifiers for multifunction radar and EW sensor applications. Characterize high reliability GaN based circuits for millimeter wave and Q-band applications.				
(U)					
(U)	MAJOR THRUST: Refine materials and processes for two-dimensional and three-dimensional device interconnects and component protection from the environment. Develop and demonstrate innovative RF component technology that lowers system cost through reduction of design costs, part count, chip size, production costs, and integration costs.	1.441	1.085	0.960	0.582
(U)	In FY 2004: Developed and demonstrated mixed-signal receiver/processor multi-functionality on flexible arrays using advanced two-dimensional and three-dimensional interconnects, and package-less protection schemes. Verified the electrical performance of these mixed-signal assemblies and validated 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)	In FY 2006: Develop advanced component characterization techniques to assess and mitigate failures in emerging semiconductor technologies and to develop predictive failure models.				
(U)	In FY 2007: Design and implement military specific RF components using advanced circuit compaction techniques and latest commercial foundry advances. Characterize and perform trade-space analysis with respect to traditional RF component technologies.				
(U)					
(U)	MAJOR THRUST: Evaluate the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, RF, microwave, etc.) component development in both advanced and emerging electronic component technologies.	0.990	1.628	3.843	3.320

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

(U)	In FY 2004: Laboratory tested 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). 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)	In FY 2006: Model and transition electrostatic adaptable microsystems for dense signal environments.				
(U)	In FY 2007: Design and initial modeling of next generation wideband gap devices for high power, high temperature, and broadband multi-function systems.				
(U)					
(U)	CONGRESSIONAL ADD: 3-D Packaging Technology for High Speed Radio Frequency Communication.	2.326	2.000	0.000	0.000
(U)	In FY 2004: Designed, fabricated, and demonstrated proof-of-principle experimental 3-D microcircuit packages for high speed electrical and high-power thermal military sensor applications.				
(U)	In FY 2005: Fabricate, demonstrate and evaluate additional experimental designs for 3-D radio frequency sensing microcircuits for military communication, radar and electronic warfare sensor applications.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: General Purpose Reconfiguration Signal Processors System.	2.926	2.000	0.000	0.000
(U)	In FY 2004: Accelerated the development and transition of new on-board sensor signal processors for time-critical intelligence, surveillance, reconnaissance (ISR) applications in unmanned aerial vehicles.				
(U)	In FY 2005: Fully characterize the miniature on-board signal processor feasibility unit. Develop an ISR application specific miniature signal processor to meet form, fit, and function requirements.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	Total Cost	18.416	18.905	21.284	23.614

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2002 Electronic Component Technology**

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2003	EO Sensors & Countermeasures Tech	17.961	18.097	14.377	14.734	15.049	15.943	16.125	16.302	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project determines the technical feasibility of advanced 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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Develop technology for non-cooperative identification of airborne and ground-based platforms.	3.633	2.896	1.732	1.962
(U)	In FY 2004: Conducted ground- and air-based testing and demonstration of an advanced Combat Identification (CID) system with multi-spectral detection and cueing, and active EO target long-range combat identification sensors. Integrated advanced, 3-D focal planes and algorithms in a concept design of a high altitude system to detect targets in relevant environments. Developed passive hyperspectral model and validated performance predictions specifically supporting the flying testbed. Defined 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 EO system architectures for layered sensing based on multiple platform types for deep penetration and continuous target area coverage.				
(U)	In FY 2006: Expand ground- and air-based testing and demonstration of advanced CID systems with multi-spectral, polarization-based detection and cueing and active EO combat identification sensors to include 3-D imaging. Begin development of hybrid focal planes and read-out electronics capable of				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

	simultaneous multi-discriminant sensing. Complete EO/IR system architectures for layered sensing based on multiple platform types for deep penetration and continuous area coverage.				
(U)	In FY 2007: Perform off-board cued ground- and air-based testing and demonstration of advanced CID systems with multi-spectral, polarization-based target re-acquisition and active EO interrogation for combat identification including 3-D imaging and vibration sensing. Continue development of hybrid focal planes and read-out electronics capable of simultaneous multi-discriminant sensing. Begin demonstration of EO/IR system architectures for layered sensing based on multiple platform types for deep penetration and continuous area coverage.				
(U)					
(U)	MAJOR THRUST: Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification.	1.920	2.402	2.406	5.342
(U)	In FY 2004: Laboratory demonstrated a multi-function, pulsed vibration imaging sensing system for long-range CID. Tested and evaluated sensors utilizing 3-D focal planes. Developed flight capable multi-function architectures. Fabricated a breadboard multi-spectral transmitter and evaluated 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)	In FY 2006: Begin testing of optical transmitter technologies capable of sensing multiple target characteristics for robust non-cooperative target identification. Begin development of adaptable waveforms for multi-discriminant sensing. Begin laboratory and field tests and utility analysis of multi-function pulsed vibration/imaging sensing system and evaluate performance for long range CID. Perform initial flights for pulsed gated imager and vibration CID sensor. Test breadboard active multi-spectral transmitter and evaluate performance for both hard and extended targets. Continue flight capable, long-range, multi-function brassboard sensor development. Utilize flight test platform to support testing of long-range air-to-air and air-to-ground systems under development. Collect simultaneous passive and multi-function active sensing phenomenology data in airborne environment for difficult target detection analysis including diverse background characterization.				
(U)	In FY 2007: Continue development and testing of optical transmitter technologies including waveforms capable of sensing multiple target characteristics for robust non-cooperative target identification. Continue laboratory and field tests and utility analysis of multi-function pulsed vibration/imaging sensing system and evaluate performance for long-range CID. Perform flight data collections for pulsed gated				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

imager and vibration CID sensor. Complete testing of breadboard active multi-spectral transmitter and evaluate performance for both hard and extended targets. Continue flight capable, long-range, multi-function engineering model sensor development. Utilize flight test platform to support testing of long-range air-to-air and air-to-ground systems under development. Continue collection of simultaneous passive and multifunction active sensing phenomenology data in airborne environment for difficult target detection analysis including diverse background characterization.

(U)

(U)	MAJOR THRUST: Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions.	7.161	7.553	6.109	3.734

(U) In FY 2004: Developed high altitude active sensor performance specifications and concept design. Integrated weather and obscurant penetration concepts. Evaluated non-mechanical beam steering concepts for high altitude sensor applications including precision pointing, focusing, and wavefront correction. Performed an initial demonstration of a combined EO and RF aperture. Performed tests, analyses, and evaluations of a specialized multi-function laser radar (LADAR) 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 demonstration of 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/RF aperture. Continue tests, analysis and evaluation of specialized multi-function LADAR for detection and characterization of difficult targets. Collect simultaneous passive and multi-function active sensing phenomenology data for analysis of difficult target detection. Initiate architecture definition for advanced EO unmanned aerial vehicle 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/IR for enhanced search, detection, location, and identification.

(U) In FY 2006: Begin development of techniques and components to target difficult objects in degraded atmospheric conditions. Integrate and evaluate weather/obscurant penetration concepts. Evaluate utility of non-mechanical beam steering concepts for advanced multi-mode sensor applications including precision pointing, focusing, and wavefront correction and extend to common EO/RF aperture implementation. Continue development and demonstrations of combined EO/RF aperture including preliminary sensor configuration. Continue tests, analysis, and evaluation of specialized multi-function LADAR for detection and characterization of difficult targets. Complete optimized architecture definition for advanced EO UAV based systems to find, fix, and identify difficult targets in difficult environments including the urban environment. Incorporate advanced passive and multi-function active

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

	sensing methods to exploit all salient target and background phenomenologies. Perform target phenomenology investigations.				
(U)	In FY 2007: Continue development and begin demonstration of techniques and components to target difficult objects in degraded atmospheric conditions. Integrate and evaluate weather/obscurant penetration concepts into system level tests. Demonstrate utility of non-mechanical beam steering for advanced multi-mode sensor applications, including precision pointing, focusing, and wavefront correction. Continue development and demonstrations of combined EO/RF apertures including preliminary sensor configuration. Continue analysis and evaluation of specialized multi-function 3-D LADAR for detection and characterization of difficult targets. Explore implementation of advanced architectures for advanced EO UAV-based systems to find, fix, and identify difficult targets in difficult environments including the urban environment. Incorporate advanced passive and multifunction active sensing methods to exploit all salient target and background phenomenologies. Continue target phenomenology investigations.				
(U)					
(U)	MAJOR THRUST: Develop countermeasure technologies for use against IR- and EO-guided missile threats.	1.096	0.823	2.426	2.088
(U)	In FY 2004: Completed an IR scene projector to assess imaging sensor capabilities. Evaluated onboard and offboard techniques to defeat imaging missile seekers. Exploited 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 IR missiles and IR sensor technology for countermeasure technique refinement. Initiate characterization of an IR imaging missile seeker to establish target-tracking capabilities.				
(U)	In FY 2006: Evaluate countermeasure techniques to defeat first generation IR imaging missile seekers. Continue the exploitation of advanced IR missiles and IR sensor technology for countermeasure technique updates and refinement. Initiate development of active sensing technology to defeat multi-band IR sensors.				
(U)	In FY 2007: Continue evaluation of countermeasure techniques to defeat first generation IR imaging missile seekers. Initiate development of second generation IR imaging missile seeker models/simulations for countermeasure technique development. Continue exploitation of advanced IR missiles and IR acquisition sensors for countermeasure technique updates and refinement. Conduct laboratory assessments of active sensing technology to evaluate capabilities against multi-band IR sensors.				
(U)					
(U)	MAJOR THRUST: Develop aerospace missile and laser warning technologies to accurately cue	0.951	0.823	1.704	1.608

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	countermeasures.				
(U)	In FY 2004: Laboratory tested temporal and spectral tracking algorithms focused on multi-color imaging techniques. Tested an advanced laser warning receiver for application in a space environment and expanded 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 airborne pod applications. Initiate development of a space-based laser threat scenario testbed for satellite-as-a-sensor technology evaluations. Initiate development of a new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiate new laser warning sensor concepts for integration into UAVs and night vision goggles (NVGs).				
(U)	In FY 2006: Complete developing a laser threat scenario testbed for sensor technology evaluations. Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiate development of advanced laser warning concepts for aircraft, to include integration into UAVs and NVGs.				
(U)	(U) In FY 2007: Laser warning sensor concepts for UAVs and NVGs. Continue developing new laser warning sensor technologies to address ultra-short and tunable laser threats. Initiate development of an advanced laser warning concept for integration into tactical aircraft.				
(U)					
(U)	CONGRESSIONAL ADD: Watchkeeper Ultra-Wideband (UWB) Demonstration.	3.200	1.600	0.000	0.000
(U)	In FY 2004: Developed UWB RF technology for an unattended ground sensor for perimeter defense.				
(U)	In FY 2005: Demonstrate UWB RF technology for an unattended ground sensor for perimeter defense.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Super-resolution Sensor System	0.000	2.000	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop and test a high-bandwidth transceiver for laser radar through the utilization of many modulated channels and wavelength division.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	17.961	18.097	14.377	14.734

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **2003 EO Sensors & Countermeasures Tech**

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **4916 Electromagnetic Tech**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4916 Electromagnetic Tech	12.151	17.182	10.632	11.090	11.576	12.228	12.758	13.364	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops technologies for sensor systems that cover the electromagnetic (EM) spectrum--from RF to EO. 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 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 mutli-dimensional sensors to improve battlefield awareness and identify threats at long-range.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Investigate detection of difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms.	2.269	2.469	2.658	2.824
(U) In FY 2004: Developed 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) In FY 2006: Develop integration techniques for combining EM target and clutter physics models with signal processing for improved target detection.				
(U) In FY 2007: Develop integration techniques for multiple platforms, combining EM target and clutter physics models with signal processing for improved target detection.				
(U)				
(U) MAJOR THRUST: Design and develop antennas for airborne and space-based surveillance.	2.429	2.511	2.830	3.008
(U) In FY 2004: Evaluated advanced large, lightweight antenna arrays. Evaluated new algorithms for digital beam forming and limited-scan phased array antennas. Evaluated 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) In FY 2006: Develop and demonstrate novel RF and digital hardware architectures and embedded algorithms that achieve wideband digital beamforming for multi-function phased arrays. Analyze and develop advanced 3-D micro-electro-mechanical RF structures that improve RF circuit design flexibility				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **4916 Electromagnetic Tech**

	and reduce the size and cost of microwave integrated circuits. Investigate and develop novel designs for rugged, wideband, low-profile conformal antennas for airborne applications.				
(U)	In FY 2007: Develop nonlinear embedded algorithms that enhance dynamic range and bandwidth of digital beamforming hardware, enabling the use of lower cost hardware. Demonstrate the integration of microwave integrated circuits into low-cost 3-D micro-electro-mechanical RF structures designed for a miniature seeker radar. Analyze and develop digital beamforming architectures for conformal phased array antennas for future air-to-air radar system applications.				
(U)					
(U)	MAJOR THRUST: Design and develop new EO techniques and components for detecting and identifying concealed targets.	2.179	2.201	2.314	2.250
(U)	In FY 2004: 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 laser radar (LADAR) guided munitions and other imaging applications. Developed optical processing techniques that compensate for optical aberrations in aircraft-generated turbulence.				
(U)	In FY 2005: Evaluate multi-function, multi-sensor optical arrays and the associated materials and device technologies for optical beam steering. Evaluate active components and integration techniques for autonomous 3-D LADAR-guided munitions and other imaging applications. Evaluate optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.				
(U)	In FY 2006: Test newly developed avalanche photo diodes (APD) integrated with electronic readout circuits. Integrate subcomponents with flash LADAR system and perform live tests to evaluate guidance and range resolution capability. Test and evaluate next generation APD designs and incorporate in 3-D LADAR test-bed. Continue development of quasi-phased matched materials for laser wavelength conversion applications.				
(U)	In FY 2007: Develop Zinc Oxide (ZnO), Aluminum Nitride (AlN) and Gallium Nitride (GaN) semiconductors for high power, high temperature EO applications. Develop single crystal GaN substrates for use in detection of biological agents in clouds and in harsh battlefield environments. Use developed LADAR techniques to extend range of agent and target detection. Develop ZnO, GaN, and AlN-based APDs for increased range and detection sensitivity and for non-line-of-sight covert communications.				
(U)					
(U)	MAJOR THRUST: Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates.	2.274	2.201	2.830	3.008
(U)	In FY 2004: Evaluated the viability of tomographic hyperspectral sensing techniques for aerospace applications. Evaluated the applicability of tomographic hyperspectral sensor concepts to characterizing				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **4916 Electromagnetic Tech**

	explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.				
(U)	In FY 2005: Develop 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)	In FY 2006: Design dual band tomographically based sensor system utilizing Cross Dispersion Prism (CDP) to characterize energetic battlefield events in real-time. Create CDP prototype and begin in-house calibration and performance evaluation. Refine CDP techniques used to validate target declaration and reduce false alarms. Design and develop micro-lens multi-spectral sensor for real-time threat warning and battle damage assessment.				
(U)	In FY 2007: Continue evaluation of CDP-based sensor system performance. Expand evaluation of CDP-based sensor system to field testing of various assets of interest and integration of CDP for target validation and reduction of false alarms. Continue design and development of micro-lens multi-spectral sensor for real-time threat warning and battle damage assessment. Evaluate micro-lens multi-spectral sensor performance for real-time threat warning and battle damage assessment.				
(U)					
(U)	CONGRESSIONAL ADD: Center for Advanced Sensor and Communication Antennas.	3.000	3.000	0.000	0.000
(U)	In FY 2004: Developed 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: Extend the development of innovative, low-cost designs and fabrication methods to achieve high performance and proliferation of advanced phased array antennas into new military applications.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Phased Array Antenna and Control System.	0.000	1.300	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop control system for a 12-meter diameter dome phased array antenna. Develop beam resource management of multiple simultaneous active receive and transmit apertures on the dome surface. Develop tracking algorithms for large apertures including various approaches to track the fluctuating signals from unstable beams. Develop techniques for remote dome management allowing a remote control center to configure beams and allocate them to individual users. Develop approaches for handling dome health and status information so maintenance requirements can be collected at a remote central site.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **4916 Electromagnetic Tech**

(U)					
(U)	CONGRESSIONAL ADD: Optical Signature Recognition Signal Processor System.	0.000	1.000	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop a unique optical signature recognition system for authenticity verification of Department of Defense identification cards and other documents.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Compact Optical Receiver for Smart and Loitering Standoff Weapons.	0.000	1.000	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop a small footprint, ultra-sensitive, eye-safe optical receiver.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Stable Articulating Backbone for Ultralight Radar (SABUR) Project.	0.000	1.500	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop the mechanical deployment structure for SABUR. Design the radar truss and the metrology and signal processing needed to maintain coherence and pointing accuracy. Build large-scale working prototypes of the concept.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	12.151	17.182	10.632	11.090

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602500F, Multi-Disciplinary Space Technology.										
(U)	PE 0602702F, Command Control and Communications.										
(U)	This project has been coordinated through the Reliance process to										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **4916 Electromagnetic Tech**

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

harmonize efforts and
eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5016 Photonic Component Technology**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5016 Photonic Component Technology	2.830	2.852	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in this project will transfer to Project 2002 within this PE.

(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 RF sensor aerospace applications. Enabling technologies developed under this project for ISR EW and precision engagement sensors include: low noise, aerospace environmentally-qualified signal control components (e.g., EO switches, micro-opto-electronic mixed signals); EO components for RF links; photonic signal control, distribution, and signal processing; multi-function, aerospace-qualified, 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop integrated photonic technology components.	2.104	2.852	0.000	0.000
(U) In FY 2004: Evaluated 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 2005: Laboratory test and validate 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 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop photonic analog-to-digital conversion component technology. Note: Efforts completed in FY 2004.	0.726	0.000	0.000	0.000
(U) In FY 2004: Evaluated, tested, and validated ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U) Total Cost	2.830	2.852	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5016 Photonic Component Technology**

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5017 RF Processing for ISR Sensors**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5017 RF Processing for ISR Sensors	6.221	7.297	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in this project will transfer to Project 7622 within this PE.

(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 RF phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge-aided processing techniques.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop distributed airborne sensor systems to increase sensitivity and improve location accuracy.	0.466	0.403	0.000	0.000
(U) In FY 2004: Demonstrated, 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Investigate techniques for multi-intelligence data acquisition from a single platform.	2.166	2.201	0.000	0.000
(U) In FY 2004: Evaluated multi-function radar sensing through computer simulations and emulations. Evaluated the EM 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. Investigated 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. Initiated 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 RF processing techniques to minimize the EM 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 (ECCM) techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing. Initiate research in advanced ECCM techniques that will enable maintaining a surveillance capability in various advanced jamming scenarios based upon multi-intelligence single platform sensing.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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.	2.858	1.882	0.000	0.000
(U)	In FY 2004: Developed multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, and electronic protection. Developed 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. Evaluated and refined 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Study and analyze technology for detecting and precisely locating concealed targets using stand off aerospace platforms.	0.731	2.191	0.000	0.000
(U)	In FY 2004: Developed emerging adaptive processing techniques for knowledge-aided, multi-mission processing and resource management. Studied and analyzed adaptive processing techniques for				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	multi-mission conformal arrays. Studied and analyzed wideband and polarization adaptive processing techniques for multi-function radar. Initiated 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop wideband integrated photonic components.	0.000	0.350	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate the development of 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop wideband photonic analog-to-digital mixed signal conversion component technologies.	0.000	0.270	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate the development of 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	6.221	7.297	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602500F, Multi-Disciplinary Space										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **5017 RF Processing for ISR Sensors**

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

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 2005
BUDGET ACTIVITY **02 Applied Research**		PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **6095 Sensor Fusion Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
6095 Sensor Fusion Technology	12.013	13.129	16.308	15.600	15.693	16.107	16.321	16.533	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops the technologies required to perform management and fusion of sensor information for timely, comprehensive situational awareness, 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and assess single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets.	3.673	1.600	5.712	4.404

(U) In FY 2004: Evaluated single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. Validated integrating real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Laboratory tested algorithms and concepts for detecting and targeting targets under trees. Evaluated single sensor ATR performance assessment technology, and multi-sensor and sensor fusion assessment technology. Conducted ATR performance evaluation theory research. Evaluated 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 and 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) In FY 2006: Continue to develop improvement in image formation and processing of SAR data from R&D data collections. Complete automated image analysis and truthing tools. Continue development of synthetic data generation tools to augment and enhance collected R&D and operational data sets. Complete initial ATR R&D computer and networking infrastructure via software, hardware, and network integration enhancements. Complete assessing the effectiveness of real-time ATR algorithms for time-critical targets on embedded high-performance computing systems. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Continue ATR performance evaluation theory research for radar, EO, and multiple sensor ATR

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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technologies. Laboratory test the first multi-sensor ATR performance prediction model. Initiate assessment methods and measures for moving target tracking and identification (ID) approaches using multiple sensor types. Initiate development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.

(U) In FY 2007: Continue to develop improvement in image formation and processing of SAR data from R&D data collections. Continue development of synthetic data generation tools to augment and enhance collected R&D and operational data sets. Continue laboratory tests and assessment of multi-sensor and sensor fusion algorithms for automated exploitation and weapon delivery systems. Complete initial ATR performance evaluation theory for radar ATR technology and continue for EO and multiple sensor ATR technologies. Laboratory test the first multi-sensor ATR performance prediction model. Continue assessment methods and measures for moving target tracking and ID approaches using multiple sensor types. Continue development of analysis methods and measures for assessing automated exploitation and rapid response systems proposed for post-conflict force protection, stability, and security operations.

(U)

(U) MAJOR THRUST: Develop, evaluate, and demonstrate target signature models to support ATR and sensor fusion algorithm development and testing for reconnaissance and strike mission applications.	3.853	6.372	2.946	2.730

(U) In FY 2004: Laboratory tested target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence sensors. Generated synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Developed synthetic scene data generation capability to augment and enhance existing R&D and operational data sets. Evaluated 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) In FY 2006: Continue to mature target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and signals intelligence (SIGINT) sensors. Continue to develop, signatures, algorithms, and modeling support for RF and multiple EO phenomenology ATR of tactical ground

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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targets. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Continue developing a synthetic scene data generation capability for RF scenes applicable to large area reconnaissance coverage. Initiate investigation of model-driven spectral signal processing and exploitation techniques. Initiate development of ATR algorithm-driven RF sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high diversity data.

(U) In FY 2007: Continue to mature target signature models for signature exploitation of RF sensors, EO multi-spectral systems, and SIGINT sensors. Continue to develop, signatures, algorithms, and modeling support for multiple RF and EO phenomenology ATR of tactical ground targets. Continue to generate synthetic air and ground target signatures with sufficient fidelity to support ATR of targets in operationally realistic mission environments. Demonstrate a synthetic scene data generation capability for RF scenes and begin development of an EO scene capability applicable to large area reconnaissance coverage. Continue investigation of model-driven spectral signal processing and exploitation techniques. Continue development of ATR algorithm-driven RF sensor design, new modes of operation for existing sensors, and signal processing/exploitation for high diversity data.

(U)

(U) MAJOR THRUST: Develop and demonstrate enabling ATR, sensor management, and sensor fusion technologies for target detection, tracking, and identification in ISR and CID applications.	4.487	5.157	7.650	8.466

(U) In FY 2004: Exploited adaptive learning techniques for target identification using three-dimensional sensors. Studied exploitable radar features for target detection, tracking, and identification. Laboratory tested physics-based techniques for target detection and identification for ISR and CID applications. Initiated laboratory demonstration of advanced 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) In FY 2006: Begin fusion of exploitable radar, EO/IR, LADAR, and hyperspectral features for target detection, tracking, and ID with sensor management techniques. Continue evaluation of physics-based techniques for target detection and identification for ISR and CID applications. Transition to advanced development programs laboratory demonstrated advanced algorithms for detection and identification of targets under trees and/or in the presence of heavy camouflage, concealment, and deception. Continue

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development of technology 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. Continue development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Initiate research of bio-inspired ATR for robustness. Begin ATR, sensor management, and sensor fusion research for urban ISR from small UAVs.

(U) In FY 2007: Continue fusion of exploitable radar, EO/IR, LADAR, and hyperspectral features for target detection, tracking, and ID with sensor management techniques. Continue evaluation of physics-based techniques for target detection and ID for ISR and CID applications. Continue development of technology 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. Begin investigation of pixel level registration techniques. Continue development of capabilities to represent and utilize sensor parameters and errors, along with other uncertainty reference information, for improved fused geo-location accuracy. Continue research of bio-inspired ATR for robustness. Continue ATR, sensor management, and sensor fusion research for urban ISR from small UAVs

(U)

(U)	Total Cost	12.013	13.129	16.308	15.600

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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										

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

Guidance Technology.
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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602204F Aerospace Sensors**	**7622 RF Sensors & Countermeasures Tech**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
7622	RF Sensors & Countermeasures Tech	16.501	15.914	30.662	29.448	27.539	29.103	29.370	30.162	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006 efforts in Project 5017 will transfer to this project.

(U) A. Mission Description and Budget Item Justification

This project develops and assesses affordable, reliable all weather RF sensing concepts for aerospace applications covering the range of radar sensors including ISR and fire control, both active and passive. This project also develops and evaluates technology for ISR, fire control radar, 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. Techniques exploited include the use of multiple RF phenomenologies, multi-dimensional adaptive processing, advanced waveforms, and knowledge-aided processing techniques. 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 2004	FY 2005	FY 2006	FY 2007
(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.	4.951	4.051	1.730	0.000
(U)	In FY 2004: Evaluated multi-function EW technique waveforms. Exploited evaluations against new, advanced RF threats. Developed optimized EW techniques to degrade modern radar, communications, and missile threat systems. Performed 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)	In FY 2006: Complete development and test of a complex signal communication environment simulator that contains both adversary and friendly advanced spread spectrum signals. Complete development and test of technology for an advanced digital communications jammer. Complete exploitation evaluations against new, advanced RF threats. Perform exploratory research into development of networked electronic attack techniques.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(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. Develop technologies and techniques to provide significant size, weight, and power (SWaP) reductions in RF sensors compatible with severely constrained unmanned air platforms. Develop technology to enable affordable upgrades to RF signal receivers.	2.029	1.257	6.111	14.787
(U)	In FY 2004: Developed threat identification algorithms for next generation threat warning receivers. Designed advanced very high frequency receiver improvements for detecting targets under trees. Evaluated the integrated tool suite in the modeling, simulation, design, and characterization environment for mixed-signal (digital, RF, microwave, etc.) component development in advanced and emerging technologies. Demonstrated 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 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)	In FY 2006: Identify and analyze advanced receiver/exciter techniques for operation with temporally and spatially adaptive electronic support (ES) and radar antenna systems. Identify and analyze advanced digital signal processing techniques that support distributed and adaptive ES and radar receiver/exciter sensor systems. Minimize SWaP for advanced apertures and receivers, waveform diversity, assured reference, and machine-to-machine sensor cross cueing. Investigate innovative techniques to provide concurrent RF radar and EW with EO compatibility on a single platform. Develop integrated radar and EW modeling, simulation, and analysis capabilities to address system-level multi-intelligence trades.				
(U)	IN FY 2007: Develop and evaluate advanced digital receiver/exciter technologies for ES and radar applications that support multiple degree-of-freedom adaptivity. Develop and evaluate advanced signal processing concepts that seamlessly integrate with receiver technologies to support increased levels of adaptivity for operation in complex signal environments. Continue development to reduce size, weight, and power in RF sensors compatible with severely constrained unmanned air platforms. Refine innovative techniques to provide concurrent RF radar and EW with EO compatibility on a single platform. Determine system-level multi-intelligence trades through integrated radar and EW modeling, simulation, and analysis.				
(U)					

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	MAJOR THRUST: Develop robust, ultra-widebandwidth antenna technology for use in operational and future aerospace platform electronic apertures. Develop innovative technologies and architectures for extremely wideband apertures to provide for more functionality on a set of platforms. Research of next generation applied RF aperture technology.	0.903	2.072	4.761	2.938
(U)	In FY 2004: Evaluated breadboard wideband, high-precision interferometric multi-mode direction finding antennas. Developed design tools to predict antenna performance installed on host platform models. Developed techniques that provide low-cost, lightweight phased arrays for low band applications.				
(U)	In FY 2005: Develop and laboratory demonstrate advanced wideband 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)	In FY 2006: Design and model thin profile, wideband arrays for ES receive applications. Design and fabricate array beam steering capability for wideband array jammer transmitter. Design and model compact, wideband direction finding antenna. Extend bandwidth performance of unique, low profile, low-cost antenna element.				
(U)	In FY 2007: Fabricate and test thin profile, wideband receive array. Extend array to accommodate transmit function. Evaluate performance of directional wideband array transmitter. Fabricate and test compact, wideband direction finding antenna for close in sensing.				
(U)					
(U)	MAJOR THRUST: Develop multi-function RF sensing concepts and RF transformational element level arrays for concurrent multi-mode operation.	6.448	4.644	2.944	1.855
(U)	In FY 2004: Developed and evaluated advanced multi-function and multi-intelligence RF sensors for ISR and targeting of time-critical targets. Developed testbed integration techniques for advanced multi-intelligence sensor hardware and algorithms. Developed and evaluated 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 ISR and targeting of time-critical targets with applications in UAVs and manned aircraft. Initiate testbed planning and experiment design to support validation of concepts and the subsystem requirements for advanced multi-intelligence sensors.				
(U)	In FY 2006: Fabricate and laboratory test low-cost millimeter wave sensor that provides height indication in addition to azimuth and range for landing in obscured environments. Design distributed position, navigation, and time (PNT) virtual testbed to assess assured reference techniques that achieve optimal				

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	multi-function RF sensor fusion for a Common Operation Picture (COP). Extend array simulations to determine technology shortfalls for full element level digital beam forming (DBF).				
(U)	In FY 2007: Develop distributed PNT virtual testbed to assess assured reference techniques that achieve optimal multi-function RF sensor fusion for a COP. Perform systems engineering analysis of concurrent operation to determine multi-mode array performance. Initiate technology development of critical subsystems for element level multi-mode DBF.				
(U)					
(U)	MAJOR THRUST: Develop digital RF receiver/exciter technology to support digital beamforming.	2.170	2.036	5.507	3.920
(U)	In FY 2004: Analyzed and developed approaches to address digital beamforming (DBF) issues such as coherence of multiple channels, digital true time delay, channel equalization, distributed waveform generation, and array calibration. Developed techniques for integrating multi-intelligence RF receiver/exciter subsystems into aperture and signal processing test beds.				
(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)	In FY 2006: Develop and model DBF-specific receiver/exciter technologies that stress reduced size, weight, and power consumption, as well as increased affordability for electronic support (ES) and radar sensor systems. Demonstrate through simulation and laboratory integration the benefits for DBF receiver/exciter technologies for multi-intelligence RF sensor systems.				
(U)	In FY 2007: Demonstrate receiver/exciter technologies that support DBF functionality for advanced electronic support and radar sensor systems. Perform laboratory integration and demonstration of reduced size, weight and power consumption receiver/exciter technologies that support multi-function RF sensor concepts.				
(U)					
(U)	MAJOR THRUST: Design exploratory outdoor time transfer experiments between multiple moving platforms for enhanced situational awareness. Investigate techniques for multi-intelligence data acquisition from a single platform.	0.000	1.186	1.374	0.802
(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)	In FY 2006: Demonstrate critical experiments in innovative time transfer techniques for network centric warfare applications. Develop engineering tools to implement advanced electronic				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT NUMBER AND TITLE **7622 RF Sensors & Countermeasures Tech**

		FY 2004	FY 2005	FY 2006	FY 2007
	counter-countermeasure (ECCM) techniques. Validate the engineering tools using both synthetic and field collected data.				
(U)	In FY 2007: Develop ECCM techniques capable of defeating advanced and evolving threats to long-range ISR platforms. Implement developed techniques through previously developed tools. Initiate testing of the results through synthetic data.				
(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. Develop multi-platform, multi-mission radar adaptive processing algorithms that improve detection and location performance for advanced cruise missiles, air- and ground- based targets in severe clutter and jamming environments.	0.000	0.668	8.235	5.146
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop adaptive processing techniques for multi-mission conformal arrays.				
(U)	In FY 2006: Evaluate advanced adaptive transmit waveforms for single- and multi-mode operation to improve interference rejection, self-protection, target identification, and ambiguity resolution using temporal, spatial, frequency, and polarization diversity. Initiate optimization of waveforms for multi-sensor, multi-mode operations for moving target indicator (MTI) surveillance platforms. Initiate development of advanced radar signal processing algorithms for multi-sensor, multi-mode operation. Continue to develop wideband and polarization adaptive processing techniques for multi-function radar. Evaluate adaptive processing techniques for multi-mission conformal arrays. Develop distributed processing technology for next generation deep-reach target detection and tracking.				
(U)	In FY 2007: Develop optimal waveforms for multi-sensor/multi-mode radar. Develop advanced radar signal processing algorithms that are suitable for multi-sensor, multi-mode operation. Evaluate wideband radar signal processing techniques for MTI surveillance platforms. Evaluate distributed processing technology for next generation deep-reach target detection and tracking.				
(U)	Total Cost	16.501	15.914	30.662	29.448

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602500F, Multi-Disciplinary Space										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

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.

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Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602500F MULTI-DISCIPLINARY SPACE TECH

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	99.220	95.402	81.339	102.359	120.443	120.161	119.041	120.657	Continuing	TBD
5023	Laser & Imaging Space Tech	5.590	8.471	8.166	10.333	11.493	11.922	12.082	12.223	Continuing	TBD
5025	Space Materials Development	18.325	21.310	19.864	26.202	35.422	37.666	38.482	39.254	Continuing	TBD
5026	Rocket Propulsion Component Tech	51.862	49.521	41.212	45.839	45.427	47.642	48.594	48.778	Continuing	TBD
5027	High Speed Airbreathing Prop Tech	4.700	0.178	0.246	0.239	0.245	0.242	0.240	0.239	Continuing	TBD
5028	Space Sensors, Photonics & RF Proc	3.703	1.839	1.941	4.101	4.033	4.207	4.282	4.353	Continuing	TBD
5029	Space Sensor & CM Tech	8.064	5.167	1.111	4.482	6.419	5.691	5.783	5.863	Continuing	TBD
5081	Space Antennas Tech	1.034	1.394	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5082	Optical Networking Tech	5.942	7.522	8.799	11.163	17.404	12.791	9.578	9.947	Continuing	TBD

Note: 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. In FY 2006, efforts in Project 5081 move to Project 5082 and the Air Force increased emphasis on developing optical networks for space-based applications. In addition, changes continue due to adjustments based on recategorization of space unique tasks.

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

This program advances the technology base in multiple disciplines for future space applications with projects focusing on separate technology areas including: 1) laser and imaging space technologies, which 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) space materials, which concentrate on the materials technology base for spacecraft and launch systems to improve affordability, maintainability, and performance; 3) rocket propulsion component technologies, which 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; 4) high-speed airbreathing propulsion technologies, which develop advanced and combined cycle engine technologies for revolutionary low-cost access to space; 5) space sensors, photonics, and radio frequency processes, which develop technologies to generate, control, process, receive, and transmit opto-electronic signals for space sensor applications; 6) space sensors and countermeasures technologies, which 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; 7) applied space access vehicle technologies, which develop advanced concepts for affordable on-demand access to space; 8) lightweight satellite antenna technology and affordable antenna terminal technology for communications and surveillance; and 9) optical networking technology, which focuses on the space-based laser communications to provide the warfighter with unlimited communications to any place at any time. Note: In FY 2005, Congress added $1.0 million for Internet Protocol Commanding of Satellites, $5.0 million for ETIP-Engineering Tool Improvement Program, $1.7 million for Photonics Technology, and $4.0 million for Upperstage Engine Technology (USET). Additionally, $1.5 million was appropriated to this PE for Stable Articulating Backbone for Ultralight Radar Project; however, this has been moved to PE 0602204F, Aerospace Sensors, for execution. 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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	101.360	84.581	81.118	101.359
(U)	Current PBR/President's Budget	99.220	95.402	81.339	106.114
(U)	Total Adjustments	-2.140	10.821		
(U)	Congressional Program Reductions		-0.031		
	Congressional Rescissions		-0.848		
	Congressional Increases		11.700		
	Reprogrammings				
	SBIR/STTR Transfer	-2.140			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5023 Laser & Imaging Space Tech	5.590	8.471	8.166	10.333	11.493	11.922	12.082	12.223	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

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 that support relay mirror systems. Relay mirror systems can greatly extend the range of high-power laser weapons, as well as low-power imaging systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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 that support relay mirror systems. Relay mirror systems can greatly extend the range of high-power laser weapons, as well as low-power imaging systems. Note: Increase in funding is due to greater emphasis on relay mirrors.	2.804	6.406	6.211	8.347
(U) In FY 2004: Developed technologies for lightweight primary mirrors applicable to bifocal relay mirrors. Investigated different solutions for spacecraft and optical control dynamics.				
(U) In FY 2005: Develop dual line-of-sight pointing technology for tracking a satellite with a relay mirror. Develop miniature, micro electro-mechanical systems (MEMS), liquid crystals, and novel adaptive optic devices for both monolithic and phased array telescope systems that can be used for imaging and beam projection from space.				
(U) In FY 2006: Investigate two-beam propagation techniques in support of a demonstration which tracks and illuminates a cruise missile through a relay mirror. Investigate critical advanced wavefront control devices for both monolithic and phased array imaging and beam projection from space. Develop selected devices to meet application requirements.				
(U) In FY 2007: Begin investigations in support of a high-power demonstration to kill a missile through a relay mirror. Complete development of first generation advanced wavefront control device for imaging and beam projection.				
(U)				
(U) MAJOR THRUST: Assess the vulnerability of satellites to the effects of high-energy laser weapons and maintain and update catalogued satellites.	1.812	2.065	1.955	1.986
(U) In FY 2004: Developed finite state models for space systems that enabled rapid characterization of new launches and provided a better estimate of on orbit space systems capabilities for improved space situational awareness.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5023 Laser & Imaging Space Tech**

(U) In FY 2005: Update target system response databases for continued improvement of predictive avoidance analyses and provide data to U.S. Space Command for their 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) In FY 2006: Assess the survivability and vulnerability of aerospace systems to the effects of high-energy laser and other directed energy systems. Update response databases for continued improvement of predictive avoidance analyses and provide data to U.S. Strategic Command for the performance of Laser Clearinghouse functions. Update previously completed assessments on catalogued satellites. Enhance and refine finite state modeling process, physical, and functional 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. Continue to update assessment methodology by anchoring modeling tools to empirical data. 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) In FY 2007: Develop and apply improved algorithms and hardware for satellite characterization and vulnerability assessment. Continue to update assessment methodology by anchoring modeling tools to empirical data, including results of laser illumination, tracking, and compensated imaging data. Assess the survivability and vulnerability of aerospace systems to the effects of directed energy weapons. Update response databases for continued improvement of predictive avoidance analyses and provide data to U.S. Strategic Command for the performance of Laser Clearinghouse functions.

(U)

(U) CONGRESSIONAL ADD: Starfire Optical Range Coating Facility.	0.974	0.000	0.000	0.000

(U) In FY 2004: Developed 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. Designed and built the equipment needed for washing, stripping, and vapor deposition aluminum coating of two to four meter diameter mirrors and integrated with large mirror coating room.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5023 Laser & Imaging Space Tech**

(U) In FY 2007: Not Applicable.

(U) Total Cost	5.590	8.471	8.166	10.333

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5025 Space Materials Development	18.325	21.310	19.864	26.202	35.422	37.666	38.482	39.254	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop materials and processes to dramatically improve performance, durability, and cost of rocket propulsion systems.	9.803	11.176	11.197	11.278

(U) In FY 2004: Developed candidate materials and improved processing capabilities to ensure consistent material characteristics for high-speed turbopump housings, ducts, valves, solid rocket casings, insulation, nozzle throats, and spacecraft propulsion. Evaluated 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. Established materials database and provided predictive modeling capability to anticipate materials performance and model life-cycle behavior of materials in a rocket propulsion environment. Identified 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, 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) In FY 2006: Evaluate suitability of materials for high-speed turbopumps, ducts, valves, solid rocket

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5025 Space Materials Development**

	casings, insulation, nozzle throats, and spacecraft propulsion applications. Fabricate subscale articles and test in representative rocket engine environment to validate materials performance. Analyze material behavior in rocket combustion environment for solid rocket nozzles, exit cones, throats, and spacecraft propulsion components. Validate materials performance goals for direct replacement of materials. Evaluate processes for scale-up from coupon-level testing to more complex shapes and sizes. Demonstrate innovative concepts and technologies that could enable new engine designs. Characterize material candidates, analyze material performance, and identify ways to improve thrust chambers, nozzles, and catalysts.				
(U)	In FY 2007: Develop new candidate materials and improved processing techniques to ensure more consistent material characteristics to meet the next level of performance goals for high-speed turbopump housings and turbines, ducts, valves, solid rocket casings, insulation, and nozzle throats. Evaluate performance of subscale test components in representative rocket engine environment. Continue analysis of material behavior in rocket combustion environment. Demonstrate innovative high-temperature metal, ceramic, and composite material candidates for solid rocket nozzles, exit cones, throats, and spacecraft propulsion components. Validate material models for direct replacement of materials. Scale-up testing from coupon level to more complex shapes and sizes. Fabricate subscale components. Incorporate innovative materials and concepts on demonstrator engines. Identify materials characteristics required to meet advanced performance and cost goals. Improve and optimize selected materials, test sub-elements, and sub-components for thrust chambers, nozzles, and catalysts.				
(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. Note: In FY 2006 only, effort slipped due to higher priorities. In FY 2007, increase in funding is due to greater emphasis on the nano-photonic materials efforts.	0.200	1.100	0.000	6.162
(U)	In FY 2004: Investigated 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Initiate research in nano-photonic materials for applications in very high bandwidth communications and modulators, laser communications, and radar.				
(U)					
(U)	MAJOR THRUST: Develop affordable, advanced structural and non-structural materials and processing	5.422	6.890	7.094	6.778

technologies for Air Force space applications.

(U) In FY 2004: Matured processing methods for the metallic materials that are expected to be used for lightweight, high-strength components in future space vehicles. Developed and fabricated high-temperature metallic gamma-titanium-aluminide technologies for reusable access to space vehicles. Developed advanced and reproducible joining processes for large metallic cryotanks. Developed analytical understanding of the behavior of composites in liquid oxygen environments and in a simulated space environment facility. Developed novel high-temperature protection system concepts for high-Mach, reentry, and access to space vehicles. Integrated carbon foam materials into space thermal management applications. Integrated foams into heat-pipe efficient radiator applications. Evaluated high-temperature organic matrix composites for tanks and structures for space access and launch vehicle applications. Fabricated 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. Developed baseline effects of the space environment on thermal control coatings, space lubricants, and other organic/inorganic space materials. Identified configurations suitable for use of non-oxide ceramic composites for standoff high temperature protection systems. Developed test procedures to validate candidate space materials. Developed 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. Explore candidate metallic systems for thin gage structures for component operation in robust high-temperature, long duration cruise or access to space environments. 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. Initiate testing of candidate space materials to validate test procedures. 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. Explore wear-resistant materials, lubricants, and Micro-Electro-Mechanical System (MEMS) devices for moving mechanical assemblies on spacecraft. Develop non-oxide ceramic composites for stand-off high temperature protection systems. Evaluate rapid inspection techniques for both advanced ceramic tile and stand-off high-temperature protection system materials. Assess techniques to validate candidate space materials performance. Establish suitability of repair processes for non-metallic space materials.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5025 Space Materials Development**

(U) In FY 2006: Develop candidate metallic systems for thin gage structures for component operation in robust high-temperature, long duration cruise or access to space environments. Refine analytical methods to understand behavior of materials in cryogenic environments and analyze liquid oxygen (LOX) compatibility research results through integrated technical working groups with industry and National Aeronautics and Space Administration (NASA). Develop subscale high-temperature protection systems for leading edges, nosetips, and aeroshells for expendable and reusable high-speed vehicle applications. Demonstrate oxidation-protected carbon-carbon materials in environments relevant to high-speed vehicle applications. Develop advanced composite technologies for thermal management and dimensionally stable structural space applications. Develop wear-resistant materials, lubricants, and MEMS devices for moving mechanical assemblies on spacecraft. Evaluate candidate space materials and collect critical data to facilitate materials transition.					
(U) In FY 2007: Validate initial material design concept of candidate metallic systems for thin gage structures for component operation in robust high-temperature, long duration cruise or access to space environments. Continue analysis of research results and develop knowledge base on LOX compatibility with NASA and industry. Evaluate large integrated concepts using composite materials in cryogenic environments and provide expertise for design and assessment of structural cryogenic tanks. Demonstrate high-temperature protection systems for expendable and reusable high-speed vehicle applications in collaboration with industry. Validate oxidation protection schemes for carbon-carbon materials for high-speed vehicle applications. Develop multifunctional nano-tailored composite technologies for space system capabilities and evaluate enhancements obtained. Continue to develop wear-resistant materials, lubricants, and MEMS devices for moving mechanical assemblies on spacecraft. Continue to evaluate candidate space materials and collect critical data to facilitate materials transition.					
(U)					
(U) MAJOR THRUST: Develop materials and materials processing technologies to enable improved performance and affordability of surveillance, tracking, targeting, and situational awareness systems.		2.900	2.144	1.573	1.984
(U) In FY 2004: Identified higher performance materials, including optical nanocomposites and exotic ferroelectronics, for advanced optical architecture in phased array radar and satellite-to-satellite data links. Scaled-up very long wavelength, alternative infrared detector materials to areas suitable for the fabrication of staring focal plane arrays.					
(U) In FY 2005: Develop electro-optic polymers for optical communications, data links, and radio frequency (RF) system control architectures. Demonstrate the detection performance of very long wavelength alternative materials operating at 40 Kelvin. Investigate materials and process technologies capable of providing solutions for mixed-mode (optical and RF) communications apertures.					
(U) In FY 2006: Demonstrate electro-optic polymers for optical communications, data links, and RF system					

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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

control architectures. Explore processes to allow advanced materials design and architecture development for very long wavelength alternative materials operating at 40 Kelvin. Develop materials and materials process technologies for application in combined optical and RF communication system apertures.

(U) In FY 2007: Initiate development of nano-photonic materials for high performance optoelectronic devices for optical communications and system control architectures. Validate processes and develop process control methodology to enable very long wavelength infrared detection. Continue to develop suitable materials and materials process technologies for application in combined optical and RF communication system apertures.

(U)	Total Cost	18.325	21.310	19.864	26.202

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0603112F, Advanced Materials for Weapon Systems.										
(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-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5026	Rocket Propulsion Component Tech	51.862	49.521	41.212	45.839	45.427	47.642	48.594	48.778	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 IHPRPT program, a joint Department of Defense, NASA, and industry effort to focus rocket propulsion technology on national needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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. Efforts include evaluation and development of reduced-toxicity ionic salt, high-energy-density oxidizers, nano-materials, catalyst, and polymeric binders; determining optimized paths for incorporating these materials into propellants; and for selected propellants perform laboratory and demonstrator engine evaluations. Efforts seek monopropellants with performance equivalent to bipropellants that reduce the cost of space access and space operations. Phases are referring to the IHPRPT program phases.	2.753	3.941	3.528	3.167

(U) In FY 2004: Began development of advanced catalysts for new monopropellant formulations. Downselected and began scale-up of promising high energy-density materials candidates. Evaluated selected propellants in advanced combustion devices to determine materials compatibility and performance. Formulated propellant ingredients for IHPRPT Phase III solid propellant developments and began transition to propellant formulation. Studied ablation effects on laser-propelled lightcraft fuels and fuel systems. Modeled and explored advanced propulsion concepts with enhanced performance and reliability such as rocket-based combined cycle engines.

(U) In FY 2005: Further downselect and continue scaling-up promising high energy-density materials candidates. Evaluate scaled-up and new selected propellants in advanced combustion devices to determine materials compatibility and performance, and address ballistic property concerns. Continue maturing solid propellants ingredients into Phase III solid propellant formulations. Initiate efforts to address ablation effects on laser-propelled lightcraft fuel and fuel system. Continue to model and analyze

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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 rocket-based combined cycle engines.				
(U)	In FY 2006: Further downselect and continue scaling-up promising high energy-density materials candidates. Evaluate scaled-up and new selected propellants in advanced combustion devices to determine materials compatibility and performance and prepare for large-scale motor tests. Complete initial solid propellants ingredients incorporation into Phase III solid propellant formulations. Complete efforts to address ablation effects on laser-propelled lightcraft fuel and fuel system. Continue to model and analyze advanced propulsion concepts with enhanced performance and reliability such as rocket-based combined cycle engines.				
(U)	In FY 2007: Further downselect and continue scaling-up promising high energy-density materials candidates. Evaluate scaled-up and new selected propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Continue to model and analyze advanced propulsion concepts with enhanced performance and reliability such as rocket-based combined cycle engines.				
(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. Efforts include modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as aerovehicles and potential launch systems. Phases are referring to the IHPRPT program phases. Note: The FY 2004 start of hydrocarbon combustion instability efforts was delayed until FY 2006; the associated funding was shifted to support improvements to advanced cryogenic upper stage technologies. In FY 2005, increase in funding is due to greater emphasis on the upper stage technology efforts.	3.647	7.200	8.206	7.824
(U)	In FY 2004: Characterized, studied, and evaluated gas-centered swirl injector performance to ensure chamber/injector compatibility and prevent damage to Phase II hydrocarbon boost engine. Developed, analyzed, and modeled advanced combustion devices and injectors compatible with new energetic propellants. Initiated development and early transition opportunities for near-term advanced hydrocarbon fuels for scale-up and sub-scale test.				
(U)	In FY 2005: Complete characterizing, studying, and evaluating gas-centered swirl injector performance for hydrocarbon boost engine and increase emphasis on chamber/injector compatibility for upper stage engines. Initiate advanced multi-phase modeling and subscale combustion evaluation of new high density refined and advanced hydrocarbon fuels to meet Phase II goals.				
(U)	In FY 2006: Initiate characterization, studies, and evaluations of shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Develop experiments				

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	to enhance the thermal management of upper stage engines for better performance, chamber life, and reliability. Initiate analysis and test 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 advanced synthetic hydrocarbon fuels to meet Phase II goals.				
(U)	In FY 2007: Continue to characterize, study, and evaluate shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Continue to develop, analyze, and transition advanced combustion device technology, including injectors and chambers suitable for advanced synthetic hydrocarbon fuels capable of meeting or exceeding the Phase III goals. Develop improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Develop, scale-up, and transition new energetic advanced hydrocarbon fuels and additives for rocket propulsion, including space storable high energy, non-toxic fuels.				
(U)					
(U)	MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in advanced combustion devices and propulsion systems for current and future rocket propulsion systems.	3.108	4.009	5.324	4.844
(U)	In FY 2004: Developed advanced ablative components with nano-reinforced, hybrid polymers. Characterized and developed new processes for high temperature polymers utilizing nanomaterials and carbon-carbon materials to improve process and structural density. Developed advanced material components for use with high-energy propellants. Commenced transition of advanced high temperature material components to reduce system weight and cost, and increase performance. Initiated exploration of the use of nanocomposites for liquid rocket engine tanks.				
(U)	In FY 2005: Continue additional development of advanced ablatives for use in low-cost, sprayable processing. Continue to characterize and develop new high temperature polymers incorporating synergistic effects of multiple nanomaterials and carbon-carbon materials to reduce cost and processing time. Continue developing new advanced materials for use with high-energy propellants. Continue 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 with multi-functional capability (lightweight, inert, in situ passivation).				
(U)	In FY 2006: Develop advanced, recyclable, ablative components using nano-reinforced hybrid polymers that are two times better than previously developed materials. Continue to characterize and develop				

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	processing technologies to improve nano-reinforced high temperature polymers and carbon-carbon materials. Continue developing new 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. Develop processing methodology for using nanocomposites for liquid rocket engine tanks.				
(U)	In FY 2007: Continue developing new advanced ablative components using hybrid polymers. Continue to characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Continue developing new advanced materials for use with high-energy propellants. Continue to explore using nanocomposites for liquid rocket engine tanks and optimize processing technology using multifunctional nanomaterials.				
(U)					
(U)	MAJOR THRUST: Develop propulsion component technologies for reliable, safe, and low-cost boost systems. Note: In FY 2005, these efforts were moved to the "advanced liquid engine technologies" major thrust in this Project.	2.316	0.000	0.000	0.000
(U)	In FY 2004: Completed testing a single stage hydrogen turbopump for advanced cryogenic boost engines. Completed development of components for hybrid propulsion technologies for space boosters and air launched missiles. Advanced hydrocarbon fuel characterization test rig development.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop lightweight combustion devices and nozzle technologies for liquid rocket engines. Note: In FY 2005, these efforts were moved to the "advanced liquid engine technologies" major thrust in this Project.	23.203	0.000	0.000	0.000
(U)	In FY 2004: Furthered the development of an advanced lightweight altitude-compensating nozzle. Furthered 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: 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	20.533	19.800	24.147

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(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Complete initial assessment and continue tool improvement for advanced cryogenic upper stage technologies - turbopumps and thrust chambers. Evaluate first set of potential hydrocarbon fuels and adjust/modify/develop fuel characterization test rig. Complete development of first of two concepts for new lightweight nozzles for liquid rocket engines.				
(U)	In FY 2006: Advance modeling and simulation tool development for advanced cryogenic liquid rocket upper stage technologies. Commence hardware design for advanced cryogenic upper stage technologies - turbopumps and thrust chambers. Evaluate second set of potential hydrocarbon fuels and adjust/modify/ develop fuel characterization test rig. Continue development of second concept for lightweight nozzles for liquid rocket engines.				
(U)	In FY 2007: Continue development of advanced cryogenic upper stage technologies - turbopumps and thrust chambers. Evaluate third set of potential hydrocarbon fuels and adjust/modify/ develop fuel characterization test rig. Complete development of second concept for lightweight nozzles for liquid rocket engines.				
(U)					
(U)	MAJOR THRUST: Develop missile propulsion, aging, and surveillance technology for solid rocket systems for Intercontinental Ballistic Missile to include testing missile propulsion technology and Post Boost Control Systems (PBCS). Efforts support Technology for Sustainment of Strategic Systems program - Phase I. Note: After FY 2004, these efforts were moved to Advanced Technology Development efforts in PE 0603500F.	0.500	0.000	0.000	0.000
(U)	In FY 2004: Developed and fabricated components for demonstrations of advanced full-scale, flight-like PBCS.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: 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 constellations. Phases are referring to the IHPRPT program phases.	4.944	4.917	4.354	5.857
(U)	In FY 2004: Commenced development of monopropellant thruster component technologies for chemical-based space propulsion catalyst. Completed fabrication of an extended life Hall thruster demonstrator (Phase II). Developed and fabricated subsystems for the Phase II plasma thrusters for microsatellites propulsion systems. Completed development of solar thrusters and concentrators for future orbital transfer vehicles. Furthered development and test of a controlled solid propellant.				

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(U)	In FY 2005: Continue development of monopropellant thruster component technologies for chemical-based space propulsion - catalyst and thrust chamber. Initiate Hall thruster Phase II system lifetest and commence Phase III development efforts. Integrate components and initiate Phase II plasma thruster lifetests for microsatellites propulsion systems. Continue development and test of a controlled solid propellant.				
(U)	In FY 2006: Complete initial development and test of monopropellant thruster component technologies for chemical-based space propulsion. Complete Hall thruster Phase II lifetest and continue Phase III development efforts. Complete Phase II lifetest and begin evaluating Phase III plasma thrusters for microsatellites propulsion systems. Complete development and test of a controlled solid propellant.				
(U)	In FY 2007: Continue Hall thruster Phase III development efforts. Continue evaluating Phase III plasma thrusters for microsatellites propulsion systems. Initiate advanced bi-propellant technology developments for satellite thrusters. Initiate advanced hybrid propulsion concept for satellites.				
(U)					
(U)	CONGRESSIONAL ADD: Launch Vehicles Engine Project.	0.974	0.000	0.000	0.000
(U)	In FY 2004: Conducted studies and developed hardware for proof of concept for a low-cost launch vehicle engine with 400,000 pounds of thrust using liquid oxygen and hydrogen as propellants.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Jet and Rocket Engine Test Site. Note: In FY 2005, Congress continued this program in PE 0602203F.	10.417	0.000	0.000	0.000
(U)	In FY 2004: Furthered upgrades to the rocket engine test stands at the former Norton Air Force Base in San Bernardino. Expanded testing to include thermal and vibrational test capability for satellite systems.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: ETIP-Engineering Tool Improvement Program. Note: Efforts expand upon activities in a FY 2004 Congressional Add in PE 0602203.	0.000	4.956	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Improve existing and develop new modeling and simulation tools to address spacecraft component interactions and solid rocket motor heat transfer, insulation performance, plume dispersion, and liquid rocket engine power balance. Develop the integrated reusable launch vehicle analysis tool,				

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	which will be used to determine weight, size and performance of future two-stage-to-orbit vehicle concepts.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Upperstage Engine Technology (USET).	0.000	3.965	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Provide for additional validation hardware and risk reduction to existing core effort to develop advanced modeling and simulation design tools for liquid rocket engines.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	51.862	49.521	41.212	45.839

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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										

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(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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5027 High Speed Airbreathing Prop Tech**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5027 High Speed Airbreathing Prop Tech	4.700	0.178	0.246	0.239	0.245	0.242	0.240	0.239	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 NASA. 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 2004	FY 2005	FY 2006	FY 2007
(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.	0.568	0.178	0.246	0.239
(U) In FY 2004: Conducted system trade studies to determine military payoff and establish component technology goals. Defined 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 new component and engine performance objectives to enable development of affordable hypersonic CCEs.				
(U) In FY 2006: Conduct system trade studies to determine military payoff and establish component technology goals. Continue to define new component and engine performance objectives to enable development of affordable hypersonic CCEs.				
(U) In FY 2007: Conduct system trade studies to determine military payoff and establish component technology goals. Continue to define new component and engine performance objectives to enable development of affordable hypersonic CCEs.				
(U)				
(U) MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies with improved performance, operability, durability, and scalability for affordable, on-demand access to space vehicles. Note: The FY 2004 internal flame stabilization effort was broadened to support risk mitigation for the Air Force's refocused hypersonic activities resulting from the reduction of the NASA hypersonic effort. In FY 2005, these activities were moved to PE 0602203F, Project 3012 to consolidate all 6.2 scramjet development efforts.	4.132	0.000	0.000	0.000

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(U) In FY 2004: Completed initial feasibility assessments of variable geometry devices to increase scramjet operating range (Mach 3 to Mach 8+) to provide robust options for CCEs. Further developed advanced engine components to improve operability, scalability, and structural durability for reusable applications. Assessed alternate scramjet flowpath configurations to improve engine operability and structural efficiency necessary for engine development for reusable applications. Demonstrated advanced ignition systems for scramjets. Conducted assessment of current structural concepts and identified life-limiting factors and initiated development of multi-use components. Initiated support for the development of flight test engine components.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U)

(U)	Total Cost	4.700	0.178	0.246	0.239

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0601102F, Defense Research Sciences.										
(U)	PE 0602201F, Aerospace Flight Dynamics.										
(U)	PE 0602203F, Aerospace Propulsion.										
(U)	PE 0602602F, Conventional Munitions.										
(U)	PE 0602702E, Tactical Technology.										
(U)	PE 0603111F, Aerospace Structures.										
(U)	PE 0603216F, Aerospace Propulsion and Power Technology.										

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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)

(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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5028 Space Sensors, Photonics & RF Proc**

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5028	Space Sensors, Photonics & RF Proc	3.703	1.839	1.941	4.101	4.033	4.207	4.282	4.353	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project focuses on developing methods of generating, controlling, receiving, transmitting, and processing photonic, optical, and opto-electronic (mixed) signals for 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Design and develop high performance integrated photonic technologies for use in space. Note: In FY 2006, effort moves to advanced photonic component technology for space-based sensors thrust in this Project.	0.560	0.250	0.000	0.000
(U) In FY 2004: Fabricated and evaluated 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 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Design and develop efficient, high coefficient chip-scale optical waveguide technologies. Note: In FY 2006, effort moves to advanced photonic component technology for space-based sensors thrust in this Project.	0.236	0.335	0.000	0.000
(U) In FY 2004: Fabricated, tested, and evaluated 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)					
(U)	MAJOR THRUST: Perform independent modeling, test, and evaluation for space-based sensors. Note: In FY 2006, effort moves to advanced photonic component technology for space-based sensors thrust in this Project.	0.236	0.183	0.000	0.000
(U)	In FY 2004: Applied 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Study adaptive processing techniques for large, multi-mission, space-based conformal arrays.	2.671	1.071	1.077	2.967
(U)	In FY 2004: Studied and analyzed 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 Intelligence, Surveillance, and Reconnaissance (ISR) sensing from space-based platforms.				
(U)	In FY 2006: Continue to develop adaptive processing techniques suitable for implementation on space-qualified computing architectures for multi-intelligence ISR sensing from space-based platforms. Study signal processing methods and novel adaptive transmit waveform techniques for a space surveillance platform.				
(U)	In FY 2007: Evaluate adaptive processing techniques suitable for implementation on space-qualified computing architectures for multi-intelligence ISR sensing from space-based platforms. Develop signal processing methods and novel adaptive transmit waveform techniques for a space surveillance platform.				
(U)					
(U)	MAJOR THRUST: Develop advance photonic component technology for space-base sensors that focuses on improving performance and reducing size, mass, and prime power. Supports ISR capability. Note: In FY 2006, photonics technology efforts move into this thrust from previous major thrusts in this Project.	0.000	0.000	0.864	1.134
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Develop and demonstrate photonic component technology enabling low loss true time delay				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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for wideband phased array applications

(U) In FY 2007: Develop and model a photonic metrology architecture for large area antennas.

(U)	Total Cost	3.703	1.839	1.941	4.101

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Funding:										
(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.

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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5029 Space Sensor & CM Tech	8.064	5.167	1.111	4.482	6.419	5.691	5.783	5.863	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project focuses on developing processes and techniques for electronic and electromagnetic signal processing for 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 2004	FY 2005	FY 2006	FY 2007
(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 ISR space sensors.	1.761	0.000	0.000	0.000
(U) In FY 2004: Fabricated and tested compact, affordable, multifunction receiver/exciter and phased array components for communications, GPS, radar, electronic warfare, and other ISR space sensors. Evaluated integrating these components into operational radar and electronic warfare digital receiver/exciter modules. Demonstrated a feasible architecture for performing wideband direct digital synthesis from aerospace platforms. Performed a component evaluation of an electronic/photonic digital receiver for Moving Target Indication and Synthetic Aperture Radar applications.				
(U) In FY 2005: Not Applicable. Effort terminated due to higher Air Force priorities.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop and integrate microwave technologies for advanced radio frequency apertures and phased array antennas used in military ISR space sensors. Note: In FY 2006, effort moves to array antenna subsytems and advanced materials thrust in this Project.	0.918	1.700	0.000	0.000
(U) In FY 2004: Developed the proof of concept of transmitter and receiver (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, undesired electromagnetic radiation.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	MAJOR THRUST: Develop X-band sub-assemblies based on flexible RF membranes. Note: In FY 2006, effort moves to array antenna subsytems and advanced materials thrust in this Project.	0.411	0.503	0.000	0.000
(U)	In FY 2004: Developed 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 RF subassemblies. Demonstrate ten-fold reduction in assembly cost and aperture mass.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop two- and three-dimensional interconnects for space applications. Note: In FY 2006, effort moves to array antenna subsytems and advanced materials thrust in this Project.	0.329	0.452	0.000	0.000
(U)	In FY 2004: Developed 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop techniques to accurately predict scattering phenomenology associated with electromagnetic radiation. Note: In FY 2005, effort is complete.	0.426	0.552	0.000	0.000
(U)	In FY 2004: Further refined 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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: In FY 2006, effort is complete.	2.437	1.623	0.344	0.000
(U)	In FY 2004: Designed robust precision time, position, and velocity sensor technologies for				

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

	multi-platform sensor-to-shooter network-centric engagement. Developed 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 global positioning system jamming mitigation techniques for operation in hostile RF environments.				
(U)	In FY 2006: Demonstrate highly accurate and robust precision time, position, and velocity sensor techniques for space-based applications. Develop constructive systems engineering model to assess space-based assured reference techniques in terms of measures of performance and warfighter utility.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop technology to enable affordable upgrades to space-qualified RF signal receivers. Note: In FY 2006, effort terminated due to higher Air Force priorities.	0.260	0.337	0.000	0.000
(U)	In FY 2004: Continued 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: Further 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop affordable radar technologies.	1.522	0.000	0.000	0.000
(U)	In FY 2004: Further developed a model system of the Active Electronic Scanned Antenna and On-Board Processor to demonstrate the technical readiness of the most critical element of an affordable radar. Note: In FY 2004, efforts completed.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop advanced active phased array antenna subsystems to meet the unique requirements of affordable space based sensing including the restrictions on mass, size, power. Utilize advanced materials, to demonstrate low-mass, low cost, reliable and scalable apertures. Supports intelligence, surveillance, and reconnaissance capability. Note: In FY 2006, efforts on advanced RF apertures, membranes, and interconnects move into this thrust from previous major thrusts in this Project.	0.000	0.000	0.767	0.352

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

(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Develop low-mass shallow-depth microwave antenna panels with integrated active elements and low RF distribution loss.				
(U)	In FY 2007: Demonstrate low-mass scalable tiles/panels with advanced thermal management and improved efficiency for active components				
(U)					
(U)	MAJOR THRUST: Develop hybrid space-based sensor solutions and reduce associated technology risks. Develop algorithms to solve signal processing challenges specific to space-based sensor platforms. Note: In FY 2007, space-based sensor platform technology efforts, previously performed under other major thrusts in the Project, were placed here to show greater emphasis.	0.000	0.000	0.000	4.130
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Initiate identification and development specific techniques and technologies to further expand the capabilities of space-based sensor platforms.				
(U)	Total Cost	8.064	5.167	1.111	4.482

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5029 Space Sensor & CM Tech**

(U) **D. Acquisition Strategy**

Not Applicable.

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DATE **February 2005**

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5081 Space Antennas Tech	1.034	1.394	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in this project move to Project 5082 in this PE.

(U) A. Mission Description and Budget Item Justification

This project develops the technology base for satellite antenna technology and affordable terminal technology for communications. Enabling technologies developed under this project for satellite terminals will focus on significantly lowering the life cycle cost communications system ownership, while increasing performance. The project will include new approaches to optical and RF communications transmit and receive technologies to improve network communications performance.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and demonstrate heterogeneous, seamless, secure, self-configuring, high capacity air/space/surface wireless network, ensuring applicability relevance to space missions. Develop variable data rate, networked data link hardware and the associated RF ground stations for such wireless networks.	1.034	1.394	0.000	0.000
(U) In FY 2004: Developed variable data rate, networked data link hardware and the associated RF ground stations. Designed and developed Optical Local Area Networks (LAN) and gateways for optical communications between space and airborne assets/platforms.				
(U) In FY 2005: Continue development of variable data rate, networked data link hardware and the associated RF ground stations. Continue Optical LAN and gateways for optical communications between space and airborne assets/platforms. Initiate characterization and development of industry standard single mode optical communications bus for airborne platforms and air-to-air or air-to-ground-to-air RF and laser networked communications.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U) Total Cost	1.034	1.394	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) PE 0602204F, Aerospace Sensors.										
(U) PE 0603203F, Advanced Aerospace Sensors.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602500F MULTI-DISCIPLINARY SPACE TECH**	PROJECT NUMBER AND TITLE **5081 Space Antennas Tech**

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

(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.

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

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5082 Optical Networking Tech	5.942	7.522	8.799	11.163	17.404	12.791	9.578	9.947	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in Project 5081 move to this project and 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, air and space-based communications networks on and between platforms. As the application of laser-based, point-to-point communications between satellites emerges, air and space-based optical networks, whose communications capacities are thousands of times greater than current communications satellites, become a realistic possibility. This project will assess and adapt the emerging communication and information technologies, for applications in air and space. This project will explore technologies for implementing photonic chip scale optical Code Division Multiple Access (CDMA) and Wavelength Division Multiplexed (WMD) transceivers and prototype networks, built to demonstrate the benefits associated with the advanced fiber optic, wireless, platform, and satellite networks that can be built from them. This project will develop and demonstrate technology to integrate current Radio Frequency with high data rate Optical LASER communications, along with network management techniques, tools and software to support them. These technologies have 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and assess optical network technologies for application in the space environment.	1.983	1.576	1.535	1.532
(U) In FY 2004: Assessed, explored, and adapted 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 transmission technology and control concepts to support optically networked communications.				
(U) In FY 2006: Complete design and development of a multi-path interconnection network that provides for redundancy, fault tolerance, self-routing and non-blocking switching required for air and space-based networks. Initiate demonstration of highly integrated multi-gigabit optical network with 4 x 4 optical data router and optical backbone interface chips.				
(U) In FY 2007: Complete demonstration of highly integrated multi-gigabit optical network with 4 x 4 optical data router and optical backbone interface chips. Initiate demonstration of highly integrated multi-gigabit optical network with 16 x 16 optical data router and optical backbone interface chips.				
(U)				

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

(U)	MAJOR THURST: Develop and assess existing and emerging Optical CDMA and WDM modulation schemes and protocols for use in space-based optical networks.	2.055	1.972	3.044	3.065
(U)	In FY 2004: In conjunction with industry and academia, developed or adapted appropriate standards to ensure the evolution of open systems architecture for space-based optical networks.				
(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)	In FY 2006: Demonstrate industry standard single mode optical communications bus interface chip for airborne platforms. Initiate design and development of optical burst switching and optical label switching protocols for applicability to air and space-based optical networks. Initiate flight demonstration of industry standard single mode optical communications bus interface chip for airborne platforms.				
(U)	In FY 2007: Continue design and development of optical burst switching and optical label switching protocols for applicability to air and space-based optical networks. Continue flight demonstration of industry standard single mode optical communications bus interface chip for airborne platforms.				
(U)					
(U)	MAJOR THURST: Develop and demonstrate heterogeneous, seamless, secure, self-configuring high capacity air/space/surface wireless networks that integrate current RF with high data rate Optical Laser communications. Note: In FY 2005, greater emphasis was placed on laser communication technologies.	0.000	0.324	4.220	6.566
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop variable data rate, networked data link RF/optical hardware and their associated ground stations.				
(U)	In FY 2006: Initiate design and development of waveform, coding, management, and atmospheric mitigation technologies for a combined RF/laser communications brassboard. Continue characterization and development of industry standard single mode optical communications bus for airborne platforms and air to air or air to ground RF and laser networked communication.				
(U)	In FY 2007: Continue design and development of waveform, coding, management, and atmospheric mitigation technologies for a combined RF/laser communications terminal. Demonstrate development of industry standard single mode optical communications bus for airborne platforms and air to air or air to ground RF and laser networked communication.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Establish and maintain a capability to characterize, evaluate, and optimize network components and technologies for space applications. Note: Includes	1.904	2.659	0.000	0.000

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Congressional Add funding of $1.0 in FY 2004 and $1.7 million in FY 2005. Additionally, program efforts complete in FY 2005.

(U) In FY 2004: Developed photonic chip scale optically implemented CDMA and WDM 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 WDM on board networks operating at gigabits per second. Develop and demonstrate innovative technologies, such as 16-channel WDM laser array on one chip, 16-channel WDM array receivers on one chip, and compact high-speed optical transmission subsystems, that can provide the Air Forces with a secure means of transmitting high-speed data information (imagery, video, audio and text) from various platforms, while decreasing the size, power, and weight.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U)	CONGRESSIONAL ADD: Internet Protocol Commanding of Satellites.	0.000	0.991	0.000	0.000

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Develop and demonstrate technology allowing a satellite to be commanded by a field commander for obtaining near-real-time sensor data of interest. Develop an end-to-end architecture for command and control of a satellite based on a High Assurance Internet Protocol Encryption (HAIPE) architecture, where the interface of the HAIPE command and control system with the ground and Space payload will be fully defined.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	5.942	7.522	8.799	11.163

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	PE 0602702F, Command, Control, and Communications.										
(U)	PE 0603789F, C3I Advanced Development.										

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(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.

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PE NUMBER: 0602601F
PE TITLE: Space Technology

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BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602601F Space Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	100.608	107.419	84.540	92.178	112.361	127.242	125.580	127.000	Continuing	TBD
1010	Space Survivability & Surveillance	43.023	51.742	42.085	43.849	44.162	47.291	48.843	49.346	Continuing	TBD
4846	Spacecraft Payload Technologies	22.608	19.319	16.161	17.149	24.597	29.900	28.943	29.349	Continuing	TBD
5018	Spacecraft Protection Technology	3.943	2.607	2.401	2.219	2.346	2.473	2.503	2.526	Continuing	TBD
8809	Spacecraft Vehicle Technologies	31.034	33.751	23.893	28.961	41.256	47.578	45.291	45.779	Continuing	TBD

(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 2005, Congress added $2.0 million for Elastic Memory Composites, $2.0 million for Integrated Control for Autonomous Space Systems (ICASS), $1.5 million for Converted Silicon Carbide for High Performance Optic Structures, $2.8 million for Electromagnetic (EM) Gradiometer for the Detection and Confirmation of Underground Hiding Places and Passageways, $1.0 million for Toughened Silicone Substrates for Flexible Solar Cells, $3.4 million for Lightweight and Novel Structures for Space Program, $1.1 million for USAF Center for National Security Research--Signature Exploitation, $5.5 million for High-frequency Active Auroral Research Program (HAARP), $1.5 million for Foldable Articulated Structures for Next Generation Spacecraft, and $2.8 million for Seismic Monitoring Program. 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	101.539	88.909	89.644	97.609
(U)	Current PBR/President's Budget	100.608	107.419	84.540	92.178
(U)	Total Adjustments	-0.931	18.510		
(U)	Congressional Program Reductions		-4.131		
	Congressional Rescissions		-0.959		
	Congressional Increases		23.600		
	Reprogrammings				
	SBIR/STTR Transfer	-0.931			

(U) Significant Program Changes:
Not Applicable.

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C. Performance Metrics

(U) Under Development.

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology**	**1010 Space Survivability & Surveillance**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
1010 Space Survivability & Surveillance	43.023	51.742	42.085	43.849	44.162	47.291	48.843	49.346	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops the technologies to exploit the space environment for warfighter's future capabilities. 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 2004	FY 2005	FY 2006	FY 2007
(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.	3.113	4.124	4.182	4.995

(U) In FY 2004: Developed advanced space weather forecasting models combining remote sensing of interplanetary clouds with in situ plasma and fields data. Validated dynamic radiation belt model for satellite hazard forecasts with newly acquired data sets from operational DoD satellites. Developed 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. Developed 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) In FY 2006: Initiate development of multi-sensor global data assimilation models for real-time situational awareness of energetic electron hazards to space systems. Validate dynamic radiation belt specification and forecast model with data from geosynchronous and low-Earth orbit DoD satellites. Complete physical design and accomplish Program Design Review of next generation, high-resolution solar telescope. Develop autonomous procedures to cross calibrate, quality control, and validate solar

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magnetic field data from disparate network of ground-based telescopes for use in kinematic, MagnetoHydroDynamics, and hybrid solar wind models. Complete analysis of promising micro- and nano-technology space plasma and energetic particle sensor concepts and transition into spaceflight hardware development programs.

(U) In FY 2007: Continue development of energetic electron data assimilation models for real-time situational awareness by coupling to dynamic radiation belt model to provide data-driven specification and forecast capability. Initiate coupling of radiation belt model to global geospace environment models to increase accuracy and lead time. Complete initial predictive model of solar explosive events, including flares, bursts, and coronal mass ejections. Develop concepts for active beam and wave probes of radiation belt dynamics.

(U)

(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.	9.902	12.772	14.148	16.887

(U) In FY 2004: Developed all-altitude, infrared background radiance model for atmospheric transmission of extended radiance sources such as missile hard bodies and plumes. Incorporated spectral signature variability into simulation codes to improve performance predictions. Collected high quality spectral data from existing systems and evaluated system requirements for theater surveillance and area search missions. Developed and demonstrated sensors, algorithms, and clutter removal techniques for space-based hypertemporal imaging sensor. Tested, validated, and improved decision aids and turbulence performance predictions tools to be used for theater ballistic missile boost phase negation test for an airborne laser platform. Expanded models for other high-energy laser systems and explored a forecasting capability for high altitude turbulence effects on aircraft platforms.

(U) In FY 2005: Validate and deliver all-altitude, 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) In FY 2006: Develop infrared background radiance model capturing full range of background variability. Develop model for visible to infrared wavelength spatially and temporally structured backgrounds required for space-to-space resident space object characterization and environmental monitoring. Using available airborne and spaceborne data, validate daytime spectral processing algorithms and related

	signature databases for remaining terrain classes. Use test data and validated simulations to evaluate candidate sensor technologies for spectral theater surveillance and area search missions. Refine real-time hypertemporal processing algorithms and continue determination of optimal parameters for operational system. Improve turbulence forecasting skill, as required, and assist in transition of airborne laser decision aid for testing to operational decision aid status. Perform case studies on existing and improved stratospheric clear air turbulence forecast tools. Address decision aid requirements for tactical high-energy lasers and laser communication systems.				
(U)	In FY 2007: Develop capability to forecast background variations required to manage assets for resident space object characterization, environmental monitoring, and missile warning/defense. Develop super-resolution techniques for space-based resident space object characterization at long stand off range and detection of foreign agent environment perturbations. Initiate transition of validated spectral processing and exploitation algorithms and related signature databases to appropriate users. With available thermal spectral sensors, validate night-time spectral processing algorithms and related signature databases for specific environments. Initiate transfer of sensor technologies and architecture concepts to acquisition and operational commands as appropriate. Develop third generation hypertemporal sensor for space. Initiate transition of improved stratospheric clear air turbulence forecast models to Air Force Weather Agency. Continue to address technology requirements for transition of operational decision aids for airborne lasers, tactical high-energy laser systems, and laser communication systems.				
(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.	6.529	5.857	6.776	5.395
(U)	In FY 2004: Developed nowcasting and forecasting validation algorithms applicable to concepts such as the Communication/Navigation Outage Forecasting System (C/NOFS) Advanced Concept Technology Demonstration (ACTD). Integrated validation algorithms into ionospheric specification and forecast modeling architecture. Validated communication and navigation outage forecasts with ground-based data to demonstrate utility of outage warning due to scintillation. Integrated polar region plasma tracking models into global models of scintillation to provide seamless equator-to-pole outage specification. Validated multi-scale algorithms and data assimilation techniques to increase reliability of global ionospheric electron profile specifications and forecasts to improve radar and geolocation performance. Explored concept development of scintillation mitigation techniques to overcome satellite-to-ground link degradation in real-time.				

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(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 ACTD. 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)	In FY 2006: Generate nowcasts and forecasts of communication/navigation outages due to ionospheric scintillation using C/NOFS space and ground system to give the warfighter improved space and battlefield awareness and operational flexibility. Perform metric tests making standardized comparisons between C/NOFS forecast model and product output parameters and selected available measurements to assess effectiveness of scintillation forecasting process. Develop statistical database and tools to track C/NOFS forecast metrics to assess military utility of outage warning due to scintillation. Develop technology to produce artificial ionization patches for use in over-the-horizon radar/comm applications and to mitigate scintillation conditions. Develop specification and forecast models and applications that exploit international network of ionospheric sensors.				
(U)	In FY 2007: Perform metric tests of C/NOFS scintillation forecasting system. Integrate C/NOFS results into ionospheric specification and forecasting algorithms and models for enhanced military utility of scintillation warning system. Investigate coupled solar-magnetospheric-ionospheric-thermospheric models to improve forecast lead times for radar operations, and communications/navigation outages. Develop portable ionospheric sensor suite for measuring total electron content and communications/navigation scintillation.				
(U)					
(U)	MAJOR THRUST: Develop High-frequency Active Auroral Research Program site transmitting and diagnostic instrument infrastructure.	10.021	9.911	10.000	9.757
(U)	In FY 2004: Continued 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)	In FY 2006: Complete 180-element high frequency transmitter array with 3.6 megawatt radiated power capacity.				
(U)	In FY 2007: Validate performance of 3.6 megawatt transmitting array in Extremely Low Frequency/Very				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT NUMBER AND TITLE **1010 Space Survivability & Surveillance**

	Low Frequency wave generation and optical emissions research programs.				
(U)					
(U)	MAJOR THRUST: Develop basic seismic technologies to support national requirements for monitoring nuclear explosions with special focus on regional distances less than 2,000 kilometers from the sensors.	6.476	6.985	6.979	6.815
(U)	In FY 2004: Conducted 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. Performed 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 (shifting focus towards in situ measurements below the source), 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)	In FY 2006: Provide further updated seismic codes for operational use. Focus on seismic energy partition, magnitudes, and source physics moves from hypothesis development towards major hypothesis flyoff. Continue efforts on seismic calibration; seismic detection, location, and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Initiate focus on transition between local and regional seismic wave propagation and implications for all topics above. Continue assessment future directions based on results obtained so far.				
(U)	In FY 2007: Continue to update seismic codes for operational use. Develop hypothesis test results into potential discrimination and yield estimation techniques, while addressing unresolved hypothesis issues for seismic energy partition, magnitudes, and source physics. Incorporate seismic energy partition effects into implications for local and regional seismic wave propagation. Continue efforts on seismic calibration; seismic detection, location, and discrimination; and observational studies of seismic wave propagation, including propagation in Eurasia. Continue assessment future directions based on results obtained so far.				
(U)					
(U)	CONGRESSIONAL ADD: High-frequency Active Auroral Research Program (HAARP).	4.918	5.452	0.000	0.000
(U)	In FY 2004: Developed planned diagnostic infrastructure at the HAARP site. Provided facility management and environmental oversight functions. Conducted research programs concentrating on the generation of Extremely Low Frequency/Very Low Frequency (ELF/VLF) 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.				

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(U)	In FY 2005: Develop Ultra High Frequency radar and optical diagnostic infrastructure at the HAARP site. Provide facility management and environmental oversight functions. Conduct research programs to develop key engineering parameters related to exploiting ELF/VLF waves generated in space for subsurface communications, the imaging of underground structures, and the reduction of charged particle concentrations in the earth's radiation belts.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Electromagnetic Gradiometer (EM) Gradiometer for the Detection and Confirmation of Underground Hiding Places & Passageways.	2.064	2.775	0.000	0.000
(U)	In FY 2004: Miniaturized a recently developed, rugged, man-portable hardware system. Assessed the viability of an unmanned ground-based, randomly distributed-array detection concept. Assessed viability of an airborne application.				
(U)	In FY 2005: Develop covert man portable hardware system using remote Very Low Frequency illumination. Access the viability of a small, low-flying Unmanned Aerial Vehicle based system using a higher frequency local illuminator for detection of detonation wires on Improvised Explosive Devices. Initiate development of demonstration system for unmanned, randomly distributed array and begin preliminary field-testing of system concept.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Seismic Monitoring Program.	0.000	2.775	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Perform academic and industry research that will enable operational monitoring of high priority areas of U.S. national concern that would be otherwise inadequately monitored in the near-term. This research supports the Air Force Technical Application Center mission of global nuclear explosion monitoring.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: USAF Center for National Security Research - Signature Exploitation.	0.000	1.091	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop engineering model smart single detectors and small smart detector arrays with very large dynamic range, broad range of integration times, very large frame rates, local data storage, and				

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in-line processing for each detector element. Ground tests will be done on the first generation.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	43.023	51.742	42.085	43.849

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology**	**4846 Spacecraft Payload Technologies**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4846 Spacecraft Payload Technologies	22.608	19.319	16.161	17.149	24.597	29.900	28.943	29.349	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, decrease in funding is due to higher Air Force priorities.

(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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop advanced infrared device technologies for space applications that enable hardened space detector arrays with improved detection, to perform acquisition, tracking, and discrimination of bodies such as decoys, satellites, and warheads throughout their trajectory.	2.822	4.067	3.693	3.762
(U) In FY 2004: Fabricated and characterized strained-layer superlattice detectors and used results to modify designs to improve absorption efficiency and eliminate manufacturing or operationally induced defects. Worked the two-dimensional focal plane array development effort by identifying, designing, and fabricating the appropriate cryogenic detector multiplexers required for transitioning the technology. Began 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. Continue wafer growth of strained-layer superlattice detector structures and other promising technologies as alternatives to mercury cadmium telluride developing 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 space systems. Investigate wavelength agility in detectors. Further investigation of proton-damage in long wavelength infrared focal plane arrays in the space-relative environment				
(U) In FY 2006: Continue studies in metal films. Demonstrate two-layer single-pixel polarimeter. Improve quantum dot detector responsivity. Continue characterizing superlattice detectors. Continue				

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	investigating magnetic and electric field tuning of detector wavelength responsivity ("wavelength agility"). Perform comparisons of emerging detector technologies for transfer to applied research. Characterize and assess performance of long wavelength infrared focal plane arrays developed with radiation hardened-by-design process.				
(U)	In FY 2007: Pursue detector response tunability. Complete assessment of quantum interference towards amplification of incoming weak signals.				
(U)					
(U)	MAJOR THRUST: Develop spectral sensing and data exploitation methodologies for military imaging and remote sensing applications.	0.749	0.994	1.003	1.019
(U)	In FY 2004: Completed initial assessment of technology and modeling for understanding the electro-optical/infrared spectral polarimetric phenomenology. Demonstrated partially validated polarimetric signature model capability and continued validation with measured data from on-going field collects. Integrated 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)	In FY 2006: Complete development and continue validation of polarimetric scene modeling capability for space-based surveillance applications. Integrate additional models for accurate prediction of satellite materials signatures and compare with available laboratory and field data. Complete development of instrument models for staring polarimetric surveillance systems. Develop polarimetric and spectral measurement and database of relevant materials for inclusion in the model.				
(U)	In FY 2007: Complete validation of polarimetric scene and signature modeling capability, comparing simulated data to measured field data. Complete initial polarimetric database of materials for use in signature and scene modeling. Define concepts for polarimetric or multi-band imaging sensors for space-based space 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 devices, and advanced electronics packaging for next generation high performance space electronics.	3.708	3.905	3.784	3.939
(U)	In FY 2004: Researched radiation effects in electronics components based on emerging silicon-on-insulator, sapphire, or other radio frequency (RF) and analog technology compatible				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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substrates. Evaluated monolithically integrated low power, silicon-based quantum-sized devices for system-on-a-chip applications. Developed radiation hardening design techniques to enable fabrication of electronics on commercial lines. Evaluate architecture and components supporting analog memory. Built micro-electro-mechanical system based switches supporting complex switching harnesses in support of self-adaptable spacecraft hardware. Developed 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 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) In FY 2006: Design new chalcogenide materials for reconfigurable RF circuits and for reconfigurable wiring. Develop fundamental understanding of exotic high-dielectric constant materials and predict candidate materials for insertion into aggressively scaled electronic devices for space electronics. Research radiation effects in highly integrated microelectronics employing the most recent techniques in power management, clock domain partitioning, and monolithic integration of multiple radio frequency, analog, and digital functions. Identify and evaluate radiation hardening techniques for enhancing immunity to single event and other radiation effects arising from the natural space environment, as well as nuclear events. Develop a "liquid manifold" approach based on combining micro-electromechanical switches and reconfigurable wiring and demonstrate operation.

(U) In FY 2007: Complete study of dynamics of phase change materials, and of their interactions with pertinent technological materials. Explore use of polymers in reconfigurable electronics. Continue study of alternative dielectrics for advanced electronics, especially the nitrided oxides. Initiate a nanotechnology collaboration with the Air Force Research Laboratory Materials Directorate. Research radiation effects mitigation schemes using best commercial practices in design and manufacturing to identify new methods for creating radiation hardened, long-lifetime, commodity and custom mixed signal microcircuits for next generation space and missile systems. Evaluate devices using advanced hardening techniques to determine robustness and compatibility with state of the art design and fabrication technology. Develop morphable electronic panels suitable for demonstration in a relevant environment.

(U)

(U)	MAJOR THRUST: Develop modeling, simulation, and analysis tools for space-based surveillance	1.247	3.300	2.479	2.516

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systems, rendezvous and proximity operations, optical/infrared imaging space systems, and distributed satellite architecture payloads.

(U) In FY 2004: Extended simulation architecture to support flight experiment ground-to-space segment simulation. Extended the architecture for use in objective system-of-systems, military utility assessment. Developed extensions to the simulation architecture to address missions associated with responsive space and space capability protection.

(U) In FY 2005: Ready the simulation architecture to support flight experiment simulation and data validation for experiments on deployable structure technology, 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 enhancements to optical/infrared imaging system simulation to include polarimetric and hyperspectral effects.

(U) In FY 2006: Support autonomous and responsive space flight experiments with simulations and data validation. Extend the simulation architecture to feed engineering-level data to mission/campaign models. Extend the architecture to address missions associated with space situational awareness and tactical surveillance. Continue to develop enhancements to imaging system simulations to include polarimetric and hyperspectral effects. Tailor toolset and methodology developed for the multi-aperture strategic system feasibility study for tactical applications

(U) In FY 2007: Continue to support autonomous and responsive space flight experiments with simulations and data validation. Continue to extend the simulation architecture to feed engineering-level data to mission/campaign models. Ready the simulation architecture to support flight experiment simulation and data validation for experiments on space situational awareness and tactical surveillance. Complete evaluation of the technical feasibility and cost-effectiveness of a multi-aperture system to meet future space-based tactical intelligence, surveillance and reconnaissance needs.

(U)

(U)	MAJOR THRUST: Develop advanced architectures and performance characterization tools for future large, lightweight, modular space antennas. Note: In FY 2005, work terminated due to higher Air Force priorities.	0.951	0.000	0.000	0.000

(U) In FY 2004: Refined 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. Characterized performance of new wide-bandwidth antenna subsystems and correlated results to model predictions; updated models based on actual performance. Developed algorithms for performance characterization of sparse cooperating apertures and for advanced antenna array calibration.

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(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop bandwidth efficient modulation and high bandwidth communications technologies to support next generation satellite communication systems. Note: In FY 2006, efforts terminated due to higher Air Force priorities.	1.935	1.783	0.000	0.000
(U)	In FY 2004: Explored architecture studies and guided technology investment in support of satellite communications roadmap. Developed 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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.	9.426	5.270	5.202	5.913
(U)	In FY 2004: Developed standards for combining multiple airborne intelligence, surveillance, and reconnaissance and space asset feeds into a single optical data path. Designed 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)	In FY 2006: Start verification of standards of combining multiple airborne intelligence, surveillance and reconnaissance and space asset feeds into a single optical data path. Perform component testing using laboratory testbed.				
(U)	In FY 2007: Finish verification of standards of multiple airborne intelligence, surveillance and reconnaissance and space asset feeds into a single optical data path. Perform system testing using laboratory testbed.				
(U)					
(U)	CONGRESSIONAL ADD: Mixed Signal Very Large Scale Integrated (VLSI) [Circuits] for Space Vehicle Communication Subsystems.	1.770	0.000	0.000	0.000

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BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT NUMBER AND TITLE **4846 Spacecraft Payload Technologies**

(U) In FY 2004: Developed improved, radiation-hard, analog circuit elements for mixed-signal VLSI circuits. Refined and employed 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. Designed and fabricated innovative circuit configurations and test devices using new radiation-hard analog elements and circuit architectures.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	22.608	19.319	16.161	17.149

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology**	**5018 Spacecraft Protection Technology**

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5018	Spacecraft Protection Technology	3.943	2.607	2.401	2.219	2.346	2.473	2.503	2.526	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop key satellite threat warning technologies and tools for high value satellite asset defense.	1.256	0.899	0.911	0.977
(U) In FY 2004: Investigated opportunities for development of proximity and threat warning sensor systems. Explored reconfigurable processor electronics capability and build test bed in support of multi-threat warning sensors. Analyzed light, adaptable single antenna performance for threat detection and geo-location applications. Completed false alarm research for relevant threats. Selected antenna technology for wide-band and narrow-band threat detectors for multi-threat capability space experiment.				
(U) In FY 2005: Update micro-satellite threat characteristics. Select most promising proximity sensor technology and initiate development of an experimental proximity sensor. Design and develop ground demonstration plan for the purpose of confirming proximity sensor performance.				
(U) In FY 2006: Begin process of integrating most promising proximity or threat warning sensor into a space experiment. Identify potential of multiple usage of sensor to detect threats and measure environmental phenomenon associated with space flight (weather experiments, debris analysis, assist in navigation, etc.).				
(U) In FY 2007: Conduct sensor space flight experiment and analysis. Identify technology transfer opportunities and report findings to major commands.				
(U)				
(U) MAJOR THRUST: Develop high value space asset defensive capabilities.	0.830	0.581	0.597	0.631
(U) In FY 2004: Designed and fabricated miniaturized narrowband radio frequency attack reporting receiver with of goal of five times reduction in power and size.				
(U) In FY 2005: Select most promising defensive technologies and begin development of experimental defensive capabilities. Design and report ground and space demonstration plan for the purpose of confirming defensive capability performance.				
(U) In FY 2006: Select the most promising defensive technology and begin space experiment planning and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	integration. Identify potential of multiple use technology to detect threats and measure environmental phenomenon associated with space flight (weather experiments, analysis debris, assist in navigation, etc.).				
(U)	In FY 2007: Conduct defensive technology space demonstration and post flight analysis. Identify technology transfer opportunities and report findings to major commands.				
(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.	0.816	0.576	0.588	0.611
(U)	In FY 2004: Developed technology for currently fielded or launch-ready satellites to detect anomalies that result from radio frequency/laser illumination or kinetic impact. Explored 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.				
(U)	In FY 2005: Conduct laboratory proof-of-concept for selected subsystems with 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)	In FY 2006: Develop space experiment of existing cooperative onboard system or develop proof of concept space experiment to validate concept.				
(U)	In FY 2007: Transition technology to other compatible space systems for multiple use protection.				
(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. Note: In FY 2007, effort is complete.	1.041	0.551	0.305	0.000
(U)	In FY 2004: Continued integration of 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)	In FY 2006: Analyze military utility of C/NOFS demonstration. Develop and integrate selected enhancements to C/NOFS scintillation warning and forecasting system for warfighter space and battlefield situational awareness and operational flexibility.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	3.943	2.607	2.401	2.219

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U) C. Other Program Funding Summary ($ in Millions)

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602601F Space Technology**	**8809 Spacecraft Vehicle Technologies**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
8809 Spacecraft Vehicle Technologies	31.034	33.751	23.893	28.961	41.256	47.578	45.291	45.779	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 space experiments of maturing technologies for space qualification.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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.	3.947	4.089	3.640	3.827

(U) In FY 2004: Completed identification of mechanical and long-term failure mechanisms for assessing cryocooler performance and reliability. Built first generation analytical performance prediction models, empirical measurements, and thermophysical fluid flow and heat transfer models for low-temperature cryocooler regenerator performance. Investigated technology development to improve cryocooler capability and performance for regenerative and recuperative cycle cryocoolers. Fabricated multi-junction solar cells using lattice-mismatch technology with efficiencies that break even with the efficiency of current production multi-junction 28% Germanium solar cells. Demonstrated 10% efficient thin-film solar cells on polymer substrates.

(U) In FY 2005: Build second-generation empirically verified thermo-physical 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 multi-junction solar cell based on lattice-mismatch technology. Fabricate 10% efficient thin-film, monolithically integrated solar cell.

(U) In FY 2006: Build experimental capabilities for flow field measurements in pulse tube cryocoolers. Refine and validate cryocooler component and system models with experimental data. Investigate thermodynamic loss mechanisms in regenerative cycle cryocoolers through computational fluid dynamics models. Demonstrate 12% efficient thin-film solar cell on polymer substrate. Demonstrate five- or six-junction solar cell.

(U) In FY 2007: Develop component-based system model of pulse tube cryocoolers for parametric optimization of cryocooler system design. Design an ultra low-temperature (10 degrees Kelvin), low

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	mass and high efficiency advanced engineering model cryocooler. Transition optimal design methodologies to cryocooler industry. Demonstrate greater than 33% efficient solar cell using either lattice mismatch or five- or six- junction solar cell technology. Develop a greater than 12% efficient thin-film solar cell on a polymer substrate at least 20 square centimeters in area.				
(U)					
(U)	MAJOR THRUST: Develop technologies for advanced space platform structures such as structural controls for vibration suppression, multi-functional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures.	7.798	7.074	6.462	6.869
(U)	In FY 2004: Completed characterization of multi-functional small spacecraft bus. Developed tunable nanotechnology-enhanced lightweight space structures. Developed lightweight structures and precision structural controls for large-aperture space optics. Developed 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)	In FY 2006: Develop advanced mechanisms and guidance strategies for capture and servicing of disabled (non-cooperative) spacecraft. Develop high-temperature, long-soak time thermal re-entry structures.				
(U)	In FY 2007: Characterize thermal protection structural performance in reentry environment. Develop autonomy concepts to support defensive/protection actions by spacecraft.				
(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. Note: In FY 2006, efforts move to Project 4846 in this PE and to PE 0603401F, Project 2181.	2.768	1.082	0.000	0.000
(U)	In FY 2004: Applied modeling and simulation techniques to evaluation of technical feasibility and cost-effectiveness of multi-aperture systems to meet future space-based radio frequency intelligence, surveillance, and reconnaissance needs.				
(U)	In FY 2005: Complete evaluation of the technical feasibility and cost-effectiveness of a multi-aperture system to meet future space-based radio frequency intelligence, surveillance and reconnaissance needs.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

(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.	4.425	10.207	13.791	18.265
(U)	In FY 2004: Designed a space flight experiment with the goal of significantly reducing power, aperture, and the mid-earth-orbit environment as constraints to DoD space capability. Selected and matured the best technologies in the areas of advanced structures, controls, power-generation, space weather sensors and radiation-belt remediation to design spacecraft. Developed concept design for all experimental payloads, define requirements and interfaces, and complete spacecraft design. Performed modeling and simulation to quantify benefits towards enhancing DoD warfighter capability for surveillance, space capability protection from natural and man-made threats, high-rate communication to the battlefield, and space access and mobility.				
(U)	In FY 2005: Mature space flight experiment design. Develop breadboard hardware for all experimental payloads. Build engineering model for the core spacecraft. Close design trades and advance all designs to a Preliminary Design Review level. Design interfaces to launch vehicle and co-manifested spacecraft needed to secure launch manifest. Continue modeling and simulation to quantify benefit to DoD warfighter capability.				
(U)	In FY 2006: Build and test core spacecraft and experimental payloads. Complete mission planning and on-orbit operations guide.				
(U)	In FY 2007: Complete fabrication and test of spacecraft and individual payloads. Deliver flight payloads for integration to spacecraft. Assemble and test integrated spacecraft.				
(U)					
(U)	CONGRESSIONAL ADD: Technology Satellite of the 21st Century (TechSat-21).	2.951	0.000	0.000	0.000
(U)	In FY 2004: Developed and ground tested advanced subsystem flight units that demonstrated responsive microsatellite bus technologies. Key advances in microsatellite bus technologies included high power density batteries, lightweight thin-film solar arrays with micro-gimbals, and a modular large capacity non-volatile mass memory subsystem. These microsatellite bus technologies support mission applications ranging from distributed aperture formations to space surveillance, threat warning, and protection.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Affordable Multi-Junction Solar Cells.	2.261	0.000	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

(U)	In FY 2004: Developed a process for affordable production of single crystal Germanium (Ge) wafers, a key component of multi-junction solar cells on all DoD satellites, comprising approximately half the cost of the entire cell. Developed 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 Germanium 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)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Toughened Silicone Substrates for Flexible Solar Cells.	1.180	0.991	0.000	0.000
(U)	In FY 2004: Developed 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 CIGS solar cells on these substrates. Reduced touch labor necessary for interconnection of individual cells into solar arrays. Demonstrated 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: Scale-up and transition of free standing silicone resin substrates to roll-to-roll manufacturing. Initiate transition to production for monolithic integration process of CIGS solar cells on silicone resin substrates. Optimize performance of CIGS solar cells deposited in roll-to-roll production on free standing silicone resin.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Integrated Control for Autonomous Space Systems (ICASS).	0.984	1.982	0.000	0.000
(U)	In FY 2004: Developed 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. Fabricated the engineering models of integrated controls architecture designs, initiated laboratory validation and verification, and incorporated the engineering models into a spacecraft design.				
(U)	In FY 2005: Advance the spacecraft system engineering to test and validate the advanced control techniques in a flight experiment. Fabricate breadboard models of spacecraft experimental computer system, networked data acquisition sensors, and networked data interface cards. Test advanced attitude and dynamic control technologies on breadboard electronics. Close design trades, initiate mechanical				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	and electrical designs to Preliminary Design Review level.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Elastic Memory Composites and Elastic Memory Composites Materials.	3.245	1.983	0.000	0.000
(U)	In FY 2004: Developed elastic memory composite (EMC) material technologies for unconventional approaches in satellite component utility. Designed, built, and integrated elastic memory composite hinge hardware for possible on-orbit demonstration. Designed and built a composite deploying gravity gradient boom as the primary attitude-stabilizing element for a satellite. Designed and analyzed large-scale rollout flexible solar array deployment mechanism.				
(U)	In FY 2005: Improve the reliability of spacecraft deployment mechanisms. Raise the flight readiness of the EMC technology by generating material test data, creating and refining material models and engineering methods for designing EMC components, designing, fabricating, and testing structural validation models of EMC components, and performing a space flight demonstration to build flight heritage.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Converted Silicon Carbide for High Performance Optic Structures.	1.475	1.486	0.000	0.000
(U)	In FY 2004: Refined the fabrication process for converted silicon carbide for high-tolerance applications in aerospace large optical systems to shorten the overall fabrication time and improve part quality.				
(U)	In FY 2005: Apply the converted silicon carbide technology from FY 2004 efforts to Air Force systems currently under development. Identified products include the optical elements and support structure for a spaceborne optical system and optical support structures for an airborne directed energy system. Build specimens for integrated testing for potential optical space systems.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Lightweight and Novel Structures for Space Program.	0.000	3.371	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Review and examine new structures concepts that will enable revolutionary improvements on weight and cost of space structural systems. The most promising concepts will be identified for further research and development.				
(U)	In FY 2006: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Foldable Articulated Structures for Next Generation Spacecraft.	0.000	1.486	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop advanced space boom architectures and the mechanisms that enable them to be deployed in space and to enhance the performance of lightweight deployable structures for spacecraft. Prove flight readiness of this technology by performing the following: optimization of design of a family of deployable truss structural system; develop advanced analytical tools and quantitative design methods; design, fabrication, testing and qualitative assessment of the system; integration and flight readiness testing of the deployable structure and deployment control system.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	31.034	33.751	23.893	28.961

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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 efforts and eliminate duplication.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT NUMBER AND TITLE **8809 Spacecraft Vehicle Technologies**

(U) **D. Acquisition Strategy**

Not Applicable.

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Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602602F Conventional Munitions

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	45.312	51.790	58.058	60.210	58.011	58.262	58.164	58.145	Continuing	TBD
2068 Advanced Guidance Technology	15.997	16.215	17.612	17.418	17.965	18.679	18.752	18.803	Continuing	TBD
2502 Ordnance Technology	29.315	35.575	40.446	42.792	40.046	39.583	39.412	39.342	Continuing	TBD

Note: In FY 2006, funding increased to support added emphasis on Battlefield Air Operations efforts.

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

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

	FY 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	46.061	52.251	50.260	54.704
(U) Current PBR/President's Budget	45.312	51.790	58.058	60.210
(U) Total Adjustments	-0.749	-0.461		
(U) Congressional Program Reductions				
Congressional Rescissions		-0.461		
Congressional Increases				
Reprogrammings				
SBIR/STTR Transfer	-0.749			

(U) Significant Program Changes:
Not Applicable.

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602602F Conventional Munitions**	**2068 Advanced Guidance Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2068 Advanced Guidance Technology	15.997	16.215	17.612	17.418	17.965	18.679	18.752	18.803	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	6.371	6.100	5.241	5.256
(U) In FY 2004: Developed a low-cost, synthetic aperture radar seeker to assess future advanced guidance applications. Completed initial efforts to support 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. Design of an optical seeker using multiple discriminates to improve performance against obscured or hidden targets.				
(U) In FY 2006: Incorporate and test improved components in laser ranging and detection seekers with goal to provide "single-shot" imaging at useful ranges. Complete testing of a low-cost synthetic aperture radar seeker. Begin fabrication of an optical seeker that uses multi-discriminate signatures to improve targeting against obscured targets. Using ground test data, augment the shape signatures in the automatic target acquisition algorithms to add laser multi-discriminate signatures.				
(U) In FY 2007: Continue improving and testing components in laser ranging seeker to provide "single-shot" imagining. Continue fabrication of an optical seeker that uses multi-discriminate signatures to improve targeting obscured targets. Using ground test data, continue augmenting the shape signatures in the automatic target acquisition algorithms to add laser multi-discriminate signatures.				
(U)				
(U) MAJOR THRUST: Investigate and develop advanced navigation and control technologies for	4.008	4.060	4.971	5.100

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	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, improve resistance to Global Positioning System (GPS) jamming, and enhance strike aircraft effectiveness and survivability.				
(U)	In FY 2004: Evaluated new design technologies for tactical munitions flight control systems. Developed novel ways to enhance weapon system effectiveness through higher levels of integration of guidance, navigation, control, and estimation algorithms. Further investigated the neuro-physiology of insects for applications to guidance. Investigated concepts for penetrator guidance below the ground surface.				
(U)	In FY 2005: Complete 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. Complete investigating concepts for penetrator guidance below the ground surface.				
(U)	In FY 2006: Initiate development of navigation and guidance techniques to autonomously guide cooperative robotic weapons without location information from GPS. Begin developing guidance techniques for small agile vehicles in close proximity to cluttered terrain. Continue investigating the neuro-physiology of insects for application to guidance, particularly engaging moving ground targets. Begin evaluating advanced navigation systems within GPS jamming environments.				
(U)	In FY 2007: Continue developing navigation and guidance techniques to autonomously guide cooperative robotic weapons without location information from GPS. Continue developing small agile vehicle guidance to avoid obstacles. Continue applying the neuro-physiology of insects to guide small vehicles to moving targets in an urban-like environment. Continue evaluating navigation systems within GPS jamming environments.				
(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. Continue developing highly innovative concepts and approaches in guidance and control. These seekers will deny an enemy the ability to hide or camouflage a target, while also decreasing aircrew workload.	1.892	2.250	2.900	2.762
(U)	In FY 2004: Enhanced 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, transitioned biomimetic principles developed in basic research for variable resolution sensors that will emulate biological or human characteristics for use in advanced seeker components for moving target scenarios. Completed investigation of algorithms to perform flight trajectory shaping that reduces human error design effects. Initiated investigating polarization				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions	PROJECT NUMBER AND TITLE 2068 Advanced Guidance Technology

measurement to differentiate the properties of manmade materials from natural backgrounds.

(U) In FY 2005: Continue transitioning biomimetic principles developed in basic research for variable resolution sensors that 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) In FY 2006: Continue work in biomimetic principles by developing modular models to investigate particular target attributes. Continue investigating polarization techniques to develop model behavior theory. Continue in-house capability to evaluate contractor developed optic-flow algorithms.

(U) In FY 2007: Continue developing innovative approaches in guidance and control. Continue investigating particular target attributes using biomimetic principles. Continue developing polarization behavior theory models. Continue to evaluate contractor developed optic-flow algorithms.

(U)

(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.	3.726	3.805	4.500	4.300

(U) In FY 2004: Furthered analysis efforts and multi-sensor modeling to improve target signature prediction models, expedite development, and reduced the acquisition cycle expense for state-of-the-art seekers. Investigated the long-term technology and strategy for developing an advanced laser ranging and detection scene projector capability. Developed two-dimensional laser arrays for laser ranging and detection scene projectors. 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 to provide comprehensive comparisons among inventory, planned, and conceptual munitions to identify high payoff technologies and weapon attributes.

(U) In FY 2005: Complete 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 models and reusable end-system simulation tools. Develop a prototype waveform generator, meeting DoD simulator requirements, using a commercial synthesizer chip.

(U) In FY 2006: Complete development and establish a reusable, simulation architecture consisting of a set of reusable interoperable simulations to evaluate emerging munitions technologies. Complete developing an arbitrary waveform simulation using a commercial synthesizer chip. Improve existing multi-spectral phenomenology models for synthetic scene generation.

(U) In FY 2007: Continue refining the set of interoperable simulations, validating the reusable aspect, to evaluate emerging munitions technologies. Improve existing multi-spectral phenomenology models and evaluate in a synthetic scene environment. Develop a set of reusable modeling tools to allow munition simulations to be built from standardized components using standard commercial products.

(U)	Total Cost	15.997	16.215	17.612	17.418

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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.

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602602F Conventional Munitions**	**2502 Ordnance Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2502 Ordnance Technology	29.315	35.575	40.446	42.792	40.046	39.583	39.412	39.342	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 and weapon drag.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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.	6.200	7.125	7.600	7.650

(U) In FY 2004: Upgraded and refined basic models describing fragmentation effects against various target facilities, including weapons of mass destruction (WMD). Used campaign analysis tools to compare inventory, budgeted, and conceptual munitions to identify high payoff technologies. Developed improved engineering level predictive methods for blast effects, combined effects environment, and target structural response. Improved methodologies for predicting the penetration performance of unitary penetrating materials into complex target structures.

(U) In FY 2005: Complete upgrading and refining basic models illustrating fragmentation effects against various target facilities, including hardened facilities and WMD. Finish 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 strikes. Develop models to assess the failure of blast doors and other hardened assets in deep underground facilities.

(U) In FY 2006: Develop code enhancements to computer model for dynamic submunition dispensing of new weapon concepts. Continue developing a simplified finite element model to estimate damage to buildings caused by direct weapon effects. Improve methods for predicting the effects of munition detonations in embedded soil, concrete or rock.

(U) In FY 2007: Continue modeling damage to buildings caused by direct weapon effects. Continue improving methods for predicting damage caused by detonation of penetrating warheads in a variety of materials. Develop a model to predict the vulnerability of protected assets in deep underground facilities.

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(U)					
(U)	MAJOR THRUST: Investigate and develop more efficient, affordable explosives including inert dense metal 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, more insensitive to unplanned stimuli, and less expensive explosive fills for inventory and future weapons.	4.372	5.119	5.803	5.800
(U)	In FY 2004: Developed a highly energetic material that has twice the power density of conventional explosives, while still exhibiting insensitive munition attributes. Developed an explosive capable of surviving Mach 4 impacts that still functions as desired when initiated by the fuze. Developed characterization and evaluation methodologies to test the munition application performance of high energy density materials developed in other laboratories. Initiated increasing the energy output, while maintaining the producible capability of cast and cure composite explosives by using advanced energetic materials, plasticizers, and formulation techniques.				
(U)	In FY 2005: Continue developing a highly energetic material with twice the power density of conventional explosives by establishing experimental fragment threshold on-set velocities for a variety of new energetic candidates. Continue increasing the energy output, while maintaining the producibility of cast/cure Plastic Bonded Explosives (PBX), 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 attributes are required.				
(U)	In FY 2006: Continue developing highly energetic material with twice the power density of conventional by developing and validating new energetics ignition parameters. Demonstrate use of multi-functional material or nano energetic fills. Fabricate cast/cure PBX using advanced materials, plasticizers, and formulation techniques.				
(U)	In FY 2007: Continue developing highly energetic material with twice the power density of conventional explosives by delivering a modeling and simulation capability for enhanced blast materials. Develop energetic liner technology to enhance blast output yet improve the insensitive munition attributes of the weapon system. Demonstrate performance of cast/cure PBX using advanced materials, plasticizers, and formulation techniques.				
(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	6.240	6.705	7.300	7.300

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requirements.
(U) In FY 2004: Furthered development of a high resolution, electromagnetic countermeasure-hardened, active imaging fuze that calculates warhead burst direction and detonation time. Investigated technologies that communicate battle damage assessment information through hardened mediums. Developed miniaturized fuze to effectively control the release of 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. Complete initial design of 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 four cubic inch package. Begin developing a wireless communication system to fuze a hard target munition.
(U) In FY 2006: Demonstrate a high resolution, electromagnetic countermeasure-hardened, active imaging fuze that calculates warhead burst direction and detonation time. Continue developing a miniaturized fuze to provide safe and arm, burst point sensor and low power initiator in a four cubic inch package. Continue developing a wireless communication system to fuze a hard target munition. Begin to develop waveform agile fuze to defeat smart jamming devices.
(U) In FY 2007: Continue developing a miniaturized fuze to provide safe and arm, burst point sensor and low power initiator in a four cubic inch package. Continue developing a wireless communication system to fuze a hard target munition. Continue to develop a waveform agile fuze to defeat smart jamming devices.
(U)

(U) MAJOR THRUST: 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 formulations, 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: In FY 2006, funds are increased to support Battlefield Air Operations efforts.	5.567	8.745	11.067	13.242

(U) In FY 2004: Expanded investigations of subsystem technologies necessary to develop an optimum kill missile against low-observable air targets. Performed 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 miniature cruise missile. Begin developing technologies to deny enemy operations through loitering, persistent, low-cost multiple-shot

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BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT NUMBER AND TITLE **2502 Ordnance Technology**

munitions.

(U) In FY 2006: Continue research to develop precise time-of-arrival munitions. Continue to identify critical technologies needed for an advanced next generation, low-cost miniature cruise missile. Continue investigating technologies to deny enemy operations through loitering, persistent, low-cost, multiple-shot munitions. Begin investigating application of nanotube-reinforced composites to reduce structural weight of weapons. Develop a miniaturized attack system to communicate target aim point position from behind enemy lines. Develop a covert video capability to collect and transmit data to coordinate attack of enemy targets.

(U) In FY 2007: Complete precision time-of-arrival investigation to defeat tunnel blast doors. Continue investigating technologies for miniature cruise missile development. Finish the design studies for loitering, persistent, low-cost multiple-shot munitions. Finish the initial investigation of nanotube reinforced composites to reduce structural weight of weapons. Continue miniaturizing the attack system to communicate target aim point position from behind enemy lines. Continue to develop a covert video capability to collect and transmit data to coordinate attack of enemy targets.

(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 with a corresponding increase in aircraft load-out and sortie effectiveness.	6.936	7.881	8.676	8.800

(U) In FY 2004: Evaluated initiation-based, adaptable, and multi-mode warheads using enhanced lethality materials and miniaturization technologies for the advanced warhead kill mechanism. Advanced evaluations of an ordnance package designed for low collateral damage with high near-field and minimum far-field lethality. Improved 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. Completed preliminary evaluation of tungsten to be used for high-speed, penetrating-warhead case material. Developed the design constraints to provide adaptable warhead technologies to better attack mobile ground targets. Developed experimental data analysis techniques to characterize the dynamic response of metals used for warhead cases. Investigated 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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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) In FY 2006: Demonstrate an ordnance package designed for low collateral damage and minimum far-field lethality. Complete 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. Begin an effort to develop focusing kill mechanisms for dual role, dual range missiles. Begin to investigate micro damage technologies to neutralize electronics with small robotic weapons.

(U) In FY 2007: Continue evaluating tungsten for high-speed penetrating weapons. Continue an effort to develop focusing kill mechanisms for dual role, dual range missiles. Continue investigating micro damage technologies to neutralize electronics with small robotic weapons.

(U)	Total Cost	29.315	35.575	40.446	42.792

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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.

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY: **02 Applied Research**

PE NUMBER AND TITLE: **0602605F DIRECTED ENERGY TECHNOLOGY**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	40.827	43.594	37.709	42.602	40.830	41.252	41.591	41.934	Continuing	TBD
4866	Lasers & Imaging Technology	26.725	28.215	22.737	25.642	24.701	24.857	25.061	25.272	Continuing	TBD
4867	Advanced Weapons & Survivability Technology	14.102	15.379	14.972	16.960	16.129	16.395	16.530	16.662	Continuing	TBD

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

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 2005 Congress added $2.5 million for Adaptive Optics Lasercom, and $5.0 million for Ultra Short Pulse Laser Technology Development.

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) <u>B. Program Change Summary ($ in Millions)</u>

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	42.077	36.532	38.540	44.413
(U)	Current PBR/President's Budget	40.827	43.594	37.709	42.602
(U)	Total Adjustments	-1.250	7.062		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.438		
	Congressional Increases		7.500		
	Reprogrammings				
	SBIR/STTR Transfer	-1.250			

(U) <u>Significant Program Changes:</u>

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4866 Lasers & Imaging Technology	26.725	28.215	22.737	25.642	24.701	24.857	25.061	25.272	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop high power chemical laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications.	4.826	7.420	6.124	5.887
(U) In FY 2004: Performed sub-scaled evaluation of optimized high pressure ejector nozzles and integrated iodine atom generation for airborne applications. Evaluated the feasibility of low-flow rate basic hydrogen peroxide and zero-gravity singlet delta oxygen generator concepts for airborne applications. Investigated 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. Demonstrate beam control technology applicable to future airborne lasers.				
(U) In FY 2006: Continue to investigate scalability of high performance zero-gravity singlet delta oxygen generator concepts for airborne laser applications. Demonstrate advanced chemical and electrical singlet oxygen generator technology to help improve current levels of performance. Investigate laser/fiber pumped molecular gas lasers. Develop advanced diagnostics for chemical oxygen iodine laser performance measurements to identify potential enhancements. Begin work on technologies that would increase the range of future high power airborne lasers. Investigate chemical-electrical hybrid laser technologies that offer potential for power scaling and component size and weight reduction.				
(U) In FY 2007: Continue work on technologies that would increase the range of future high power airborne				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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lasers. Evaluate and refine advanced chemical laser technologies demonstrated in FY 2006. Develop additional advanced diagnostics for chemical oxygen iodine laser performance measurements to identify potential enhancements. Develop chemical-electrical hybrid laser technologies that offer potential for power scaling and component size and weight reduction.

(U)

(U)	MAJOR THRUST: Develop moderate power solid state laser device, beam control, and associated technologies for airborne tactical applications, primarily aircraft self-defense with integrated sensors. Technologies being addressed include; tailored high-brightness, multi-wavelength compact lasers and advanced beam control techniques to minimize platform vibration, atmospheric jitter, and aero-optical effects.	4.200	5.458	6.888	9.435

(U) In FY 2004: Collected aero-optical data from tactical aircraft to anchor computer models. Addressed thermal management issues and packaging/integration/test issues for tactical laser applications on airborne platforms. Demonstrated improvements in semiconductor laser efficiency and operating temperatures that could enable future tactical systems and combat identification systems.

(U) In FY 2005: Develop laser component technologies for detecting, identifying, tracking, and defeating electro-optic targets from airborne tactical platforms. Design and fabricate new laser structures for near-infrared, mid-infrared, and long-wavelength operation. Focus development on power scaling, lower weight, reduced volume, robustness, improved beam quality, and higher efficiency. Develop laser system for optical augmentation to detect optical threats such as sniper scopes. Develop integrated aero-optical wavefront sensor beam control technology for tactical applications. Identify inertial reference unit operating requirements for these laser applications and evaluate existing advanced inertial reference unit technology. Test tactical beam control propagation codes.

(U) In FY 2006: Develop laser component technologies for detecting, identifying, tracking, and defeating electro-optic targets from airborne tactical platforms. Enhance new laser structures for near-infrared, mid-infrared, and long-wavelength operation focusing on power scaling, lower weight, reduced volume, robustness, improved beam quality, and higher efficiency. Develop single- and multi-wavelength packaging and delivery methods. Begin development of system-level solutions to aero-optical issues involving tactical laser applications on airborne platforms. Transition most promising concepts to field testing. Assess laser requirements for destroying detectors in the threat sensors. Analyze the failure modes and other effects when various optics are damaged. Complete integrated aero-optical wavefront sensor development. Complete evaluation of advanced inertial reference unit. Continue testing of tactical beam control propagation codes.

(U) In FY 2007: Design and develop laser sources for jamming/damaging optical threats. Focus on higher efficiency and higher reliability. Perform ground testing of ultra-short pulse laser sources to evaluate

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	tactical applications. Continue development of system-level solutions to aero-optical issues involving tactical laser applications on airborne platforms. Investigate technologies for tracking in clutter and tactical platform disturbance mitigation. Develop selected technologies for transition from laboratory to field testing.				
(U)					
(U)	MAJOR THRUST: Perform system assessments to include vulnerability assessments on potential high-energy laser targets. Provide critical design data for laser systems to defeat these targets. Develop directed energy concepts and identify issues relating to system architectures, technology readiness, technology tradeoffs, mission effectiveness, and military utility.	0.904	0.955	1.145	1.305
(U)	In FY 2004: Identified system constraints and performance degradation in environments such as battlefield conditions and weather. Performed susceptibility experiments to quantify damage thresholds on indium antimony focal plane arrays. Initiated the development of a vulnerability database on threats to electro-optical sensor systems. Established a classified database of high energy laser data and reports.				
(U)	In FY 2005: Identify additional laser system constraints and performance degradation in real world situations, including battlefield conditions and weather. Investigate the integration of technologies into relay mirror concepts. Perform system assessments of laser systems on tactical and bomber platforms.				
(U)	In FY 2006: Perform lethality assessment studies to assess the effectiveness of the various laser concepts in relevant scenarios. Validate vulnerability assessment models by performing mid-scale and full-scale demonstration experiments. Simulate and investigate advanced adaptive optics for uplink beam control. Develop and evaluate two-beam propagation techniques for tracking and illumination of a cruise missile through an airborne relay mirror. Simulate and investigate tactical and bomber defense laser system technologies.				
(U)	In FY 2007: Perform additional lethality assessment studies to assess the effectiveness of the various laser concepts in relevant scenarios. Continue mid-scale and full-scale demonstration experiments to validate vulnerability assessment models. Investigate the scalability, affordability, and application of selected relay mirror, bomber defense, and tactical laser systems.				
(U)					
(U)	MAJOR THRUST: Develop scalable high power solid state laser technologies for applicable next-generation laser device applications such as tactical airborne laser weapons.	6.265	3.611	6.385	6.769
(U)	In FY 2004: Demonstrated 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 that could be a building-block for future directed energy, megawatt-class solid state lasers. Demonstrate wavelength versatile laser at five watt power levels in the various wavelengths.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4866 Lasers & Imaging Technology**

(U)	In FY 2006: Investigate and demonstrate alternative laser architectures and gain media. Demonstrate wavelength versatile laser at greater than five watt power levels in the various wavelengths. Refine laser technologies to obtain architectures that are favorable in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability, environmental acceptability (air, land, and maritime), and ruggedness for tactical laser weapon applications.				
(U)	In FY 2007: Work on scaling modular lasers up to the weapon class power level. Refine technologies to obtain architectures that are favorable in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability, environmental acceptability (air, land, and maritime), and ruggedness for tactical laser weapon applications.				
(U)					
(U)	MAJOR THRUST: Develop broadly applicable technologies to support future tactical and strategic relay mirrors systems.	0.141	0.331	0.554	0.604
(U)	In FY 2004: Selected the best lightweight, low power optics candidate technologies for airborne relay mirrors and started 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)	In FY 2006: Simulate and investigate advanced adaptive optics for uplink beam control. Develop and evaluate two beam propagation techniques for tracking and illumination of a cruise missile through an airborne relay mirror. Design low-altitude relay mirror field experiments.				
(U)	In FY 2007: Continue investigation of advanced adaptive optics techniques for uplink beam control.				
(U)					
(U)	MAJOR THRUST: Develop optical and beam control technologies to enhance high energy laser beam propagation over long distances in the atmosphere.	3.488	3.006	1.641	1.642
(U)	In FY 2004: Evaluated the performance of various wavefront sensors to maximize the ability to correct atmospheric effects on laser beams through laboratory demonstrations. Evaluated a compensated beacon illumination technique. Evaluated novel tracking algorithms. Completed initial evaluations using physics level wave optics simulations of several advanced concepts designed to improve performance of the Airborne Laser (ABL). These concepts included a compensated beacon approach, a focused track illuminator concept, several advanced tracking algorithms, and an adaptive reconstructor concept.				
(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 stressing atmospheric turbulence. Anchor wave optics propagation code to recent actual beam control performance. Complete concept evaluations using the ABL wave optics code				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	that includes more detailed models of the ABL beam control system. Complete field testing of advanced tracking algorithms and adaptive optics techniques at the North Oscura Peak propagation range.				
(U)	In FY 2006: Demonstrate high-bandwidth active tracking of uncooperative targets. Begin development of predictive processing techniques to correct atmospheric turbulence-induced track jitter. Experimentally characterize turbulence-induced track jitter over large apertures. Develop and evaluate sensor data, tools, and processes to support an end to end model-based analysis approach for a range of beam control applications.				
(U)	In FY 2007: Demonstrate active tracking of small/dim targets in conjunction with compensated laser illumination and overall laser system performance characterization. Continue development of predictive processing techniques to correct atmospheric turbulence-induced track jitter. Begin field experiments to measure track jitter compensation.				
(U)					
(U)	CONGRESSIONAL ADD: National High Energy Laser Consortium.	0.486	0.000	0.000	0.000
(U)	In FY 2004: Developed 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Stabilized Fiber Laser Pump Development.	4.471	0.000	0.000	0.000
(U)	In FY 2004: Developed 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Adaptive Optics Lasercom.	1.944	2.478	0.000	0.000
(U)	In FY 2004: Designed, developed, and began integration of existing technology for air-to-air optical communication with performance goal of 2.5 gigabit per second. Designed airborne experiment using unmanned air vehicle simulator aircraft and ground facilities at the North Oscura Peak, White Sands Missile Range, New Mexico, test site.				
(U)	In FY 2005: Develop and test advanced technologies for a 2.5 gigabit per second air-to-air-to-ground optical communications system on a government test range. Interface with other Air Force and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	Department of Defense agencies to incorporate joint requirements into system performance.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Ultra-Short Pulse Laser technology Development.	0.000	4.956	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop ultra-short pulse laser technology to obtain high-average, high-peak power. Investigate system engineering issues to package the ultra-short pulse laser technology into a low-weight, low-volume component. Investigate the relevance of ultra-short pulse laser technology for man portable and vehicle portable applications.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	26.725	28.215	22.737	25.642

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0601108F, High Energy Laser Research Initiatives.										
(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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U) C. Other Program Funding Summary ($ in Millions)

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 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4867 Advanced Weapons & Survivability Technology**	

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4867	Advanced Weapons & Survivability Technology	14.102	15.379	14.972	16.960	16.129	16.395	16.530	16.662	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	6.830	7.355	7.160	6.976
(U) In FY 2004: Developed compact repetitively operated source technologies. Conducted pulsed atmospheric breakdown experiments. Integrated explosive generator development experiments with compact single-shot HPM sources. Investigated conformal phased array antenna for HPM systems. Developed sub-scale (laboratory) repetitively pulsed multi-gigawatt technology for HPM breadboard munitions and airborne electronic attack proof-of-concept. Conducted laboratory evaluation of nanotechnology developed cathodes and anodes for repetitively pulsed HPM experiments. Utilized nanotechnology and other technologies to reduce the HPM source weight. Conducted a sub-scale (laboratory) wideband technology target identification experiment.				
(U) In FY 2005: Investigate higher-power 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 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 high power microwave (HPM) experiments. Develop target identification concept using wideband technology. Further develop wideband technology target identification source to demonstrate increased standoff range.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U) In FY 2006: Develop a compact repetitively pulsed gigawatt-class HPM source. Develop a conformal high power phased array antenna for the compact pulsed HPM source. Develop compact permanent magnets for the compact pulsed gigawatt HPM source. Develop a compact pulse power system to drive the HPM source. Conduct laboratory measurements of the compact pulsed gigawatt HPM demonstration unit. Develop vacuum systems that are compact and can be installed in an airborne platform. Develop compact solid-state wideband source and antenna for target identification. Develop target identification algorithms. Conduct target identification field experiments to determine optimal design.

(U) In FY 2007: Conduct measurements using the compact repetitively pulsed gigawatt-class HPM demonstration unit. Improve the compact HPM source and conformal antenna that they can be integrated into an airborne platform. Develop a command and control system for the airborne platform HPM unit. Implement nanotechnology to reduce the HPM source weight and size. Develop a compact portable wideband target identification system.

(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.	2.086	2.313	2.164	2.256

(U) In FY 2004: Conducted susceptibility tests to determine relative importance of source parameters in causing the desired effects on targets. Used current effects data and results in narrowband and wideband HPM experiments. Refined HPM codes to predict probability of effect on target equipment and to guide experiment direction. Developed better modeling techniques to incorporate HPM technologies into warfighting/wargaming activities. Further validated 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) In FY 2006: Continue to advance elemental modeling methodology to predict target susceptibility through modeling. Develop advanced descriptions of target functional behavior for insertion into modeling and simulation codes. Continue susceptibility testing of electronic targets.

(U) In FY 2007: Predict susceptibility of relevant current electronic systems. Conduct further experiments on the systems and compare predictions with experiments. Adjust models as required.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT NUMBER AND TITLE **4867 Advanced Weapons & Survivability Technology**

(U)	MAJOR THRUST: Develop and apply sophisticated models to enhance the development of high power microwave (HPM) and related technology.	0.726	0.782	0.758	0.777
(U)	In FY 2004: Investigated plasma models and develop physics algorithms for HPM technologies. Developed improved algorithms for higher frequency wideband HPM modeling. Performed further virtual modeling for HPM component 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 modeling for HPM component technologies.				
(U)	In FY 2006: Validate plasma model on dielectric pulse power interfaces and antenna breakdown. Improve the fidelity of the solution to electromagnetic models by statically refining the numerical grid and by having a boundary conformal solution. Continue integration of electromagnetic codes with thermal and electron transport codes.				
(U)	In FY2007: Validate integration of electromagnetic codes with thermal and electron transport codes for HPM sources and components. Continue improving the fidelity of the solution to electromagnetic models by automatically refining the numerical grid.				
(U)					
(U)	MAJOR THRUST: Investigate HPM technologies that support offensive and force protection airborne tactical applications made possible by the increased power available on future aircraft.	4.460	4.929	4.890	6.951
(U)	In FY 2004: Investigated enhanced source components of promise, especially plastic-laminate pulse forming lines, with an integrated Marx pulser. Modeled and performed simulation of the complete source. Completed determination of effect of air breakdown on transmitted HPM pulse over time. Finished 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. 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)	In FY 2006: Refine high power microwave (HPM) system source code to reflect payload to platform integration issues such as thermal, x-ray, and electrical issues. Examine the status of power conditioning subsystems to determine their applicability to an airborne experiment. Ensure understanding of air breakdown potentials given specific antenna interfaces. Continue refinement of solid state subsystem				

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designs.

(U) In FY 2007: Further develop HPM source materials and assess applicability of solid state subsystem designs supporting a ruggedized high power airborne system. Extend HPM system source code to reflect multiple options for high power subsystem components. Improve air breakdown predictions with specific antenna compositions. Refine existing beam control/antenna concepts to meet airborne requirements for Active Denial including addressing issue related to propagation, breakdown, and radomes. Research, study, and identify advanced technologies or data (effects, safety, stabilization, engagement) that could enhance the airborne Active Denial conceptual approach.

(U)	Total Cost	14.102	15.379	14.972	16.960

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005**

BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	78.879	84.887	93.316	102.163	98.109	100.198	102.109	97.352	Continuing	TBD
4519	Communications Technology	16.383	17.083	23.598	25.619	26.484	27.115	26.503	23.335	Continuing	TBD
4594	Information Technology	28.345	27.765	27.570	30.404	30.244	29.754	30.213	30.336	Continuing	TBD
4917	Collaborative Information Tech	7.678	5.587	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5581	Command and Control (C2) Technology	26.473	34.452	42.148	46.140	41.381	43.329	45.393	43.681	Continuing	TBD

Note: Increased funding in FY 2006 and out reflects increased emphasis on developing high payoff applications of information technologies to meet C3 needs. In FY 2006, efforts in Project 4917 move into Project 4594, Project 4519, and Project 5581 in this PE.

(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 2005, Congress added $2.5 million for Measurement and Signatures Intelligence Warfighter Visualization Tools, and $1.0 million for Joint Battlespace Infosphere. 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	79.594	82.147	82.865	90.866
(U)	Current PBR/President's Budget	78.879	84.887	93.316	102.163
(U)	Total Adjustments	-0.715	2.740		
(U)	Congressional Program Reductions		-0.006		
	Congressional Rescissions		-0.754		
	Congressional Increases		3.500		
	Reprogrammings				
	SBIR/STTR Transfer	-0.715			

(U) Significant Program Changes:
Not Applicable.

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BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4519 Communications Technology	16.383	17.083	23.598	25.619	26.484	27.115	26.503	23.335	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: Increased funding in FY 2006 and out reflects increased emphasis on developing information and networking technologies and the transfer of information technologies development effort from Project 4917 in FY 2006.

(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. 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop assured and survivable information and networking technologies enabling worldwide command, control, and communications operations for the Air Force. Note: FY 2006 and out increase reflects increased emphasis on developing information and networking technologies.	5.534	5.969	10.168	11.767
(U) In FY 2004: Developed technologies to improve quality of service for globally distributed information systems (e.g., Joint Battlespace Infosphere (JBI)). Developed assured networking and information systems technologies to improve survivability against critical infrastructure attacks. Developed securely managed enterprise network technology for development of assured network services across multiple network security domains and coalitions. Developed 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 information delivery services, independent of the underlying physical infrastructure devices. Initiate development of capabilities for self-organizing, self-healing, autonomous networking.				
(U) In FY 2006: Complete development of technologies to improve quality of service and survivability for				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4519 Communications Technology**

globally distributed information systems (e.g., JBI). Complete development of programmable networking algorithms that enable wide area dynamic creation of advanced information delivery services, independent of the underlying physical infrastructure devices. Continue development of capabilities for self-organizing, self-healing, autonomous networking. Initiate development of policy-based network management technologies for real-time network response to changes in information condition (INFOCON) levels. Initiate developments focused on communications/resource network management schemas and sensor exploitation technologies enabling the dynamic integration of communications and sensor management functions for more effective moving target exploitation and fusion. Initiate development of content-based delivery networking (CBDN) technologies for intelligent network delivery and management of end user information.

(U) In FY 2007: Complete development of capabilities for self-organizing, self-healing, autonomous networking. Continue development of policy-based network management technologies for real-time network response to changes in INFOCON levels. Continue development and test of communications/resource network management schemas and sensor exploitation technologies enabling the dynamic integration of communications and sensor management functions for more effective moving target exploitation and fusion. Continue development of airborne CBDN, synergistic with the Joint Tactical Radio System Wideband Networking Waveform's Network Service Layer, and applied to extremely dynamic infrastructure and network/platform mobility dictated by tactical aircraft.

(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.	4.378	4.470	4.549	4.674

(U) In FY 2004: Developed information assurance technologies that will improve the robustness of the Global Information Grid in both wireline 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. Developed 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. Developed 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4519 Communications Technology**

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) In FY 2006: 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 development of higher performance, adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities over wireless channels which support command and control, and intelligence, surveillance, and reconnaissance missions, and the use of intelligent munitions. Complete development of higher performance video compression and modulation techniques that enable critical objectives for high bandwidth information transmission and exploitation capabilities over wireless channels. Initiate the design and development of a multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods to support, under fast-changing environments, higher-throughput, anti-jam, low probability of intercept, and/or robust [assured] voice, data, and video communications. Perform such design and development within the framework of the Joint Tactical Radio System or compatible software defined radios. Explore/exploit feasible applications of quantum key distribution and cryptography to effect ultra-secure communications for wireline and wireless networks.

(U) In FY 2007: Complete first phase 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. Demonstrate promising higher performance, adaptively combined multi-dimensional (space, time, frequency, coding, polarization) transmission techniques that enable high bandwidth information transmission and exploitation capabilities amongst airborne command and control, and intelligence, surveillance, and reconnaissance platforms and various weapon delivery systems with their smart munitions. Test and demonstrate a multi-mode, multi-function, sense-and-adapt air-mobile communications capability to dynamically alter communications methods under fast-changing environment within the framework of the Joint Tactical Radio System or compatible software defined radios. Develop and test promising quantum key distribution and cryptography technologies to effect ultra-secure communications for wired and wireless networks. Perform transition planning.

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(U)					
(U)	MAJOR THRUST: Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems' C2, intelligence, surveillance, and reconnaissance data/information. Note: Effort transferred from Project 4917 in FY 2006.	0.000	0.000	1.822	1.870
(U)	In FY2004: Not Applicable.				
(U)	In FY2005: Not Applicable.				
(U)	In FY2006: Initiate exploration of techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses. Continue development, test, and assessment of exploratory radio frequency and optical information transfer technologies.				
(U)	In FY2007: Continue to explore multiple technologies/techniques for tunable, high power radio frequency filtering to reduce overall radio frequency component equipment size, weight, and signal losses. Continue development, test, and assessment of exploratory radio frequency and optical information transfer technologies.				
(U)					
(U)	MAJOR THRUST/CONGESSIONAL ADD: Develop cyber operations technologies for enabling worldwide command, control, communications and intelligence. Note: This effort includes Congressional Add funding of $1.2 million in FY 2004.	6.471	6.644	7.059	7.308
(U)	In FY 2004: Developed automated capabilities for damage assessment and recovery techniques. Developed network forensics and data mining tools for detecting adversary information warfare attacks and to provide early warning notification. Developed detection and eradication techniques for malicious code. Developed active response technologies. Completed work in detection of hidden data. Developed advanced correlation fusion techniques for defensive course of action analysis. Developed intrusion detection techniques for wireless networks. Developed new tools and techniques to protect command, control, communications, intelligence, and information systems, and allowed 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 command, control, communications, intelligence, and information systems, and allow for integration of coalition information elements.				
(U)	In FY 2006: Continue development of intrusion detection techniques for wireless networks. Continue to				

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develop automated capabilities for damage assessment and recovery. Continue to develop techniques for defining defensive courses-of-action to counter adversary information warfare attacks. Continue to develop defensive techniques for wireless, mobile and embedded systems. Continue to develop detection and eradication techniques for malicious code. Continue development of active response and computer network attack (CNA) technologies. Continue development of advanced correlation fusion techniques for defensive course of action analysis. Initiate work addressing self-healing systems.

(U) In FY 2007: Complete development of intrusion detection techniques for wireless networks. Continue to develop automated capabilities for damage assessment and recovery. Continue to develop techniques for defining defensive courses-of-action to counter adversary information warfare attacks. Continue to develop defensive techniques for wireless, mobile and embedded systems. Continue to develop detection and eradication techniques for malicious code. Continue development of active response and CNA technologies. Continue development of advanced correlation fusion techniques for defensive course of action analysis. Continue efforts in self-healing systems.

(U)	Total Cost	16.383	17.083	23.598	25.619

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602702F Command Control and Communications**	**4594 Information Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4594 Information Technology	28.345	27.765	27.570	30.404	30.244	29.754	30.213	30.336	Continuing	TBD
Quantity of RDT&E Articles	0	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, other government agencies, and open source information. 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. This project develops high-payoff embedded information systems technologies for the next generation of distributed information integration architectures to enable global information dominance and air and space superiority. The embedded information systems technologies provide affordable, innovative, secure, net-enabled embedded information systems to the warfighter.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop innovative multi-sensor collaborative fusion technologies in a fully distributed air and space environment.	6.571	6.753	6.460	7.241
(U) In FY 2004: Developed techniques to quantitatively evaluate fusion algorithms that support the analysis of a new emerging information era. Developed optimized multi-source fusion techniques for continuous tracking of militarily significant vehicles in the battlespace. Developed and evaluated 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) In FY 2006: Continue to develop and evaluate fusion techniques for optimal fusion management. Test and analyze vehicle motion models for variable state multiple algorithm to associate the current location of vehicle with a future state. Enhance multi-source fusion techniques for probabilistic identification and continuous tracking of military significant threats in the battlespace. Evaluate evidence accrual and data mining techniques for improved fusion performance. Develop new measures of performance for higher levels of fusion in analyzing situational assessment and process refinement.				
(U) In FY 2007: Evaluate fusion management and advance the state-of-the-art in track-to-track fusion				

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	techniques. Continue the process of probabilistic identification though the use of multi-source fusion. Increase probabilistic confidence through the inclusion of higher-level fusion techniques in the situational assessment and process refinement area. Develop techniques to dynamically update advanced reasoning fusion engines to adapt to changing threat conditions. Develop intelligence, surveillance, and reconnaissance management techniques that optimize the fusion process for identification and continuous tracking of military significant threats. Evaluate network centric approaches to provide distributed fusion techniques to the warfighter.				
(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.	5.468	5.644	5.785	6.386
(U)	In FY 2004: Developed 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. Developed data mining techniques for a self-organizing data repository and content-based extraction to support prediction of potential events in the world. Developed 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. Develop new techniques addressing key entity extraction technology gaps, to improve the accuracy of Air Force and joint systems that exploit information from unstructured text for situation analysis.				
(U)	In FY 2006: Complete development of intermediate information extraction techniques to decrease analysis time for decision-making and enabling the ability to populate knowledge base systems. Complete development of techniques addressing key entity extraction technology gaps, to improve the accuracy of Air Force and joint systems that exploit information from unstructured text for situation analysis. Continue development of interactive contextual reasoning with inference techniques for self-organizing data repositories, and content-based extraction to support identification of potential events in the world. Continue enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational understanding. Develop inferencing techniques for reasoning				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	about the situation and predict enemy intent and threat possibility.				
(U)	In FY 2007: Enhance techniques for interactive contextual reasoning with inference techniques for self-organizing data repositories and content-based extraction to support identification of potential events in the world. Continue enhancement of web-based search techniques, data filtering techniques, and information aggregation methods to take advantage of the explosion of available open source data on the Web required for rapid situational understanding. Continue developing inferencing techniques for reasoning about the situation and for predicting enemy intent and threat possibility.				
(U)					
(U)	MAJOR THRUST: Develop automatic and dynamically reconfigurable, affordable, scalable, distributed petaflop processing technologies for real-time C2 global information systems.	3.606	3.913	4.099	4.508
(U)	In FY 2004: Developed and demonstrated architectures for rapid extraction of information from globally distributed knowledge bases. Evaluated architectures to support real-time requirements for dominant battlespace awareness. Studied 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)	In FY 2006: Complete architecture for support of real-time requirements for dominant battlespace awareness. Complete study results of next generation information technologies for C2 systems. Continue evaluation of architectural features for cognitive information processing. Initiate algorithm development for next generation information technologies for C2 systems. Initiate architectural development for cognitive information processing. Develop and characterize high performance computers for quantum computing applications.				
(U)	In FY 2007: Complete evaluation of architectural features for cognitive information processing. Continue algorithm development for next generation information technologies for C2 systems. Continue architectural development for cognitive information processing. Continue development and characterization of high performance computers for quantum computing applications. Initiate development and characterization of the next generation of high performance computers.				
(U)					
(U)	MAJOR THRUST: Develop modeling and simulation technologies for the next generation of planning, execution, and assessment environments.	1.916	1.989	2.461	2.630
(U)	In FY 2004: Completed model abstraction and multi-resolution modeling techniques to reduce the complexity of existing high-resolution models and simulations for next generation distributed				

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BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT NUMBER AND TITLE **4594 Information Technology**

	collaborative decision support environments. Developed decision support technologies and their theoretical foundation to support 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 Air Force Concepts of Operations.				
(U)	In FY 2006: Continue to develop advanced modeling and simulation technologies to support next generation planning execution and assessment environments. Continue development of adversarial behavior models and modeling techniques for dynamic course of action assessment and prediction. Initiate investigation of techniques for integrated interaction and assessment of friendly versus enemy courses of action. Develop simulation techniques for dynamic situation assessment and prediction.				
(U)	In FY 2007: Demonstrate advanced modeling and simulation technologies to support next generation planning execution and assessment environments. Demonstrate adversarial behavior models and modeling techniques for course of action assessment and prediction. Conduct concept demonstrations of integrated interaction and assessment of friendly versus enemy courses of action. Demonstrate a prototypical dynamic situation assessment and prediction system. Investigate advanced concepts to provide approaches for a modeling toolset that enables the warfighter to build composable simulations.				
(U)					
(U)	MAJOR THRUST: Develop real-time embedded information system technologies for complex, time-critical, embedded systems to enable affordable design and development of state-of-the-art hardware and software, innovatively incorporate new capabilities, reactively adapt to multiple missions and changing environments, verify, validate, and assure functionality and integrity, and facilitate rapid insertion to support real-time, collaborative operations within a net-centric enterprise. Note: Effort transfered from Project 4917 in FY 2006.	0.000	0.000	2.007	2.130
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Continue to develop adaptive embedded computing technologies to support enhanced interoperability and information exchange between tactical C2 platforms to support network centric operations, based on Real-Time Java and reconfigurable computing. Continue to develop processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Continue to				

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develop algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms. Continue to develop multi-level secure middleware for real-time embedded system architectures. Continue development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Initiate development of power-aware, polymorphic aerospace systems for mission-aware computing.

(U) In FY 2007: Continue development of dynamically reconfigurable aerospace systems using adaptive computing techniques to support image/video processing and data compression. Complete program to develop adaptive embedded computing technologies to support enhanced interoperability and information exchange between tactical C2 platforms to support network centric operations, based on Real-Time Java and reconfigurable computing. Continue to develop processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Continue to develop algorithms, methods, and processes to support real-time, adaptive resource management of system resources across multiple tactical platforms. Continue to develop multi-level secure middleware for real-time embedded system architectures. Continue development of methods of computation and computing processes using biologically-inspired and biologically-based computation for embedded systems application. Continue development of power-aware, polymorphic aerospace systems for mission-aware computing.

(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 Congressional Add funding of $4.0 million in FY 2004 and $2.5 million in FY 2005.	10.784	9.466	6.758	7.509

(U) In FY 2004: Developed 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. Researched 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.

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Initiate investigation of new techniques to improve open systems techniques for multi-sensor exploitation for enhanced indications and warning and situational awareness.

(U) In FY 2006: Continue to develop tools to increase the production capability of the intelligence analyst. 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. Continue the development of tools to detect, track, and analyze document and file tampering through the use of steganography, steganalysis, and digital watermarking.

(U) In FY 2007: Complete first phase development of techniques in steganography, steganalysis, watermarking, and digital data forensics for imagery, video, and speech information protection and authentication, and intelligence exploitation. Continue the development of the multi- intelligence toolsets for the processing, exploitation and dissemination of actionable intelligence.

(U) Total Cost	28.345	27.765	27.570	30.404

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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.

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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4917 Collaborative Information Tech	7.678	5.587	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in this Project move to Project 4594, Project 4519, and Project 5581 in this PE.

(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 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems' C2, intelligence, surveillance, and reconnaissance data/information. Note: In FY 2006, this effort moves to Project 4519 in this PE.	1.989	1.992	0.000	0.000
(U) In FY 2004: Developed assured communications technology, leveraging commercial infrastructure, for positive C2 of aerospace assets in commercial airspace. Developed 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 C2 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop processes, methods, and techniques to provide assured performance,	1.388	1.495	0.000	0.000

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	integrity, and security of real-time embedded information systems. Note: In FY 2006, this effort moves to Project 4594 in this PE.				
(U)	In FY 2004: Developed dynamically reconfigurable aerospace systems using adaptive computing techniques. Defined and developed 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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 Congressional Add funding of $2.4 million in FY 2004. In FY 2006, this effort moves to Project 5581 in this PE.	4.301	2.100	0.000	0.000
(U)	In FY 2004: Developed techniques to assist in performing the collaborative planning for the seven Air Force Concepts of Operations (CONOPS). Developed distributed collaborative environment technology for effects-based operations and predictive battlespace awareness. Developed 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 Air Force 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	Total Cost	7.678	5.587	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
02 Applied Research	**0602702F Command Control and Communications**	**5581 Command and Control (C2) Technology**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5581	Command and Control (C2) Technology	26.473	34.452	42.148	46.140	41.381	43.329	45.393	43.681	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: Increased funding in FY 2006 and out reflects increased emphasis on developing automatically reconfigurable information system technologies and the transfer of collaborative technologies development effort from Project 4917 in FY 2006.

(U) A. Mission Description and Budget Item Justification

The Air Force requires 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 in this project must be capable of taking advantage of future net-centric environments including new structured and ad hoc processes in response to rapidly changing warfare challenges. Technologies being developed will increase capability, quality, and information interoperability, 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 a Net-Centric Aerospace Force. Advances in robust information management and dissemination technologies will ensure the delivery of high-quality, timely, secure information to the warfighter.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems.	6.576	7.327	6.924	6.943
(U) In FY 2004: Developed tools that will automate the intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Investigated and developed ultra-large, all-source information repositories and associated privacy protection technologies. Completed 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) In FY 2006: Demonstrate tools that will automate the intelligent extraction, correlation, and				

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	classification of link patterns for discovering relevant linkages between entities. Continue to develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Initiate development of foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real world requiring intelligence. Initiate development of cognitive architectures for self-aware, learning agents.				
(U)	In FY 2007: Complete development of technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Continue to develop foundations, technology, and tools to enable effective, practical automated reasoning of the scale and complexity required for computers to perform complex tasks in the real world requiring intelligence. Investigate and develop specialized cognitive architectures using self-aware, learning agents that can generate well-focused knowledge bases for automated intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities.				
(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. Note: FY 2006 and out increase reflects increased emphasis on developing automatically reconfigurable information system technologies.	7.385	8.154	12.975	13.577
(U)	In FY 2004: 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 Operations Center (AOC) C2 process. Developed advanced interactive displays suitable for deployment with C2 applications and command centers. Completed the development of techniques and applications for visualization of multiple, heterogeneous data sets. Developed 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)	In FY 2006: 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				

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process. Continue to develop advanced interactive displays suitable for deployment in harsh environments with C2 applications and command centers. Continue 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. Initiate development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the battlespace.

(U) In FY 2007: 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 rapid deployment in harsh environments with C2 applications and command centers. Continue 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. Continue development of technologies for a holistic tool set that commanders can use to probe, study, analyze, visualize, reason, and predict activities in the battlespace.

(U)

(U) MAJOR THRUST: Investigate and develop technologies to securely share information via publish, subscribe, and query with coalition partners as part of the overall Global Information Grid approach. Sharing of information is in part a function of secure sharing, but is also a function of the managing of the information in assessing the trustworthiness of the information and its markup. Note: This effort was broken out from the next Major Thrust below due to the increased emphasis on C2 in a coalition environment.	0.000	5.229	6.548	9.248

(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 net-centric environment. Initiate development of technology approaches that will rapidly incorporate coalition force structure units into an operational Community of Interest (COI) Infosphere.

(U) In FY 2006: Complete investigation of technologies to dynamically filter and fuse information and produce customized coalition information products. Continue development of technology approaches to rapidly assimilate appropriate coalition partners into appropriate COI Infospheres. Extend cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources such as firewalls/guards/routers, application servers, intrusion

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detection systems, etc. Investigate the ability to perform and enforce role-based access control to these COI Infospheres. Focus research on multi-domain event correlation from a centralized perspective (e.g., guarding services enabled, multi-level security repository) in order to establish a composite picture of resource status with the ability to centrally react to that status. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Initiate development of publish/subscribe technologies for application to a CBDN system for intelligent network management of user information.

(U) In FY 2007: Complete development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Complete development of technology approaches to rapidly assimilate appropriate coalition partners into appropriate COI Infospheres. Complete investigation on performing and enforcing role-based access control to these COI Infospheres. Continue cross-domain information sharing research and development to include collaborative monitoring and management of multi-national enterprise resources. Continue development of techniques and tools that will ensure availability, integrity, and survivability of information within a coalition net-centric environment. Investigate technologies, which can determine the pedigree of information in a coalition environment and assess the trustworthiness of the marked up information to be shared throughout the coalition. Investigate and prototype the application of information fusion and information management technologies such as fuselets to extend composite views of events across a multi-domain enterprise into fused events. Continue development of publish/subscribe technologies for application to a CBDN system for intelligent network management of user information.

(U)

(U) MAJOR THRUST: Develop 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. Note: This effort was performed in Project 4917 prior to FY 2006.	0.000	0.000	2.002	1.937

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Continue development of advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning, Air Force concepts of operations, and next generation planning, execution, and assessment environments. Continue development of distributed collaborative environment technology for operations other then war and similar applications.

(U) In FY 2007: Continue development of advanced information technologies for collaborative decision-making and knowledge management in support of capability-based planning and next

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generation planning, execution, and assessment environments. Prototype distributed collaborative environment technologies for advanced decision support for high-profile system concepts, such as the Global Strike Concept of Operations and operations other then war.

(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 Congressional Add funding of $1.0 million in FY 2004.	9.841	9.873	9.667	9.044

(U) In FY 2004: Developed the next generation of monitoring, planning, execution, and assessment technologies and tools enabling aerospace commanders to efficiently and collaboratively develop effects-based campaigns. Developed technologies to dynamically and rapidly assess the battlespace, and provide near-real-time command of manned and unmanned forces to execute the required missions. Investigated developments in decision support science for incorporation into C2 tools. Developed tools to visualize the probability of success of qualitatively different courses of action. Developed intelligent information systems capable of supporting joint/coalition C2 for various missions. Developed and assessed active template and semantic ontology technologies for use in mobile C2 applications. Developed 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 C2 of available resources to execute the required missions incorporating 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 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, such as family of web service concepts; secure, shareable object spaces; legacy bridges; component-based architectures; information presentation components; and incorporation of Network Centric Warfare Service concepts. Investigate application of decision support sciences to C2 activities within a Coalition AOC.

(U) In FY 2006: Continue to develop technologies to dynamically and rapidly assess the battlespace with a special emphasis on effects based assessment. Continue to investigate application of decision support sciences to C2 activities within a Coalition AOC. Extend Course of Action analysis capability to allow collaboration between geographically remote locations. Continue to develop intelligent information

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systems capable of supporting joint/coalition C2 for various missions. Continue to develop and apply semantic ontology technologies for use in C2 applications, such as effects-based planning and dynamic tasking. Continue to develop tools to increase situational awareness through intelligent information push and pull in dynamic environments. Continue investigation of intelligent information processing techniques to enhance the C2 decision-making process, such as family of web service concepts; secure, shareable object spaces; legacy bridges; component-based architectures; information presentation components; and incorporation of Network Centric Warfare Service concepts. Prototype these techniques and demonstrate feasibility and usefulness. Explore the application of system of systems and federation of systems engineering principles to enable joint C2 capabilities.

(U) In FY 2007: Complete development of next generation of monitoring, planning, execution, and assessment technologies and tools enabling aerospace commanders to efficiently and collaboratively develop effects-based campaigns. Complete development of technologies to dynamically and rapidly assess the battlespace, and provide near-real-time command of manned and unmanned forces to execute the required missions. Complete the incorporation of decision support science into C2 tools. Complete Course of Action analysis capability to allow collaboration between geographically remote locations. Continue to investigate application of decision support sciences and advanced decision-making concepts to C2 activities within a Coalition AOC. Continue to develop intelligent information systems capable of supporting joint/coalition C2 for various missions in a dynamically changing environment. Continue to develop tools to increase situational awareness through intelligent information processing. Continue the application of system of systems and federation of systems engineering in the creation of joint C2 capabilities. Explore the application of intelligent software agents as virtual battle staff members to enhance various C2 processes. Develop and demonstrate an effects-based dynamic tasking process enabled by dynamically accessible data and information services.

(U) MAJOR THRUST/CONGRESSIONAL ADD: Investigate and develop technologies to implement flexible, high performance, secure, scalable, and survivable information management and dissemination services to enable a Global Information Grid-based COI Infosphere. Note: This effort includes Congressional Add funding of $1.0 million in FY 2005.	2.671	3.869	4.032	5.391

(U) In FY 2004: Developed techniques and tools for integrating legacy client-server 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 COI 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 at various levels of security classification, and can operate within a coalition warfighting environment. Investigate new advanced publish, subscribe,

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and query technologies for the information management services, which provide higher levels of performance, security, and scalability to meet Air Force net-centric requirements. Investigate techniques to optimize these publish, subscribe, and query mechanisms to be used within bandwidth limited environments. Investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Investigate the interoperability of various COI Infospheres (e.g., Combat Support, Intel, Business) with respect to the management and sharing of information across them. Investigate the ability to monitor, obtain feedback, and assert control over the COI Infosphere.

(U) In FY 2006: 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 at various levels of security classification, and can operate within a coalition warfighting environment. Complete investigation of new advanced publish, subscribe, and query technologies for the Information Management services, which provide higher levels of performance, security, and scalability to meet Air Force net-centric requirements. Complete investigation of techniques to optimize these publish, subscribe, and query mechanisms to be used within bandwidth-limited environments. Continue to investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Complete investigation of the interoperability of various COI Infospheres (e.g., Combat Support, Intel, Business) with respect to the management and sharing of information across them. Develop high payoff publish, subscribe and query laboratory prototypes which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force Net-centric environment needs. Continue to investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Focus on automated composition of tailoring entities, and runtime environments. Continue to investigate methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment. Focus is on representation of real-time performance guarantees and negotiation for various levels of service as would be required in tactical aircraft. Investigate and assess the use of semantic markup and semantic web languages as part of the COI Infosphere. Initiate the investigation of technology and approaches to prioritizing information in a COI Infosphere so as to effectively utilize communication and computing resources. Continue to develop technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere.

(U) In FY 2007: Complete investigation in the use of semantic markup and semantic web languages as part of the COI Infosphere. Complete investigation of technology and approaches to prioritizing information

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in a COI Infosphere so as to effectively utilize communication and computing resources. Continue to develop high-payoff publish, subscribe, and query laboratory prototypes, which provide higher levels of performance, security, and scalability capable of exceeding commercial products and support Air Force net-centric environment needs. Continue to investigate automated methods of tailoring the user perspective of the COI Infosphere to reduce information overload and increase information awareness and utilization. Continue to develop technology and techniques to monitor, obtain feedback, and assert control over the COI Infosphere. Investigate the security policy enforcement between COI Infospheres at various levels of security classification. Continue to investigate methods and techniques for dynamically evolving the net-centric environment so as to avoid system crashes or latency as new information sources arrive or depart the environment.

(U)	Total Cost	26.473	34.452	42.148	46.140

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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.

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BUDGET ACTIVITY
02 Applied Research

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0602805F Dual Use Science & Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	10.205	5.105	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
4770	Dual Use Science and Technology (S&T)	10.205	5.105	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

In FY 2006, this PE will be cancelled as a result of higher Air Force priorities.

(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. 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	10.496	5.151	2.961	5.147
(U)	Current PBR/President's Budget	10.205	5.105	0.000	0.000
(U)	Total Adjustments	-0.291	-0.046		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.046		
	Congressional Increases				
	Reprogrammings				
	SBIR/STTR Transfer	-0.291			

(U) Significant Program Changes:

In FY 2006, this PE will be cancelled as a result of higher Air Force priorities.

C. Performance Metrics

(U) Under Development

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	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4770	Dual Use Science and Technology (S&T)	10.205	5.105	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, this PE will be cancelled.

(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. 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. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Advance materials and manufacturing technologies. 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.	2.589	1.300	0.000	0.000
(U) In FY 2004: Enhanced the capability, performance, durability, and affordability of Air Force and commercial air and space systems.				
(U) In FY 2005: Continue to enhance the capability, performance, durability, and affordability of Air Force and commercial air and space systems.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Design and develop advanced sensors and associated technologies. 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.	1.680	0.838	0.000	0.000
(U) In FY 2004: Expanded the design and development of affordable advanced sensors and related technologies to enhance the capabilities of military and commercial air and space platforms.				
(U) In FY 2005: Continue to expand the design, efficiency, and affordability of advanced sensors and				

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	associated technologies for military and commercial air and space platforms.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop propulsion, power, energy, and fuel efficiencies and affordability. 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.	2.542	1.273	0.000	0.000
(U)	In FY 2004: Enhanced the operational capability, expanded the life, and reduced the cost of military and commercial air and space operations.				
(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.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Advance information and communication technologies. 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.	1.713	0.855	0.000	0.000
(U)	In FY 2004: Further enhanced the collection, processing, dissemination, security, accuracy, and presentation capabilities of military and commercial information systems.				
(U)	In FY 2005: Promote new technologies to collect, collate, process, distribute, recall, and secure high-accuracy data on and across military and commercial platforms.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Enhance weapon systems sustainment to prolong system life and reduce life cycle costs. 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.	1.681	0.839	0.000	0.000
(U)	In FY 2004: Prolonged and enhanced the performance capabilities, reliability, and maintainability, while extending the life of both Air Force and commercial air and space systems.				
(U)	In FY 2005: Enhance sustainability, reliability, maintainability, operability, efficiency, and affordability of military and commercial air and space propulsion.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.

(U)	Total Cost	10.205	5.105	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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 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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

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 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.

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Exhibit R-2, RDT&E Budget Item Justification

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BUDGET ACTIVITY
02 Applied Research

PE NUMBER AND TITLE
0602890F High Energy Laser Research

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	40.458	50.229	45.678	49.598	49.986	54.179	55.439	56.383	Continuing	TBD
5096 High Energy Laser Research	40.458	50.229	45.678	49.598	49.986	54.179	55.439	56.383	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 Joint Technology Office.

(U) A. Mission Description and Budget Item Justification

This program funds Department of Defense (DoD) high energy laser (HEL) applied research through the HEL Joint Technology Office. 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. Note: In FY 2005, Congress added $2.4 million for the Joint High Power Solid State Laser program, $1.0 million for High Energy Laser Research, and $2.0 million for Manufacturing Technology Development Solid State of Advanced Components for High Solid State Laser.

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

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	41.498	45.333	48.316	51.699
(U)	Current PBR/President's Budget	40.458	50.229	45.678	49.598
(U)	Total Adjustments	-1.040	4.896		
(U)	Congressional Program Reductions		-0.058		
	Congressional Rescissions		-0.446		
	Congressional Increases		5.400		
	Reprogrammings				
	SBIR/STTR Transfer	-1.040			

(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-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602890F High Energy Laser Research**	PROJECT NUMBER AND TITLE **5096 High Energy Laser Research**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5096 High Energy Laser Research	40.458	50.229	45.678	49.598	49.986	54.179	55.439	56.383	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds Department of Defense (DoD) high energy laser (HEL) applied research through the HEL Joint Technology Office. 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. Note: In FY 2005, Congress added $2.4 million for the Joint High Power Solid State Laser program, $1.0 million for High Energy Laser Research, and $2.0 million for Manufacturing Technology Development Solid State of Advanced Components for High Solid State Laser.

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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST/CONGRESSIONAL ADD: 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.	6.174	8.871	6.333	6.899
(U) In FY 2004: Conducted applied research to develop component technologies. This included thermal management, diode pump sources, gain media, and advanced configurations such as optical fibers. Developed thermal management with improved efficiency, and improved size and weight characteristics including heat capacitor technology. Developed diode pump sources with improved efficiency, lifetime, and brightness. Developed improved materials such as ceramics, which may provide improved optical-mechanical performance and controlled dopant profiles. Developed optical fiber technology including power scaling of single fibers, and fibers capable of coherent combination under various beam combination technologies.				
(U) In FY 2005: Develop component technologies such as laser gain media with improved opto-thermal-mechanical properties. Develop thermal management techniques leading to reduced optical distortion, modular and scalable architectures for power scaling including beam combining, and optical ceramic materials. For ceramics, enhance manufacturing processes for laser applications, fully characterize materials, and set the stage for performance comparison to single crystal material. Develop				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	and demonstrate more efficient and higher brightness diode arrays that can pump fiber lasers. Develop and demonstrate fiber laser beam combining through spectral and tiled aperture approaches. Develop and demonstrate a heat exchanger building block for phase change thermal management/storage systems. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.				
(U)	In FY 2006: Conduct research to enable power scaling with reduced optical distortion, improved efficiency, and improved size and weight characteristics. Develop technology that will lead to improved fieldability, serviceability, and ruggedness. Develop scalable architectures for laser power scaling including technologies for beam combining. Examine architecture improvements, such as elimination of free-space optics in fiber systems. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.				
(U)	In FY 2007: Continue maturing technologies that will provide system level performance commensurate with fieldable devices. Provide power scaling with good beam quality and suitable size and weight. Develop technology that will lead to improved fieldability, serviceability, and ruggedness. Explore power scaling technology that will lead to a broader application space. Develop new power-scalable architectures including technologies for beam combining. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(U)					
(U)	MAJOR THRUST: Explore free electron lasers (FEL) that have potential in future high energy laser (HEL) weapons because they require only electrical energy in order to run and can be designed to operate at the best wavelength for a specific application within a large range of wavelengths.	5.422	8.259	8.643	9.425
(U)	In FY 2004: Developed enabling technologies for scaling free electron lasers to weapon-class power levels. Achieved 10 kilowatts from the laboratory demonstrator. Developed a photocathode model as a tool to design advanced robust long-life photocathodes. Designed and began fabrication of a high average current radio frequency cavity. Conducted a study to determine if new optical coating technologies produce coatings suitable for high-average-power FEL.				
(U)	In FY 2005: Develop FEL system components for power scaling. The 10 kilowatt laboratory demonstrator will be used as a test bed. Develop a separate photocathode test bed and refine photocathode models as a tool to design advanced robust, long-life photocathodes. Fabricate a high average current radio frequency cavity and study beam breakup mitigation technology. Perform laboratory tests to determine the suitability of high power optical components. Determine if currently planned technology for power scaling of the optical cavity will be satisfactory; explore alternatives as necessary. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.				
(U)	In FY 2006: Conduct research in power scaling for powers in the 100 kilowatt class. Design high-average-current photocathode and injector capability, suitable beam-breakup thresholds, and power				

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	scaling capability of the optical resonator. Continue component testing with the 10 kilowatt laboratory demonstrator to define a development path for scaling to a 100 kilowatt class field test demonstrator and eventual megawatt class free electron laser (FEL). Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.				
(U)	In FY 2007: Conduct system-level technology development and trade studies to facilitate scaling of FELs to weapon class power levels and shipboard integration. As appropriate, augment the existing 10 kilowatt laboratory testbed or build new testbeds with components showing traceability to larger systems, including radio frequency power systems, and optical and electron beam lines. Continue to investigate the development path for scaling toward 100 kilowatt field test demonstrator and eventual megawatt class FEL. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop advanced solid state laser technologies that are applicable to future high energy laser (HEL) weapon laser devices.	11.348	17.153	14.015	15.092
(U)	In FY 2004: Developed 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 (JHPSSL) program, pursued development of solid state laser technologies supporting the demonstration of 25 kilowatts.				
(U)	In FY 2005: Demonstrate components for power scaling technology in concert with the 25 kilowatt JHPSSL. Develop hardware that can be used for quantitative characterization of the 25 kilowatt JHPSSL lasers. Develop enabling technologies that will support improved performance at 25 kilowatt and are traceable to 100 kilowatt.				
(U)	In FY 2006: Mature enabling technologies through applied research necessary for the demonstration of solid state lasers at initial weapon-grade power levels. Support technology development for the JHPSSL system in the 100 kilowatt program phase.				
(U)	In FY 2007: Continue to support the JHPSSL program design and demonstration of 100 kilowatts devices. Examine the potential for new technologies, such as dopant-tailored ceramics to impact this program.				
(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	10.481	8.182	8.562	9.329

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relevant to tactical high energy laser (HEL)systems, and developing and testing real-time characterization tools to assist the HEL operator.

(U) In FY 2004: Developed beam control technology to improve HEL system performance. Developed technology options for use on platforms such as tactical aircraft and ground vehicles. Developed technology to fabricate conformal HEL windows for tactical air vehicles. Developed wavefront sensors that are insensitive to high scintillation environments and prepared to benchmark performance in a simulated high scintillation environment. Established a government optical metrology capability to precisely measure adsorption and reflectivity of optical coatings. Developed methods for discrimination, pointing, and tracking in high clutter using three-dimensional imaging. Continued to characterize atmospheric limitations in low-altitude tactical scenarios in order to increase the lethal range.

(U) In FY 2005: Develop architecture and component technology that can be used to support integrated beam-control technology demonstrations. Address multiple architecture approaches, such as passive and active wavefront control, and target-in-the loop as well as wavefront-reconstruction based techniques. Explore next-generation component technology for phase control such as micro-electrical-mechanical and high power, high speed spatial light modulators. Explore improvement of optical coatings technology. Continue technology development for conformal windows and improved wavefront sensors for high scintillation environments. Continue atmospheric characterization and propagation studies for low-altitude tactical scenarios in order to increase the lethal range. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.

(U) In FY 2006: Develop technology to support high performance beam control systems and integrated demonstrations. Explore advanced components and control techniques for difficult environments such as those found in high speed flight, high turbulence, and extended range. Advanced techniques include conformal and tiled apertures, and fiber-based technologies with improved isolation from platform disturbance. Develop component technology including durable optical coatings. Provide critical technology options for use in tactical scenarios on platforms such as aircraft, ground vehicles, and ships. Continue the study of atmospheric limitations in low-altitude tactical scenarios such as turbulence, thermal blooming, and with platform disturbances. Begin to plan an outdoor thermal blooming experiment. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.

(U) In FY 2007: Mature existing and develop new technologies that support integrated beam control demonstrations. Continue technology development to support next-generation control technologies, such as all-solid fiber laser systems with conformal apertures and active control for boundary-layer mitigation. Provide technology options for laser use on multiple platforms (aircraft, ground vehicles, and ships). Continue study of atmospheric compensation technology. Continue to fund the contract efforts started in

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(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. Emphasis in this area is being reduced based on the relative maturity of chemical lasers.	2.120	4.261	4.459	4.859
(U)	In FY 2004: Developed closed-cycle and recyclable chemical lasers, especially chemical oxygen iodine lasers appropriate for tactical applications. Emphasized technologies for improved battlefield operation and logistics. Developed chemical 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 lasers. Continue to develop chemical laser generators that are capable of operating in a gravity free environment and conduct proof-of-concept testing of these devices. Evaluate advanced chemical or electrochemical cycles that promote improved recycling and use less hazardous materials. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.				
(U)	In FY 2006: 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 generators and chemical regeneration techniques that can be scaled for tactical weapon applications. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.				
(U)	In FY 2007: 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. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(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 high energy laser (HEL) systems with the maximum kill probability for the minimum system size and cost.	4.142	3.503	3.666	3.994
(U)	In FY 2004: Developed a physics-based understanding of the mechanisms involved in the interaction between HEL beams and the targets. Developed databases that will be accepted by the HEL community and validated models that will be available to laser-weapon systems designers. Developed a subset of target folders for tactical laser weapons like the Advanced Tactical Laser and Mobile Tactical High Energy Laser.				
(U)	In FY 2005: Begin to explore feasibility of developing a predictive, physics-based model for target				

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lethality that would reduce the need for detailed lethality testing with the large number of known targets. 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 future tactical laser weapons. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.

(U) In FY 2006: Continue work to establish a predictive, physics-based methodology for prediction of target lethality based on previously gained understanding of the mechanisms of interaction between laser beams and targets. Continue to develop databases that will be accepted by the high energy laser (HEL) community and validated models that will be available to systems designers. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.

(U) In FY 2007: Continue to develop lethality information that will be accepted by the HEL community and validated models that will be available to systems designers. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.

(U)

(U)	MAJOR THRUST: Develop a fully realistic model of end-to-end HEL system performance, from the generation of photons in the laser to their impact on the target, thereby improving the design of HEL systems and reducing the need for expensive field testing.	0.771	0.000	0.000	0.000

(U) In FY 2004: Assessed available models and begin 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. Developed a widely accepted engagement model for non-expert users capable of supporting many HEL systems, targets, and scenarios. The model included platform constraints, provided parametrically represented probability of kill for various target surfaces, and allowed for constrained sensitivity analyses.

(U) In FY 2005: 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 a 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. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.

(U) In FY 2006: 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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specific scenarios. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.

(U) In FY 2007: Continue the validation process 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. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.

(U)	Total Cost	40.458	50.229	45.678	49.598

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	PE 0602500F, Multi-Disciplinary Space Technology.										
(U)	PE 0601108F, High Energy Laser Research Initiatives.										
(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.										
(U)	PE 0602307A, Advanced										

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

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 2005**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603112F Advanced Materials for Weapon Systems

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	59.655	64.905	36.714	43.162	38.382	41.531	42.305	42.983	Continuing	TBD
2100	Laser Hardened Materials	16.462	25.523	25.845	33.239	28.163	30.545	31.188	31.769	Continuing	TBD
3153	Non-Destructive Inspection Development	9.076	6.808	3.797	3.889	3.938	4.265	4.345	4.412	Continuing	TBD
3946	Materials Transition	23.415	25.768	4.863	3.755	3.972	4.216	4.215	4.197	Continuing	TBD
4918	Deployed Air Base Demonstrations	10.702	6.806	2.209	2.279	2.309	2.505	2.557	2.605	Continuing	TBD

(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) hardened materials technologies for the 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 2005, Congress added $1.1 million for Advanced Polymer Technology for Agile Combat Support, $1.5 million for Transparent Conductive Polymer Technology Development, $7.5 million for the Metals Affordability Initiative, $1.2 million for Quantitative Inspection Techniques for Assessing Aging of Military Aircraft, $1.7 million for Plasma Enhanced Chemical Vapor Deposition for Advanced Laser Program, $1.5 million for Large Panel Sapphire Producability, $1.4 million for Advanced Composite Processes, $2.8 million for Fast Field Repair of Coated Aircraft and Equipment, $1.1 million for Materials Integrity Management Research, $3.5 million for Stealth RAM Coatings, $3.0 million for Titanium Matrix Composites, $3.4 million for Plasma Arc/Waste to Energy Production, and $0.5 million for Continuous Integrated Vehicle Health Monitoring System. An additional $1.4 million for Hybrid Bearing was appropriated to this program, but it was transferred to PE0602203F, Aerospace Propulsion, for execution. Likewise, $1.0 million for Ultra-Lightweight Composites for Ballistic and Bomb Protection was appropriated to PE0603205F, Flight Vehicle Technology, but it was tranferred to this program for execution. 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.

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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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	61.948	34.284	39.814	46.517
(U)	Current PBR/President's Budget	59.655	64.905	36.714	43.162
(U)	Total Adjustments	-2.293	30.621		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.579		
	Congressional Increases		31.200		
	Reprogrammings	-0.767			
	SBIR/STTR Transfer	-1.526			

(U) Significant Program Changes:
Not Applicable.

C. Performance Metrics
Under Development.

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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2100 Laser Hardened Materials	16.462	25.523	25.845	33.239	28.163	30.545	31.188	31.769	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced materials technologies that enhance protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in threat environments. Advanced materials technologies are also developed and demonstrated to enhance protection for Air Force sensor systems to ensure safety, survivability, and operability in threat environments.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials technologies that enhance 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. This effort includes Congressional Add funding of $1.5 million in FY 2005 for Large Panel Sapphire Producability.	4.100	14.143	21.457	29.252
(U) In FY 2004: Developed hardening options for replacement sensors selected for the electro-optical sensor system. Demonstrated image intensifier tube hardening. Evaluated hardening options for charge coupled device (CCD) imaging systems.				
(U) In FY 2005: Demonstrate hardening options that can be incorporated into selected electro-optical sensor systems. Initiate hardening development for multispectral and hyperspectral sensor systems.				
(U) In FY 2006: Develop a mid-wavelength infrared testbed based on a candidate optical system. Evaluate solid state limiter materials having potential for dual band operation. Evaluate jamming and damage phenomenologies for large format CCDs.				
(U) In FY 2007: Mature hardening technology and develop a hardened candidate system. Develop candidate dual band limiter materials. Develop protection strategies for large format CCDs.				
(U)				
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced materials technologies that enhance protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a threat environment. Note: This effort includes Congressional Add funding of $1.7 million in FY 2004 and $1.7 million in FY 2005 for Plasma Enhanced Chemical Vapor Deposition for Advanced Laser Program.	12.362	11.380	4.388	3.987
(U) In FY 2004: Identified next generation technology advancements to improve performance of tristimulus filter technology. Transitioned in-band interim agile protection for night vision goggles. Characterized tunable filter technology in a representative panoramic night vision goggle demonstrator. Developed				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

optical limiter devices to protect eyes from agile threats.

(U) In FY 2005: Transition candidate materials technology advancements to improve performance of daytime statistical filter technology. Demonstrate night vision goggle (NVG) compatible peripheral protection eyewear. Characterize the performance of breadboard panoramic NVG (PNVG)/NVG systems incorporating agile filter technology. Continue to develop agile filter and optical limiter technologies.

(U) In FY 2006: Develop and characterize an NVG brassboard system using state-of-the-art agile filters and optical power limiters. Continue to develop agile filter and optical limiter technologies.

(U) In FY 2007: Demonstrate brassboard performance using state-of-the-art agile filters and optical power limiters. Characterize and incorporate agile filter and optical limiter technologies into devices for Air Force applications.

(U)	Total Cost	16.462	25.523	25.845	33.239

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

Agile Laser Eye Protection 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 2005**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603112F Advanced Materials for Weapon Systems**	**3153 Non-Destructive Inspection Development**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3153	Non-Destructive Inspection Development	9.076	6.808	3.797	3.889	3.938	4.265	4.345	4.412	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced nondestructive 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. 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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Develop and demonstrate advanced technologies to improve capabilities to inspect for cracks and other damage to extend the total safe life of turbine engines.	1.825	1.582	1.060	0.918
(U)	In FY 2004: Characterized enhanced NDI/E approaches to extend the life of fracture-critical gas turbine engine components and established protocols for component inspections.				
(U)	In FY 2005: Develop methods to detect and characterize damage in repaired (linear friction welded) turbine engine components. Demonstrate enhanced NDI/E approaches to extend the life of fracture-critical gas turbine engine components.				
(U)	In FY 2006: Demonstrate methods to detect and characterize damage in repaired (linear friction welded) turbine engine components. Validate enhanced NDI/E approaches to extend the life of fracture-critical gas turbine engine components.				
(U)	In FY 2007: Transition methods to detect and characterize damage in repaired (linear friction welded) turbine engine components. Transition enhanced NDI/E approaches to extend the life of fracture-critical gas turbine engine components.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate advanced inspection technologies supporting low-observable (LO) systems to enhance affordability and ensure full performance and survivability.	0.000	0.823	0.633	0.651
(U)	In FY 2004: Not Applicable.				
(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, multifunctional, multi-platform diagnostics tool for use in battle damage repair of LO materials and structures.				
(U)	In FY 2006: Develop and demonstrate a portable, multifunctional, multi-platform diagnostics tool for use in battle damage assessment and repair of LO materials and structures.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2007: Transition a portable, multifunctional, multi-platform diagnostics tool for use in battle damage assessment and repair of LO materials and structures. Initiate development of advanced sensors and computational algorithms to trace LO material defects and degradation to signature impact.				
(U)					
(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 Add funding of $3.6 million in FY 2004 and $1.2 million in FY 2005 for Quantitative Inspection Techniques for Assessing Aging of Military Aircraft.	4.811	2.340	1.229	1.382
(U)	In FY 2004: Demonstrated and validated pulsed eddy current automated scanner technology for improved capabilities in detection and characterization of corrosion of joints in aging aircraft. Validated 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. Demonstrate advanced methods such as magneto-resistive arrays to detect cracks in multiple layers to meet aging aircraft life extension requirements.				
(U)	In FY 2006: Transition advanced electromagnetic techniques to detect cracks in multiple layers to meet aging aircraft life extension requirements. Identify and develop application-focused NDI/E technologies to meet emerging inspection requirements for aging aircraft.				
(U)	In FY 2007: Demonstrate application-focused NDI/E technologies to meet emerging inspection requirements for aging aircraft.				
(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: This effort includes Congressional Add funding of $1.4 million and a Congressional Reduction of $0.7 million in FY 2004 and Congressional Add funding of $1.6 million in FY 2005 ($1.1 million for Materials Integrity Management Research and $0.5 million for Continuous Integrated Vehicle Health Monitoring System).	2.440	2.063	0.875	0.938
(U)	In FY 2004: Developed 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: Initiate development of sensors to monitor real-time health of high-temperature protection systems. Initiate development of smart sensor technologies for wiring health analysis. Initiate development of novel field-level inspection tools for assessing the structural health of airframes.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) In FY 2006: Continue development of sensors to monitor real-time health of high-temperature protection systems. Continue development of smart sensor technologies for wiring health analysis. Continue development of field-level inspection tools for assessing the structural health of airframes.

(U) In FY 2007: Validate optimal sensing approaches for real-time health monitoring of high-temperature protection systems and characterize power scavenging and signal transmission issues. Validate smart sensor technologies for wiring health analysis. Validate field-level inspection tools for assessing the structural health of airframes.

(U)	Total Cost	9.076	6.808	3.797	3.889

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3946 Materials Transition	23.415	25.768	4.863	3.755	3.972	4.216	4.215	4.197	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced materials and processing technologies for fielded and planned Air Force weapon, airframe, and propulsion 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. These design and scale-up data improve the overall affordability of promising materials and processing technologies, providing needed initial incentives for their industrial development.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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 performance, and overall affordability of air vehicles. Note: This effort includes Congressional Add funding of $13.3 million and a Congressional Reduction of $0.3 million in FY 2004 and Congressional Add funding of $17.9 million in FY 2005 ($7.5 million for the Metals Affordability Initiative, $1.4 million for Advanced Composite Processes, $1.5 million for Transparent Conductive Polymer Technology Development, $3.0 million for Titanium Matrix Composites, $3.5 million for Stealth RAM Coatings, and $1.0 million for Ultra-Lightweight Composites for Ballistic and Bomb Protection).	21.862	22.638	4.596	3.420

(U) In FY 2004: Developed an affordable high-temperature composite process that enables the fabrication of turbine engine components for future air vehicles to meet cost and performance criteria. Demonstrated fabrication processes and properties of ceramic composite materials for turbine engine exhaust components. Identified materials and their properties for a mid-infrared laser source enabling aircraft infrared countermeasures. Demonstrated improved materials and inspection tools/processes to enhance reliability and maintainability of LO platforms. Developed and evaluated advanced fluids, lubricants, and surface treatments for combined cycle engine components in high-speed vehicle applications. Developed and assessed advanced metallic materials and processing technologies for weapon system development and sustainment, and for application to cryogenic structures and scramjet and combined-cycle engine components and structures. Accelerated the development of advanced bearing materials for gas turbine engines. Demonstrated 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 of

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3946 Materials Transition**

ceramic composite materials for exhaust components in a turbine engine environment. Develop and characterize advanced materials and materials process capabilities for ultra-lightweight, ultra-high power generation for airborne directed energy weapons. Develop materials and their suitability for a mid-infrared laser source enabling aircraft infrared countermeasures. Validate and transition improved materials and inspection tools/processes for LO systems to enable higher mission capable rates.

(U) In FY 2006: Develop materials-damage predictive approaches for engine health determination and life extension capability. Transition reliable life extension capability for turbine engine rotors. Continue development and demonstration of high temperature composites for turbine engine applications and initiate transition of these materials to relevant platforms. Scale-up advanced materials and initiate scale-up of fabrication processes to increase the capabilities of coated conductors for ultra-lightweight, ultra-high power generation for airborne directed energy weapons. Evaluate materials properties for a mid-infrared laser source enabling aircraft countermeasures and integrate best material improvement methods. Investigate primer/sealer material for improved durability of LO materials in fluid contaminated areas on emerging fighter aircraft. Develop flexible/lightweight conductive gap filler for LO aircraft. Develop processes for removal of radar absorbing material on large aircraft areas. Develop hot-melt conductive fastener fill. Improve processing of room-temperature-storable radar absorbing structure repair materials. Develop nondestructive evaluation tool for limited access areas on aircraft.

(U) In FY 2007: Develop materials-damage predictive approaches for engine health determination and life extension capability. Complete transition of high-temperature organic matrix composites for turbine engine components. Characterize advanced materials and materials process capabilities for scaled-up processing techniques and assess process repeatability for power generation materials for airborne directed energy weapons. Demonstrate functionality of integrated methods for a mid-infrared laser source enabling aircraft countermeasures. Demonstrate flexible/lightweight conductive gap filler. Evaluate processes for removal of radar absorbing material on large aircraft areas. Demonstrate primer/sealer material for improved durability of LO materials in fluid contaminated areas on emerging fighter aircraft. Evaluate improved processing of room-temperature-storable radar absorbing structure repair materials. Demonstrate nondestructive evaluation tool for limited access areas on aircraft.

(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: This effort includes Congressional Add funding of $2.8 million in FY 2005 for Fast Field Repair of Coated Aircraft and Equipment.	0.487	3.130	0.267	0.335

(U) In FY 2004: Evaluated corrosion resistant coatings and corrosion prevention compounds for aging

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603112F Advanced Materials for Weapon Systems**	PROJECT NUMBER AND TITLE **3946 Materials Transition**

	aircraft structures applications. Initiated effort to determine durability and failure mechanisms of hybrid structures in unmanned air vehicles (UAV).				
(U)	In FY 2005: Demonstrate 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)	In FY 2006: Develop test methodologies and evaluation techniques to facilitate transition of emerging materials and processes for sustainment of Air Force systems.				
(U)	In FY 2007: Continue to develop test methodologies and evaluation techniques to facilitate transition of emerging materials and processes for sustainment of Air Force systems.				
(U)					
(U)	CONGRESSIONAL ADD: Educate 21st Century Information Operations (IO) Workforce.	1.066	0.000	0.000	0.000
(U)	In FY 2004: Established an Information Operations curriculum at New Mexico State University to educate graduate and undergraduate students.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	23.415	25.768	4.863	3.755

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0603203F, Advanced Aerospace Sensors.										
(U)	PE 0603211F, Aerospace Technology Dev/Demo.										
(U)	PE 0603216F, Aerospace Propulsion and Power Technology.										
(U)	PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) 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 2005
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**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4918 Deployed Air Base Demonstrations	10.702	6.806	2.209	2.279	2.309	2.505	2.557	2.605	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced, rapidly deployable airbase technologies that reduce airlift and manpower requirements, setup times, and sustainment costs, and improve protection and survivability of deployed Air Expeditionary Force (AEF) warfighters. Affordable, efficient technologies are developed and demonstrated to provide deployable infrastructure, advanced weapon system support, force protection, and fire fighting capability for deployed AEF operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST/CONGRESSIONAL ADD: Demonstrate and transition advanced rapidly deployable airbase infrastructure technologies that reduce airlift and manpower requirements, setup times, and sustainment costs in support of AEF operations. Note: This effort includes Congressional Add funding of $4.8 million in FY 2004 and $4.5 million in FY 2005 ($3.4 million for Plasma Arc/Waste to Energy Production and $1.1 million for Advanced Polymer Technology for Agile Combat Support).	6.265	5.872	1.105	1.139

(U) In FY 2004: Transitioned air-inflatable shelter technology to support logistics footprint reduction in AEF operations. Developed 10 kW fuel cell power system that improves deployable power system performance and reduces airlift requirements for AEF operations. Demonstrated rapid airfield assessment and repair technologies that improve performance and enhance AEF operations support.

(U) In FY 2005: Continue development of a 10 kW fuel cell power system that improves deployable power systems performance and reduces airlift requirements for support of AEF operations. Demonstrate rapid airfield assessment technologies that improve deployable systems performance and reduce airlift requirements for support of AEF operations.

(U) In FY 2006: Demonstrate a 10 kW fuel cell power system that improves deployable power systems performance. Demonstrate packed bed fuel treatment technology to remove sulfur and integrate with both proton exchange membrane fuel cell and solid oxide fuel cell stacks. 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 continuous load deflection technology and improved crater/spall repair materials and methodologies for improved airfield assessment and rapid repair.

(U) In FY 2007: Demonstrate a 10 kW fuel cell power system that improves deployable power systems performance. Demonstrate packed bed fuel treatment technology. Demonstrate advanced integrated shelter power/heating, ventilation, and air conditioning concept. Continue to develop continuous load

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	deflection technology and improved crater/spall repair materials and methodologies for improved airfield assessment and rapid repair.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Demonstrate and transition affordable, efficient technologies to provide force protection and fire fighting capability for deployed AEF operations. Note: This effort includes Congressional Add funding of $4.5 million in FY 2004.	4.437	0.934	1.104	1.140
(U)	In FY 2004: Demonstrated deployable protective and advanced blast suppression technologies to protect deployed warfighters. Developed a reduced-size full-capability fire fighting vehicle for deployed operations. Developed self-sterilizing coatings and laminates for expeditionary structures. Demonstrated system to integrate threat sensor data for airbase protection. Evaluated molecular tagging technology for explosive materials.				
(U)	In FY 2005: Demonstrate deployable protective and advanced blast suppression technologies to protect deployed warfighters. Demonstrate a reduced-size full-capability fire fighting vehicle for deployed operations. Develop improved fire fighter safety technologies. Develop advanced air filtration technologies for expeditionary structures.				
(U)	In FY 2006: Demonstrate improved blast suppression technologies and fragmentation protection materials for new and existing structures. Initiate demonstration of explosive storage protective technologies. Demonstrate improved fire fighter safety technologies. Continue development of advanced air filtration technologies for expeditionary structures.				
(U)	In FY 2007: Continue demonstrating improved blast suppression technologies and fragmentation protection materials for new and existing structures and for explosive storage facilities. Complete demonstration of improved fire fighter safety technologies and transition technology to operational units. Initiate an integrated crash/rescue fire fighting demonstration. Integrate air filtration technologies into demonstration for expeditionary structures.				
(U)	Total Cost	10.702	6.806	2.209	2.279

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0603287F, Physical Security Equipment.										
(U)	PE 0604617F, Agile Combat										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) **C. Other Program Funding Summary ($ in Millions)**

Support.

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

(U) **D. Acquisition Strategy**

Not Applicable.

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Exhibit R-2, RDT&E Budget Item Justification

DATE **February 2005**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603203F Advanced Aerospace Sensors

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	41.015	43.837	35.157	42.366	41.484	45.261	41.989	41.696	Continuing	TBD
5019	Advanced RF Technology for ISR Sensors	3.464	3.545	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
665A	Advanced Aerospace Sensors Technology	15.841	12.742	13.100	14.217	15.324	16.524	16.788	17.005	Continuing	TBD
69DF	Target Attack and Recognition Technology	21.710	27.550	22.057	28.149	26.160	28.737	25.201	24.691	Continuing	TBD

Note: In FY 2006, efforts in Project 5019 will transfer to Project 665A within this PE.

(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 radio frequency (RF) sensors for aerospace intelligence, surveillance, and reconnaissance (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 2005, Congress added $11.5 million for National Operational Radar Signature Production and Research Capability, $1.0 million for Testbed for Accelerated Transition - Advanced Multi-Discriminating Sensing, and $1.1 million for Phase Diversity - Imaging Through Volume Turbulence. 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.

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	41.124	30.634	34.010	42.947
(U)	Current PBR/President's Budget	41.015	43.837	35.157	42.366
(U)	Total Adjustments	-0.109	13.203		
(U)	Congressional Program Reductions		-0.008		
	Congressional Rescissions		-0.389		
	Congressional Increases		13.600		
	Reprogrammings				
	SBIR/STTR Transfer	-0.109			

(U) Significant Program Changes:
Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5019	Advanced RF Technology for ISR Sensors	3.464	3.545	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in from this project will transfer into Project 665A within 665A.

(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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop techniques for advanced air moving target indication (AMTI), ground moving target indication (GMTI), and foliage penetrating ground target indication.	0.764	1.627	0.000	0.000
(U) In FY 2004: Collected data for multi-intelligence AMTI, GMTI, and foliage-obscured ground target indication. Matured 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop multi-intelligence sensor designs. Note: Efforts completed in FY 2004.	0.897	0.000	0.000	0.000
(U) In FY 2004: Completed the design of a multi-intelligence surveillance system and modeled it in mission area simulations. Validated the system through computer simulation and emulation techniques for discerning ground and air targets under multi-intelligence waveform, pulse repetition frequency, and signal processing scenarios. Planned an experiment to validate electronic protection signal processing techniques for multi-intelligence data collection systems.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				

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(U)	In FY 2007: Not Applicable.				
(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.	0.741	1.097	0.000	0.000
(U)	In FY 2004: Demonstrated and evaluated knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indicator (GMTI) sensors. Implemented 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 continued 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate photonic digital and analog mixed signal multi-gigahertz component architectures.	0.182	0.000	0.000	0.000
(U)	In FY 2004: Continued providing impartial performance modeling, verification, and analyses of photonic and hybrid mixed signal devices for radio frequency (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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate techniques to surveil venues denied to stand off ISR platforms.	0.880	0.821	0.000	0.000
(U)	In FY 2004: Initiated developing techniques to surveil venues denied to stand off ISR platform. The emphasis was on denied access areas, such as urban canyons, inner areas of buildings, and heavily concealed targets that use advanced camouflage, concealment, and deception techniques. Specifically,				

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the effort concentrated on short-range, low-cost, expendable sensors that can exploit multiple RF phenomenologies.

(U) In FY 2005: Continue developing techniques to surveil venues denied to stand off ISR platforms, concentrating on short-range, low-cost, expendable sensors that can exploit multiple RF phenomenologies.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Total Cost	3.464	3.545	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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.

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03 Advanced Technology Development (ATD)	**0603203F Advanced Aerospace Sensors**	**665A Advanced Aerospace Sensors Technology**

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
665A	Advanced Aerospace Sensors Technology	15.841	12.742	13.100	14.217	15.324	16.524	16.788	17.005	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts in Project 5019 within this PE will transfer to this project.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates aerospace sensor and processing technologies for ISR and target and attack radar applications in both manned and unmanned platforms, including EO 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 in adverse clutter and jamming environments. 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 2004	FY 2005	FY 2006	FY 2007
(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.	3.555	2.082	3.946	4.486

(U) In FY 2004: Extended performance of ground demonstration sensor to flying test-bed configuration. Ground tested aircraft integration components. Extended 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) In FY 2006: Complete multi-spectral passive cueing demonstration in an airborne environment. Begin development of a multi-function active/passive EO/infrared (IR) sensor demonstration system to detect, locate, and identify difficult targets in both obscured and urban environments for ISR applications. Analyze advanced passive and multi-function active sensing methods to optimize detection and identification of difficult targets. Perform preliminary design for multi-mode unmanned aerial vehicle based sensor, including platform integration plans. Design and fabricate optical components for long wave infrared spectral/polarimetric imager for high altitude sensor. Conduct in-house target/background characterization studies with modified long wave infrared imaging spectrometer.

(U) In FY 2007: Continue development of a multi-function active/passive EO/IR sensor demonstration system to detect, locate, and identify difficult targets in both obscured and urban environments for ISR applications. Finalize analysis of advanced passive and multi-function active sensing methods to

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	optimize detection and identification of difficult targets. Complete design for multi-mode unmanned aerial vehicle based sensor, including platform integration plans. Initiate development of coarse to fine sensing methodologies which progress from wide area search to pinpoint identification and characterization. Incorporate long wave infrared spectral/polarimetric imager into high altitude sensor. Conduct flight test to demonstrate target detection capabilty.				
(U)					
(U)	MAJOR THRUST: Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace ISR applications.	3.948	4.682	1.435	0.812
(U)	In FY 2004: Extended performance of a demonstration sensor for high altitude reconnaissance aircraft to incorporate an emissive broadband imaging capability. Fabricated, laboratory integrated, and tested reflective spectrometer components.				
(U)	In FY 2005: Complete integration and testing of a demonstration sensor for high altitude reconnaissance aircraft. Perform flight characterization and assess signature-based data processing performance.				
(U)	In FY 2006: 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 2007: Complete fabrication and testing of demonstration system for high altitude aircraft incorporating reflective and emissive spectral sensing capability for day and night operations. Perform flight characterization and support transition to acquisition center.				
(U)					
(U)	MAJOR THRUST: Develop advanced EO sensor technology for non-cooperative target identification. Note: Effort completed in FY 2004.	1.010	0.000	0.000	0.000
(U)	In FY 2004: Completed developing and demonstrated a multi-function laser for air and ground target identification based on target geometry and vibration.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop technologies to maximize positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities.	1.302	0.902	1.755	2.972
(U)	In FY 2004: Demonstrated precise reference aerospace sensing technologies to adaptively operate underground and in buildings. Designed geo-registration technologies to maximize navigation warfare exploitation techniques for enhanced offensive and defensive combat capabilities. Developed virtual flight test simulation technology to assess advanced GPS anti-jam techniques.				

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(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) In FY 2006: Develop critical experiments using virtual flight test simulation to characterize assured reference technologies for net centric warfare. Design follow-on distributed position, navigation, and timing (PNT) advanced technology demonstration to optimize time-sensitive targeting, battlespace awareness, and persistent ISR capabilities. Improve report, track, and image georegistration technologies for multi-intelligence sensor data.

(U) In FY 2007: Demonstrate critical experiments using virtual flight test simulation to characterize assured reference technologies for net centric warfare. Develop follow-on distributed PNT advanced technology demonstration to optimize time-sensitive targeting, battlespace awareness, and persistent ISR capabilities. Develop sensor phenomenology-based georegistration for imagery and perform lab tests of multi-intelligence georegistration.

(U)

(U) MAJOR THRUST: Develop, test, evaluate, and demonstrate lightweight, low power, compact RF sensors to detect, track, and target high-value, time-critical targets that are difficult to detect through either stealth or concealment and enable persistent ISR from an unmanned aerial vehicle (UAV). Develop and validate long-range ISR sensor technologies and techniques for the detection and track of advanced air and ground targets. Advanced target characteristics include targets with low radar cross section, concealment capabilities, or electronic counter-countermeasures.	0.421	2.590	5.003	5.119

(U) In FY 2004: Laboratory tested "mini" unmanned aerial vehicle 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" unmanned aerial vehicle 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) In FY 2006: Flight test a lightweight, low profile multi-function active electronically scanned array on an airborne test bed to demonstrate integrated radar technology capability. Analyze data from flight test and predict system performance on target platforms using advanced computational techniques. Demonstrate accurate, real-time detection and location with enhanced millimeter wave sensor. Begin demonstration of the RF sensors for an integrated EO/RF sensor suite for UAVs with severe size, weight,

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	and power constraints, to enable single platform persistent ISR capability compatible with a system of systems architecture. Construct a multi-intelligence sensor suite ground test bed to emulate an airborne moving platform. Perform risk reduction efforts for airborne implementations. Conduct radar systems engineering support fostering the transition of developed enabling technologies and concepts to weapon systems and ISR assets. Initiate integrated electronic support measures (ESM)/passive radar concept for enhanced target detection and tracking. Initiate development program for threat analysis/mitigation of passive multistatic, multi-intelligence sensing.				
(U)	In FY 2007: Continue demonstration of the RF sensors of an integrated EO/RF sensor suite for UAVs with severe size, weight, and power constraints, to enable single platform persistent ISR capability compatible with a system of systems architecture. Develop highly integrated receiver-aperture technologies for improved functionality and greatly reduced size, weight, and power. Continue experiments with the ground test bed providing input into a design for an airborne multi-intelligence experiment. Continue radar systems engineering support fostering the transition of developed enabling technologies and concepts to weapon systems and ISR assets. Further develop an integrated ESM/passive radar concept for enhanced target detection and tracking. Develop program for threat analysis/mitigation of passive multistatic, multi-intelligence sensing.				
(U)					
(U)	MAJOR THRUST: Develop weapons guidance quality track radar performance in advanced jamming environments. 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.	0.436	0.386	0.961	0.828
(U)	In FY 2004: Developed advanced radar techniques, sub-systems, and methods to establish and maintain track radar performance of weapons-guidance quality in advanced jamming environments. Devised 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)	In FY 2006: Demonstrate and evaluate adaptive processing techniques for multi-mission conformal arrays and wideband and polarization adaptive processing techniques for multi-function radar. Implement novel space-time adaptive processing techniques that are robust to heterogeneous data. Develop multi-sensor waveform transmission and signal processing techniques on selected advanced computing architectures				
(U)	In FY 2007: Demonstrate and evaluate novel space-time adaptive processing techniques that are robust				

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	to heterogeneous data. Demonstrate and evaluate multi-sensor waveform transmission and signal processing techniques on selected advanced computing architectures				
(U)					
(U)	MAJOR THRUST: Develop technology for aerospace sensors compatible with hypersonic flight parameters. Note: Effort completed in FY 2004.	5.169	0.000	0.000	0.000
(U)	In FY 2004: Defined a technically feasible, operationally effective sensor suite and concept of operations for use on the hypersonic reconnaissance/attack vehicle. Developed a feasibility analysis and sensor performance simulation tool. Recommended airframe configurations that will maximize the effectiveness of the vehicle as a reconnaissance platform in a hypersonic environment.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Phase Diversity - Imaging Through Volume Turbulence.	0.000	1.100	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Investigate current operational slant and horizontal-path imaging scenarios to determine the impact of turbulence on operational performance. Extend the Phase-Diverse Speckle (PDS) algorithm to improve performance in the volume-turbulence imaging scenario. Conduct simulations to evaluate candidate algorithmic approaches. Investigate strategies for increased efficiencies in the PDS algorithm implementation to achieve near-real-time processing. Conduct a data collection to benchmark improvement in imaging quality in the volume-turbulence imaging scenario.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Testbed for Accelerated Transition - Advanced Multi-Discriminant Sensing.	0.000	1.000	0.000	0.000
(U)	In FY 2004: Not Applicable				
(U)	In FY 2005: Begin development of an indoor laser radar test bed facility to test, characterize, and demonstrate advanced multi-mode laser radars.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	15.841	12.742	13.100	14.217

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602204F, Aerospace Sensors.										
(U)	PE 0603205F, Flight Vehicle Technology.										
(U)	PE 0603707F, Weather Systems 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										

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

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

(U) D. Acquisition Strategy

Not Applicable.

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Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
69DF	Target Attack and Recognition Technology	21.710	27.550	22.057	28.149	26.160	28.737	25.201	24.691	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop modeling and simulation to show enhanced global awareness and precision engagement capability for warfighters.	1.154	1.561	0.000	0.000
(U) In FY 2004: Demonstrated the analysis testbed in operationally realistic environments using operationally realistic data and processes. Continued developing and employing air and ground target signature generation models that support automated target signature exploitation in automatic target recognizer and multi-sensor fusion algorithms. Continued generating synthetic target signatures for automated signature exploitation of RF and 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 a 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 radio frequency (RF) and EO sensor data. Analyze				

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	advanced ground target signature generation methods.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: Efforts complete in FY 2005.	1.354	1.813	0.000	0.000
(U)	In FY 2004: Incrementally upgraded 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. Demonstrated 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. Conducted 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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.	2.738	2.337	4.021	5.275
(U)	In FY 2004: Demonstrated a stationary ground target classification and identification capability using advanced ATR techniques in real-time in a laboratory setting using operational computer hardware devices. Developed transition plans and performed transition risk reduction tasks for integrating this capability into operational strike and reconnaissance platforms. Developed 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				

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	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)	In FY 2006: Develop radar based air-to-ground moving target algorithm for tactical and reconnaissance platforms. Continue analysis and identification of legacy systems hardware/software upgrades required for algorithm transition to strike and reconnaissance platforms.				
(U)	In FY 2007: Perform a laboratory demonstration of a radar based air-to-ground moving target algorithm for tactical and reconnaissance platforms. Refine this capability for integration into candidate radar systems and platform specific product development roadmaps. Provide transition plans of the moving target algorithm technology to operational strike and reconnaissance platforms.				
(U)					
(U)	MAJOR THRUST: Develop and assess multi-sensor ATR for Air Force ISR, strike, and weapon systems.	3.760	5.048	5.046	5.895
(U)	In FY 2004: Assessed the performance of Air Force and Defense Advanced Research Projects Agency (DARPA) multi-sensor ATR fusion algorithms using the Air Force ATR evaluation test facility. Continued characterizing both single and multiple sensor contributions from radar and EO, including hyperspectral imaging sensors with automated exploitation. Initiated developing tools to automate data collection planning for transition of algorithms. Improved ATR research and development computer and networking infrastructure via software, hardware, and network integration enhancements. Improved processing capabilities and expand Department of Defense-wide repository of research and development sensor data. Developed an integrated computational and collaborative environment to accelerate the transition of ATR and sensor fusion technologies. Utilized synthetic data generation capability to augment and enhance existing research and development (R&D) and operational data sets. Continued 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 ATR fusion algorithms using the Air Force ATR evaluation test facility for application to Air Force ISR, strike, and weapon systems. Continue characterizing both single and multiple sensor contributions from radar and EO, including hyperspectral imaging sensors with automated exploitation. Automate 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 Department of Defense-wide repository for R&D sensor data. Continue developing an integrated computational and collaborative environment to accelerate the transition of ATR and sensor fusion technologies. Continue				

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developing synthetic data generation capability to augment and enhance existing R&D and operational data sets. Continue to show impact of automated multi-sensor ATR 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) In FY 2006: Further assess the performance of Air Force and DARPA multi-sensor ATR fusion algorithms using the Air Force ATR evaluation test facility for application to Air Force ISR, strike, and weapon systems. Further characterize both single and multiple sensor contributions from radar and EO, including hyperspectral imaging sensors with automated exploitation. Complete the automation of data collection planning for transition of algorithms. Complete the initial ATR R&D computer and networking infrastructure via software, hardware, and network integration enhancements. Complete the initial processing capabilities and the on-line DoD-wide repository for R&D sensor data. Complete the on-line integrated computational and collaborative environment to accelerate the transition of ATR and sensor fusion technologies. Further develop synthetic data generation capability to augment and enhance existing R&D and operational data sets. Further assess 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. Initiate the modeling of platform and sensor systems in simulated operational environments. Initiate assessment of moving target tracking and identification approaches for multiple sensor types. Initiate evaluation of automated exploitation and rapid response technology enhancements for post-conflict force protection, stability, and security operations.

(U) In FY 2007: Continue to assess the performance of Air Force and DARPA multi-sensor ATR fusion algorithms using the Air Force ATR evaluation test facility for application to Air Force ISR, strike, and weapon systems. Continue characterizing both single and multiple sensor contributions from radar and EO, including hyperspectral imaging sensors with automated exploitation. Collect, process, archive, and distribute R&D sensor data for automated exploitation technology development and assessment. Support automated exploitation technology development and assessment with collaborative computing environment. Complete development of synthetic data generation capability to augment collected R&D and operational data sets. Augment the Department of Defense-wide repository of R&D sensor data with multi-sensor imagery and tracking data collected at warfighter-sponsored exercises. Continue to show impact of automated multi-sensor ATR and fusion capability in terms of timeline reduction for time-critical targeting to image analysts and decision-makers in the experimental Air Operations Centers. Initiate modeling of existing and emergent sensor systems for assessing automated exploitation technologies in simulated operational environments. Continue assessment of moving target tracking and identification approaches for multiple sensor types. Initiate evaluation of technology enhancements for

	post-conflict force protection, stability, and security operations.				
(U)					
(U)	MAJOR THRUST: Develop technology to detect, identify, and engage targets under trees (TUT). Note: Efforts complete in FY 2004.	5.076	0.000	0.000	0.000
(U)	In FY 2004: Demonstrated TUT-specific intelligence preparation of the battlefield tools for improved tracking, detection, sensor management, and target identification and location. Integrated tools for multi-intelligence georegistration with fusion architecture. Finished system functionality test, including fusion and geo-registration tests, and performed study of possible trades in concepts of employment.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate a moderate confidence ATR and advanced cueing capability for stationary and moving targets.	0.000	2.055	4.552	6.037
(U)	In FY 2004: Not Applicable.				
(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)	In FY 2006: Continue developing high confidence combat identification capability to determine which combination of sensors, modes, and fusion processing techniques provide a high confidence combat identification capability for stationary and moving ground targets. Initiate critical experiments to refine high-level, near-term fusion processes. Continue characterization studies of advanced stationary and moving target radar data to determine utility for ATR/C and combat identification. Start a technology demonstration effort of promising near-term, multi-sensor technologies and fusion processing techniques. Continue analyses and characterization studies for advanced, multi-sensor, multi-platform fusion processing techniques. Refine tool development to support sensor system, sensor management, and system performance analyses. Perform advanced multi-sensor data collection(s) on stationary and				

moving targets.

(U) In FY 2007: Further develop high confidence combat identification capability to determine which combination of sensors, modes, and fusion processing techniques provide a high confidence combat identification capability for stationary and moving ground targets. Further the technology demonstration effort of promising near-term, multi-sensor technologies and fusion processing techniques. Continue critical experiments of advanced multi-sensor, multi-platform technologies and fusion processing techniques for strike and ISR assets. Further characterize studies of advanced stationary and moving target multi-sensor data to determine utility for ATR/C and combat identification. Further refine tool development to support sensor system, sensor management, and system performance analyses. Continue advanced multi-sensor data collection(s) on stationary and moving targets.

(U)

(U)	MAJOR THRUST: Develop and demonstrate an ATR capability integrated with advanced geo-registration techniques and innovative change detection algorithms.	2.628	3.236	5.569	6.766

(U) In FY 2004: Developed initial capability for an advanced real-time contingency cell in support of initial experiments for the Combined Air Operations Center. Performed 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/ATC, geo-registration, and change detection techniques. Demonstrate initial integrated time-critical targeting capability leveraging the advanced real-time contingency cell, the TUT program products and the technology developments associated with DARPA's Dynamic Tactical Targeting program.

(U) In FY 2006: Complete integration and field test of ATR/ATC, geo-registration, and change detection techniques. Continue to utilize the advanced recognition capability test bed to integrate and upgrade time critical targeting (TCT) capability and support transition to the warfighter. Complete integration and field testing of a capability that continuously tracks TCTs and reduces the kill chain through a reduction in strike platforms target acquisition time. Begin design and development of an autonomous multi-sensor management and data exploitation system supporting an all-weather mission for tactical platforms, including UAVs. Initiate critical experiments to investigate concealed target identification (ID) phenomenology. Continue data collection, modeling, and analysis for ID sensors, platforms, and concept of operations.

(U) In FY 2007: Continue to utilize the advanced recognition capability test bed to integrate and upgrade TCT capability to support the transition to the warfighter of technology products that detect concealed targets and improve ability to dynamically track TCTs. Continue development of an autonomous

	multi-sensor management and data exploitation system supporting an all-weather mission for tactical platforms, including UAVs. Initiate design and conduct concept demonstration of a concealed target ID sensor and exploitation capability. Initiate the development of an advanced tracking capability that utilizes advanced radar features to fingerprint and associate vehicle observations and integrates multiple radar sensors to maintain continuous track through difficult terrain and in dense traffic.				
(U)					
(U)	MAJOR THRUST: Develop Identify Friend, Foe, or Neutral air to ground capability using cooperative and non-cooperative identification techniques. Note: This work is an outgrowth of other work within this project.	0.000	0.000	2.869	4.176
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Initiate design studies to develop technologies to improve the performance of ATR and combat ID systems used to sort friend/foe/neutral entities during air-to-ground attack of stationary and moving ground vehicles. Studies will include ground target database enhancements, advanced algorithms for non-cooperative ID of moving targets, and RF tags for cooperative target ID. Define techniques to make ground target databases more robust and affordable for application using multiple sensors, for operation using real or synthetic data, and for modeling denied targets. Develop advanced algorithms to closely couple tracking with ID functions, exploit unique RF phenomenology, and integrate cooperative and non-cooperative ID methods. Assess RF tag systems versus warfighter requirements to define a system architecture, define techniques to assure secure data exchange without threat of exploitation, and define interfaces for cross-service or coalition interoperability.				
(U)	In FY 2007: Finalize design studies and initiate critical experiments to verify improved ground target ID capabilities resulting from ground target database enhancements, ID algorithm enhancements, and advanced RF tags. Refine advanced ID algorithms and laboratory test with operational sensor data to measure improved confidence/reliability of target ID. Finalize RF tag design and conduct simulation testing to confirm improved pilot/system operator situation awareness, verify friendly ID confirmations, and perform initial interoperability assessments.				
(U)					
(U)	CONGRESSIONAL ADD: National Operational Signature Production and Research Capability.	5.000	11.500	0.000	0.000
(U)	In FY 2004: Matured the signature modeling and simulation capability to consistently and expediently expanded database production support for critical combat identification systems. Expanded and enhanced the target and threat radar signature prediction codes and tools to support a deployed non-cooperative combat identification system.				
(U)	In FY 2005: Refine the signature modeling and simulation capability for database production support for				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

critical combat identification systems. Broaden enhancements to the target and threat radar signature prediction codes and tools to support a deployed non-cooperative combat identification system.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	21.710	27.550	22.057	28.149

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602204F, Aerospace Sensors.										
(U)	PE 0603253F, Advanced Sensor Integration.										
(U)	PE 0603500F, Multi-Disciplinary Advanced Space Technology.										
(U)	PE 0603762E, Sensor and Guidance Technology.										
(U)	PE 0603270F, Electronic Combat Technology.										
(U)	Theater Missile Defense System Program Office.										
(U)	Low Altitude Night Targeting and Infrared Navigation (LANTIRN) System Program Office.										
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

PE NUMBER: 0603205F
PE TITLE: Flight Vehicle Technology

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603205F Flight Vehicle Technology

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	0.967	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	16.419
4398 Air Base Technology	0.967	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	16.419

Note: The Air Force transferred efforts in this program to PE 0603211F in FY 2002. However, 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 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	0.992	0.000	0.000	0.000
(U) Current PBR/President's Budget	0.967	0.000	0.000	0.000
(U) Total Adjustments	-0.025	0.000		
(U) Congressional Program Reductions				
Congressional Rescissions				
Congressional Increases				
Reprogrammings				
SBIR/STTR Transfer	-0.025			

(U) Significant Program Changes:
Not Applicable.

(U) C. Performance Metrics
Under Development

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603205F Flight Vehicle Technology**	PROJECT NUMBER AND TITLE **4398 Air Base Technology**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4398 Air Base Technology	0.967	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	16.419
Quantity of RDT&E Articles	0	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 2004	FY 2005	FY 2006	FY 2007
(U)	CONGRESSIONAL ADD: Conduct a study into service life extension potentials for legacy tactical aircraft.	0.967	0.000	0.000	0.000
(U)	In FY 2004: Initiated Congressionally-directed Air Force Research Laboratory Study of Legacy Tactical Aircraft.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	0.967	0.000	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) This project was 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 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603211F Aerospace Technology Dev/Demo

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	44.828	38.602	25.133	24.345	56.245	112.431	114.805	116.907	Continuing	TBD
486U	Advanced Aerospace Structures	15.469	13.363	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
4920	Flight Vehicle Tech Integration	29.359	25.239	25.133	24.345	56.245	112.431	114.805	116.907	Continuing	TBD

Note: In FY 2006, efforts from Project 486U transfer into Project 4920 within this PE.

(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 integration of various technologies to include avionics, advanced propulsion, and weapon systems for demonstration in near-realistic operational environments. Note: In FY 2005, Congress added $2.0 million for Bias Woven Preforms, $6.8 million for Capabilities Planning Support, and $1.0 million for Haleakala Laser Communications Testbed. 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 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	47.610	29.145	27.199	26.019
(U) Current PBR/President's Budget	44.828	38.602	25.133	24.345
(U) Total Adjustments	-2.782	9.457		
(U) Congressional Program Reductions				
Congressional Rescissions		-0.343		
Congressional Increases		9.800		
Reprogrammings	-0.787			
SBIR/STTR Transfer	-1.995			

(U) Significant Program Changes:
Not Applicable.

(U) C. Performance Metrics
Under Development

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603211F Aerospace Technology Dev/Demo**	**486U Advanced Aerospace Structures**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
486U Advanced Aerospace Structures	15.469	13.363	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts from Project 486U transfer into Project 4920 within this PE.

(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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop technologies to improve traditional sustainment methods of current and future aircraft.	3.097	0.000	0.000	0.000
(U) In FY 2004: Developed 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. Developed 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.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop non-traditional sustainment methods and diagnostic/prognostic monitoring capabilities for future aircraft.	2.411	0.000	0.000	0.000
(U) In FY 2004: Developed innovative non-traditional sustainment technologies that will extend aircraft life, increase aircraft availability, and reduce operations and support costs. Completed 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: Not Applicable.				
(U) In FY 2006: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2007: Not Applicable.				
(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. In FY 2005, this effort was moved to Project 486U to address aerospace structure elements of the effort. In FY 2006, this effort was the only remaining effort in Project 486U and was transferred back to Project 4920 within this PE.	0.000	3.650	0.000	0.000
(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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	CONGRESSIONAL ADD: Advanced Aluminum Aerostructures Initiatives (A3I). Note: In FY 2004, two Congressional Adds were made for this effort; both are being managed as a single effort.	6.189	0.000	0.000	0.000
(U)	In FY 2004: Continued Congressionally-directed effort for advanced aluminum aerostructures.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Composites.	1.354	0.000	0.000	0.000
(U)	In FY 2004: Continued Congressionally-directed effort for unmanned aerial vehicle (UAV) composites.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Three-Dimensional Bias Woven Preforms Development Program.	2.418	1.982	0.000	0.000
(U)	In FY 2004: Continued Congressionally-directed effort for Three-Dimensional Bias Woven Preforms Development Program begun with FY 2002 Congressional Add.				
(U)	In FY 2005: Continued Congressionally-directed effort for Three-Dimensional Bias Woven Preforms Development Program.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)					
(U)	CONGRESSIONAL ADD: Capabilities Planning Support. Note: In FY 2005, two Congressional Adds were made for this effort; both are being managed as a single effort.	0.000	6.740	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiated Congressionally-directed effort for capabilities planning support.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Haleakala Laser Communications Testbed.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiated Congressionally-directed effort for Haleakala laser communication testbed.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	15.469	13.363	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602201F, Aerospace Vehicle Technologies.										
(U)	PE 0604015F, 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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4920 Flight Vehicle Tech Integration	29.359	25.239	25.133	24.345	56.245	112.431	114.805	116.907	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, efforts from Project 486U transfer into Project 4920 within this PE.

(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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop autonomous flight controls for safe flight operations between manned and unmanned air platforms.	11.890	9.192	7.312	5.160

(U) In FY 2004: Developed and demonstrated key control automation techniques and algorithms to enable the safe and interoperable application of unmanned vehicle systems. Developed elements 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. Developed and demonstrated control component technologies for systems integration. Developed 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 inter operable 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) In FY 2006: Complete hardware-in-the-loop simulation assessments of integrated, adaptive, fault tolerant, autonomous control system suite to verify significantly increased reliability and mission effectiveness for unmanned vehicle systems. Complete environmental testing of key photonic sensing and control elements for flight critical control. Prepare key photonic sensing and control elements for flight-testing. Flight demonstrate automated see and avoid capability for unmanned air vehicles.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2007: Complete ground simulation and flight demonstration of key hardware and software systems for adaptive, fault tolerant, autonomous unmanned air vehicle airborne control. Initiate development of situational awareness and control technologies for automated airbase ground operations for unmanned air vehicles.				
(U)					
(U)	MAJOR THRUST: Develop an Automated Aerial Refueling capability for unmanned and manned air platforms. Note: In FY 2005, Automated Aerial Refueling efforts described in the autonomous flight controls thrust area were broken out to allow for increased visibility for this effort.	0.000	5.233	0.000	0.000
(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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop, simulate, and demonstrate integrated technologies to improve the performance of manned and unmanned platforms. Note: The FY 2006 increase in funding is the direct result of incorporating the remaining effort from Project 486U into this thrust. The FY 2007 decrease is due to completion of a majority of the thrust objectives in FY 2006.	2.800	3.464	6.242	1.343
(U)	In FY 2004: Developed advanced aerodynamic/structural integration concepts to enable increased system performance at reduced cost. Continued 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. Developed and demonstrated 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)	In FY 2006: Complete initial demonstration of an actively controlled conformal inlet system for increased propulsion system performance for unmanned air vehicles. Continue demonstration of active flow control devices to significantly increase and expand the separation envelope for miniature munitions and reduce weapon bay acoustics to minimize damage to the aircraft at speeds in excess of Mach 1.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2007: Continue development of a simulation environment to enable evaluation of network centric technologies for improved capabilities for high speed operational concepts.				
(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. Demonstrate reduced support costs for future systems by incorporation of advanced monitoring capabilities. Note: Funding increase is due to increased emphasis being placed on diagnostic and prognostic health monitoring tool development for future aircraft systems.	1.535	0.577	3.520	8.704
(U)	In FY 2004: Developed advanced structural concepts and design methods for future aerospace vehicle airframes for enhanced affordability and higher performance. Completed demonstration of advanced of low-cost bonded composite 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. Developed 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)	In FY 2006: Continue development and initiate demonstration of improved sustainment technologies for existing aging aircraft and future aerospace vehicle structures to reduce operations and support costs and extend usable structural lives. Continue development and initiate demonstration of real-time diagnostic and prognostics health monitoring tools for thermal protected systems, tanks, structures, and subsystems to enable rapid turn around and high temperature operations of high-speed aircraft.				
(U)	In FY 2007: Continue demonstration of improved sustainment technologies for existing aging aircraft and future aerospace vehicle structures to reduce operations and support costs and extend usable structural lives. Continue demonstration of real-time diagnostic and prognostics health monitoring tools for thermal protected systems, tanks, structures, and subsystems to enable rapid turn around and high temperature operations.				
(U)					

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	MAJOR THRUST: Develop aircraft structures that have embedded components, which have previously been separate components that were attached to the air platforms.	3.705	4.175	4.442	6.173
(U)	In FY 2004: Developed multi-functional integrated structures to reduce acquisition cost, support costs, weight, and volume and increase performance of air vehicles. Developed 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. Developed 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)	In FY 2006: Continue development of multi-functional integrated structures to reduce acquisition and support costs, weight, and volume and increase performance of air vehicles. Initiate flight 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 and initiate demonstration of concepts for very large, low frequency antenna arrays embedded in the aircraft load-bearing structure to enable new antenna capabilities and increased performance, while reducing vehicle weight, cost, and volume.				
(U)	In FY 2007: Continue and assess results from flight 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 demonstration of concepts for 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 adaptive structures to provide in-flight modifications offering improved performance over a wide range of flight conditions and mission profiles.	3.047	2.598	3.617	2.965
(U)	In FY 2004: Developed advanced aero-structural concepts and design methods for enhanced affordability, higher performance, and survivability for future aerospace vehicles. Completed flight test demonstrating increased high-speed control authority enable by an active aeroelastic wing. Completed demonstration of reconfigurable continuous moldline structure concepts to reduce aerodynamic drag and electromagnetic signature to enable platform adaptation as mission requirements change and thus				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	maximize its versatility. Developed elements for 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, joining technologies, hot primary structure, and structural health monitoring for high speed vehicle applications.				
(U)	In FY 2006: Continue development and initiate demonstration of integrated thermal airframe structures including thermal protection systems, attachments, seals, joining technologies, hot primary structure, and structural health monitoring for high speed vehicle applications. Continue development and initiate demonstration 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 2007: Further refine integrated thermal airframe structures including thermal protection systems, attachments, seals, joining technologies, hot primary structure, and structural health monitoring for high-speed vehicle applications. Continue development and demonstration 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)					
(U)	CONGRESSIONAL ADD: Sensorcraft.	3.384	0.000	0.000	0.000
(U)	In FY 2004: Continued Congressionally-directed effort for sensorcraft unmanned aerial vehicle.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Fly-by-light Avionics for Unmanned Combat Air Vehicle (UCAV).	2.031	0.000	0.000	0.000
(U)	In FY 2004: Initiated Congressionally-directed effort for fly-by-light Avionics for UCAV.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD Add: Medlink Global Response.	0.967	0.000	0.000	0.000
(U)	In FY 2004: Initiated 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.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.
(U)

(U)	Total Cost	29.359	25.239	25.133	24.345

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602201F, Aerospace Vehicle Technologies.										
(U) PE 0604015F, 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 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603216F Aerospace Propulsion and Power Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	86.720	86.050	77.268	86.690	88.391	92.907	94.858	96.622	Continuing	TBD
2480	Aerospace Fuels	3.352	0.371	0.196	2.834	4.743	5.156	5.262	5.358	Continuing	TBD
3035	Aerospace Power Technology	3.207	5.250	4.028	5.588	6.044	4.542	4.636	4.723	Continuing	TBD
4921	Aircraft Propulsion Subsystems Int	26.887	22.420	18.430	14.172	24.777	26.841	27.408	27.918	Continuing	TBD
4922	Space & Missile Rocket Propulsion	11.649	5.986	6.627	4.784	4.787	5.191	5.301	5.400	Continuing	TBD
5098	Advanced Aerospace Propulsion	14.433	26.069	23.212	33.780	22.494	23.471	23.964	24.411	Continuing	TBD
681B	Advanced Turbine Engine Gas Generator	27.192	25.954	24.775	25.532	25.546	27.706	28.287	28.812	Continuing	TBD

Note: In FY 2005-2007, a portion of the funding in Projects 2480 and 4921 was shifted to Project 5098.

(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 and thermal systems 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. Note: In FY 2005, Congress added $1.0 million for Advanced Satellite Thermal Control Program; $2.4 million for Versatile Affordable Advanced Turbine Engine; and $3.5 million for Integrated High Performance Turbine Engine Technology Phase III Technology Demonstrator. 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 2005
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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	93.425	79.914	68.626	74.950
(U)	Current PBR/President's Budget	86.720	86.050	77.268	86.690
(U)	Total Adjustments	-6.705	6.136		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.764		
	Congressional Increases		6.900		
	Reprogrammings	-2.347			
	SBIR/STTR Transfer	-4.358			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**2480 Aerospace Fuels**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2480 Aerospace Fuels	3.352	0.371	0.196	2.834	4.743	5.156	5.262	5.358	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2005-2007, a protion of the funding in this project was shifted to Project 5098 in this PE.

(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 and technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. 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 2004	FY 2005	FY 2006	FY 2007
(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.	0.868	0.060	0.025	0.989
(U) In FY 2004: Studied, tested, and demonstrated, 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. Developed bread-board, on-engine fuel additive injection hardware. Demonstrated long-term JP-8+225 performance in bench and full-scale fuel systems. Initiated demonstrations 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) In FY 2006: Continue to study, test, and demonstrate at a pilot-light level, advanced high heat sink fuels including those produced from alternative energy resources and hardware concepts that can increase engine performance at high temperatures, improve fuel system durability, and reduce maintenance due to fuel degradation in aircraft and engine hardware.				
(U) In FY 2007: Continue to study, test, and demonstrate, advanced high heat sink fuels including those produced from alternative energy resources and hardware concepts that can increase engine performance				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **2480 Aerospace Fuels**

	at high temperatures, improve fuel system durability, and reduce maintenance due to fuel degradation in aircraft and engine hardware. Initiate demonstrations of fuel performance at fuel temperatures in the supercritical regime.				
(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.	0.448	0.147	0.025	0.500
(U)	In FY 2004: Demonstrated, 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. Refined the design and building an UAV fuel system/tank simulator to study low temperature fuel behavior. Demonstrated 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)	In FY 2006: Continue, at a pilot-light level, to study, test, and demonstrate advanced fuels for UAV applications including advanced low temperature fuels and fuels to enable extended range and duration.				
(U)	In FY 2007: Demonstrate advanced low temperature and enhanced performance fuels for UAV applications focusing on technologies that expand the flight envelope, range, or duration of UAVs to include advanced thermal management concepts.				
(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.	0.867	0.060	0.025	0.500
(U)	In FY 2004: Advanced pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent. Developed additives to improve ignition and combustion characteristics in current and advanced propulsion concepts, including combined cycle engines. Qualified additives through material compatibility, toxicology, and hot section tests, and demonstrated 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)	In FY 2006: Continue pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **2480 Aerospace Fuels**

(U) In FY 2007: Demonstrate advanced additives to reduce soot and nitrogen oxides emissions in advanced propulsion concepts including combined cycle engines.					
(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.	0.737	0.057	0.025	0.345	
(U) In FY 2004: Designed and developed 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. Improved 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) In FY 2006: 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) In FY 2007: Continue design, development, and demonstration 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 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.	0.432	0.047	0.096	0.500	
(U) In FY 2004: Furthered 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. Demonstrated applicability of rapid fuel screening and identification using 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) In FY 2006: Continue pilot-light development of novel methods including bio- and nano-technology for fuel analysis.					
(U) In FY 2007: Demonstrate advanced nano-technology fuel additives, nano-technology fuel sensors, and novel detection and mitigation technologies for biological growth.					

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**2480 Aerospace Fuels**

(U)				
(U) Total Cost	3.352	0.371	0.196	2.834

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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) <u>D. Acquisition Strategy</u>

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3035 Aerospace Power Technology	3.207	5.250	4.028	5.588	6.044	4.542	4.636	4.723	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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. Note: FY 2005 low duty cycle generator system efforts have been delayed until FY 2006 and FY 2006 synergistic efforts have been delayed to FY 2007 to allow for multi-megawatt superconducting Applied Research activities to more fully develop. In FY 2006, the megawatt superconducting power system demonstration activity will be moved to a separate effort in this Project.	0.912	1.701	0.990	0.907
(U) In FY 2004: Completed fabrication and tests of a high power, low duty cycle generator critical components for pulsed DEWs.				
(U) In FY 2005: Initiate analysis of power system integration into an airframe as part of a non-lethal weapon system. Initiate preliminary design of and develop analytical model for a megawatt class power system demonstrator.				
(U) In FY 2006: Develop technology roadmaps and complete analysis of power system integration into an airframe as part of a non-lethal weapon system. Initiate design for a megawatt non-superconducting low duty cycle generator system tailored to directed energy weapons.				
(U) In FY 2007: Complete design and perform modeling and simulation of a megawatt non-superconducting low duty cycle generator system tailored to directed energy weapons.				
(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. Note: In FY 2006, this	1.566	1.795	1.267	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	activity will be completed.				
(U)	In FY 2004: Initiated design of the demonstration electrical generator for integration into mid-thrust class engines. Fabricated and tested 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)	In FY 2006: Complete engine integration and test of the internal starter generator in mid-thrust class engines.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop power generation/conditioning/distribution, energy storage, and thermal management components and subsystem technologies that are synergistic with aerospace and weapons platforms.	0.729	0.763	0.000	1.450
(U)	In FY 2004: Fabricated low volume/low weight high temperature motor drive.				
(U)	In FY 2005: Test low volume/low weight high temperature motor drive.				
(U)	In FY 2006: Not Applicable. Note: The FY 2006 synergistic efforts will be delayed to FY 2007 to allow for multi-megawatt superconducting Applied Research activities to more fully develop.				
(U)	In FY 2007: Investigate alternative energy storage/generation systems for low power applications.				
(U)					
(U)	MAJOR THRUST: Develop analytical tools and subsystems for multi-megawatt superconducting electrical power systems including power generation, conditioning, and dynamic interaction. Note: Prior to FY 2006, the megawatt superconducting power system demonstration activity was included in the directed energy weapons effort in this Project.	0.000	0.000	1.771	3.231
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Complete preliminary design for a megawatt class power system demonstrator.				
(U)	In FY 2007: Initiate detailed design of megawatt class power system demonstrator and begin fabrication of key components.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Satellite Thermal Control Program.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Expand Electrochromics Coatings (EC) productions beyond the pilot scale level, develop processes incorporating EC into thin flexible films that can be bonded to satellite structures and test EC devices in real application environments.				
(U)	In FY 2006: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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 2007: Not Applicable.

(U)	Total Cost	3.207	5.250	4.028	5.588

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602201F, Aerospace Flight Dynamics.										
(U)	PE 0602203F, Aerospace Propulsion.										
(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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**4921 Aircraft Propulsion Subsystems Int**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4921 Aircraft Propulsion Subsystems Int	26.887	22.420	18.430	14.172	24.777	26.841	27.408	27.918	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2005-2007, a portion of the funding in this project was shifted to Project 5098 in this PE.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. This project includes the Aerospace Propulsion Subsystems Integration (APSI) program which 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, mechanical systems, exhaust nozzles, and augmentors. 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, and power and thermal management subsystems 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. 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 2004	FY 2005	FY 2006	FY 2007
(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. Note: In FY 2004, the Air Force refocused turbine efforts to complete the IHPTET by 2005 causing sustained supersonic engines advancement efforts to be reduced in FY 2004 and future efforts to be delayed until FY 2006. Additionally, as a consolidation process, these efforts were shifted to the improved performance and fuel consumption effort in this Project.	5.744	1.777	1.400	1.300
(U)	In FY 2004: Completed structural durability tests of an engine and performance tests 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 rotor system design, sprayform cast turbine case, and a high fuel/air ratio Impingement Film Floatwall Combustor. Initiated advanced engine designs for a sustained supersonic engine with advanced aero, 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 tests of advanced engine components and instrumentation.

(U) In FY 2006: Design and develop agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories.

(U) In FY 2007: Fabricate and test agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories.

(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. Note: In FY 2004 and FY 2005, for the Low Pressure Turbine efforts, Ceramic Matrix Composites (CMCs) replaced Organic Matrix Composites (OMCs) due to maturity of the technology.	14.806	11.925	11.374	9.022

(U) In FY 2004: Completed fabrication, instrumentation, and assembly, and initiated test of a High Cycle Fatigue (HCF) robust front frame, an affordable OMC fan frame, a multi-stage forward swept fan, a damped low-pressure turbine (LPT) blade, a Titanium Matrix Composite (TMC) shaft, and model-based flexible control with diagnostics in an advanced demonstrator engine. Enhanced advanced engine designs for an uncooled CMC LPT blade and completed design of a carbon counter-rotating intershaft seal and active augmentor screech control.

(U) In FY 2005: Complete test of a HCF robust front frame, an affordable OMC fan frame and duct, a multi-stage forward swept fan, a damped LPT blade, a TMC shaft, and model-based flexible control with diagnostics. Complete advanced engine designs with an uncooled CMC LPT blade and begin fabrication of multi-property rotor, fluidic control and modulated turbine cooling.

(U) In FY 2006: Complete fabrication and testing multi-property rotor, fluidic control, and modulated turbine cooling. Initiate advanced designs for lightweight engine (utilizes a hollow fan, radial compressor, and low profile combustor) capable of operating as primary propulsion or in a lift mode. Initiate advanced engine designs for a sustained supersonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, and lightweight CMC cases and ducts.

(U) In FY 2007: Enhance advanced designs for lightweight high bypass engine (utilizes a hollow fan, radial

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	compressor, and low profile combustor) capable of operating as primary propulsion or in a lift mode. Enhance advanced engine designs for a sustained supersonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, and lightweight CMC cases and ducts.				
(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 vehicles (UAVs), and subsonic to hypersonic weapon applications.	3.921	2.870	5.656	3.850
(U)	In FY 2004: Completed engine structural durability testing a high stage loading splittered fan and uncooled ceramic low-pressure turbine. Completed testing of an uncooled ceramic high-pressure turbine, and slinger combustor. Completed testing a low volume combustor. Completed fabrication and conducted durability test an uncooled Ceramic Matrix Composite turbine blisk/nozzle, and a Carbon/Carbon exhaust nozzle. Initiated designs of advanced component technologies for intelligent and durability engine test.				
(U)	In FY 2005: Enhance designs of advanced component technologies for intelligent and durability engine testing for UAVs. Initiate designs of advanced component technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and improved oil-less bearings.				
(U)	In FY 2006: Enhance design and begin fabrication of advanced high temperature cooled turbine blade and combustor for UAV applications. Enhance designs of advanced components for technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and oil-less bearings.				
(U)	In FY 2007: Continue fabrication of advanced high temperature cooled turbine blade and combustor for UAV applications. Begin fabrication of advanced components for technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and oil-less bearings.				
(U)					
(U)	CONGRESSIONAL ADD: IHPTET Phase III Technology Demonstrator. Note: In FY 2004, this was referred to as "Advanced Turbine Engine Gas Generator and Aircraft Propulsion Subsystem Integration."	2.416	3.469	0.000	0.000
(U)	In FY 2004: Designed and fabricated advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Refurbished, fabricated, instrumented, and assembled hardware from the advanced turbine engine gas generator. This gas generator will be used in engine testing the following components: two-stage forward swept fan; uncooled CMC low pressure turbine vane; Titanium Matrix Composite shaft; and model-based flexible				

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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	control with diagnostics. Each of these component technology innovations can be applied to the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines.				
(U)	In FY 2005: Complete design, fabrication, instrumentation, assembly, and test of a multi-stage forward swept fan, an uncooled CMC low pressure turbine blade, and fluidic thrust vectoring in an advanced demonstrator engine.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: VAATE. Note: Only for the XTC 58F/1 for purposes demonstrating the integration of individual technologies for highly fuel efficient 10,000-15,000 pound thrust demonstrator engines needed for evolving UAVs.	0.000	2.379	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate designs of advanced component technologies (includes an advanced fan and improved high temperature turbine blades) for intelligent and durability engine testing for UAVs.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	26.887	22.420	18.430	14.172

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

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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4922 Space & Missile Rocket Propulsion	11.649	5.986	6.627	4.784	4.787	5.191	5.301	5.400	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 are being accomplished in two phases and that could improve the performance of expendable systems' payload capabilities by approximately 15 percent (Phase I)/20 percent (Phase II) and reduce hardware and operation costs by approximately 25 percent (Phase I)/30 percent (Phase II). Aging and Surveillance efforts that could improve lifetime prediction capabilities by 10 years and reduce non-destructive test costs by 50 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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Develop and demonstrate missile propulsion and Post Boost Control Systems (PBCS) technologies for ballistic missiles.	7.024	2.417	2.284	0.970
(U)	In FY 2004: Demonstrated component technologies with readily available materials to reduce hardware costs with increased performance for the PBCS. Furthered 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, insulation, and propellant for the Missile Propulsion Demonstration Phase I.				
(U)	In FY 2006: Continue hardware development integrating case, nozzle, insulation, and propellant for the Missile Propulsion Demonstration Phase I.				
(U)	In FY 2007: Complete the Missile Propulsion Demonstration Phase I.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate missile propulsion, PBCS, aging, and surveillance technologies for strategic systems. Efforts support the Technology for Sustainment of Strategic Systems Phase II. Note: The FY 2005 start of subcomponent development for the propulsion demonstration efforts was delayed to FY 2007 to allow for modeling and simulation tools to mature. After FY 2006, the aging and surveillance efforts in this activity will become a separate activity in this project.	4.625	3.569	3.943	3.208

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2004: Completed initial development of advanced modeling and simulation tools (Phase II) applying them to actual missile components for verification, design, and modification. Began 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. Complete this development effort 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)	In FY 2006: Continue modeling and simulation tools (Phase II) development for analyzing and developing missile components.				
(U)	In FY 2007: Begin development of subcomponents to test the accuracy of the previously developed modeling and simulation tools and update the models with the resulting data for use in an upcoming Missile Propulsion demonstration.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate aging and surveillance technologies for strategic systems to improve lifetime prediction capabilities by 10 years and reduce non-destructive test costs by 50 percent. Efforts support the Technology for Sustainment of Strategic Systems Phase II. Note: Prior to FY 2006, the aging and surveillance efforts were part of another effort in this Project.	0.000	0.000	0.400	0.606
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Complete development of aging and surveillance tools for predicting the health of solid rocket motors and methods to apply these tools on a motor-by-motor basis vice a fleet wide basis.				
(U)	In FY 2007: Initiate scale-up activities for an advanced service life prediction program integrating existing and advanced sensors, models, and tools to be able to predict the service life of a solid rocket motor on a motor-by-motor basis.				
(U)	Total Cost	11.649	5.986	6.627	4.784

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602102F, Materials.										
(U) PE 0602203F, Aerospace Propulsion.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) **C. Other Program Funding Summary ($ in Millions)**

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Tec.

(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.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5098 Advanced Aerospace Propulsion	14.433	26.069	23.212	33.780	22.494	23.471	23.964	24.411	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2005-2007, funds were shifted to accelerate the Air Force scramjet flight demonstration efforts. In 2007, funding increases to support ground demonstrations and fabricate test vehicles for out-year flight demonstrations.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates via ground and flight tests the scramjet propulsion cycle to a technology readiness level appropriate for full integration with other engine cycles (including turbine and rocket-based) to provide the Air Force with transformational military capabilities. 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 low speed propulsion systems (e.g.; turbine engines) during hypersonic flight.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation over a range of Mach 4 to 8.	14.433	26.069	23.212	33.780

(U) In FY 2004: Designed and fabricated 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. Developed a robust engine start system to achieve full engine light after boost to Mach 4.5. Initiated design of an active engine sense-control system to manage start transient and engine mode changes during acceleration. Initiated 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+. Initiated selection of rocket boosters.

(U) In FY 2005: Ground test the flight weight hydrocarbon-fueled, fixed geometry flow path. Demonstrate engine start and control systems. Continue detailed design of the scramjet engine demonstrator air vehicle. Conduct wind tunnel tests of the air vehicle models to determine aerodynamic forces and moments and vehicle stability and control. 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) In FY 2006: Continue detailed design of the scramjet engine demonstrator air vehicle. Complete vehicle subsystem trade studies and designs for structures, avionics, instrumentation, booster and other necessary technologies. Conduct multiple risk reduction tests and analyses to reduce both aerodynamic and

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

propulsion uncertainties prior to Critical Design Review. Conduct extensive transonic, supersonic, and hypersonic wind tunnel tests and simultaneously conduct computational fluid dynamics analyses of tested configurations. Conduct aero-thermodynamic tests to ensure vehicle thermal protection system design meets requirements. Conduct additional propulsion related risk reduction tests to mature propulsion system subcomponents (hot gas valves, digital engine controller, fuel pump) and broaden the engine ground test matrix to better align with expected flight profiles.

(U) In FY 2007: Complete engine and vehicle designs and conduct vehicle critical design review. Fabricate and test flight clearance engine and initiate fabrication of flight engines. Establish flight test profiles and margins. Initiate fabrication of air vehicle flight hardware and begin flight test preparations at supporting test centers.

(U) Total Cost	14.433	26.069	23.212	33.780

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602102F, Materials										
(U) PE060203F, Aerospace Propulsion										
(U) This project will be coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable

Exhibit R-2a, RDT&E Project Justification

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603216F Aerospace Propulsion and Power Technology**	**681B Advanced Turbine Engine Gas Generator**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
681B	Advanced Turbine Engine Gas Generator	27.192	25.954	24.775	25.532	25.546	27.706	28.287	28.812	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. 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, a high-pressure turbine, mechanical systems, and core subsystems. 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. This project also assesses the impact of low spool components (such as inlet systems, fans, low pressure turbines, and exhaust systems) and system level technologies (such as integrated power generators and thermal management systems) on core engine performance and durability. The core performances of this project are proven in demonstrator engines in Project 4921 of this PE. Efforts are part of the IHPTET and the VAATE programs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Design, fabricate, and performance test demonstration core engines, using advanced materials to provide greater durability, improved performance, and reduced 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, thus enabling new capabilities for faster, survivable, durable, more responsive systems with longer range and greater payloads. Note: In FY 2005, funding was redirected to refocused Air Force priorities that address propulsion needs for new capabilities such as advanced fighter-attack, precision long-range strike, persistent high-altitude endurance, and agile combat support.	22.532	21.635	21.334	21.980
(U) In FY 2004: Completed advancement of 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. Improved the design of hardware for core engine test 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.				
(U) In FY 2005: Complete design and fabrication of hardware for testing a cooled-cooling air system,				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

micro-circuit cooled high pressure turbine blades, and blade outer air seals with advanced thermal barrier coating. Perform risk reduction tests of a magnetic bearing system for an advanced core engine. Initiate conceptual studies and preliminary designs of advanced core engine technologies, including systems level technologies residing within the core.

(U) In FY 2006: Complete preliminary design and begin detailed design of advanced core engine technologies, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Begin preliminary design and risk reduction planning for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Begin design of unique compression system components.

(U) In FY 2007: Complete detailed design and begin fabrication of advanced core engine technologies, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Complete preliminary design and risk reduction planning for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Continue design and begin fabrication of unique compression system components.

(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. Note: Beginning in FY 2006, this effort will be transferred to the remaining thrusts in this project since durability efforts are integral to Air Force turbine efforts.	1.506	1.500	0.000	0.000

(U) In FY 2004: Enhanced the design and furthered the fabrication of long lead hardware for turbine engine advanced core evaluations in the national durability program.

(U) In FY 2005: Complete the design and fabrication of long lead hardware for evaluation in the national durability program.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U)	MAJOR THRUST: Design, fabricate, and evaluate technology demonstration core engines to provide improved performance, greater durability, and lower fuel consumption for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft and runway independent air vehicles, special operations aircraft, theater transports, and large unmanned air vehicles.	3.154	2.819	3.441	3.552

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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 2004: Conducted core engine tests 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 tests 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) In FY 2006: Further the design and begin selective risk reduction tests of UAV small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, nanolaminate coatings, and systems for thermal management and advanced power extraction. Begin planning for multi-Service demonstration of heavy fuel engine technologies for future rotorcraft.

(U) In FY 2007: Complete design, initiate hardware fabrication, and continue selective risk reduction tests of UAV small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, nanolaminate coatings, and systems for thermal management and advanced power extraction. Continue planning for multi-Service demonstration of heavy fuel engine technologies for future rotorcraft.

(U) Total Cost 27.192 25.954 24.775 25.532

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

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

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603231F Crew Systems and Personnel Protection Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	40.873	33.595	29.775	31.726	32.246	35.284	35.926	36.237	Continuing	TBD
2830	Decision Effectiveness Technology	10.507	7.403	20.583	21.899	22.656	24.893	25.330	25.456	Continuing	TBD
3257	Helmet-Mounted Sensory Technologies	6.485	4.746	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
4923	Logistics Readiness and Sustainment	9.992	10.439	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
4924	Warfighter Readiness Technology	6.764	7.156	6.473	6.930	6.604	7.114	7.265	7.401	Continuing	TBD
5020	Bioeffects & Protection Technology	7.125	3.851	2.719	2.897	2.986	3.277	3.331	3.380	Continuing	TBD

Note: In FY 2006, Helmet-Mounted Sensory Technologies and Logistics Readiness and Sustainment efforts will move from Projects 3257 and 4923, respectively, to Project 2830.

(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 Effectiveness Technology project develops and demonstrates warfighter capability enhancing technologies that promote effective decision-making, control, and mission execution in the emerging network-enabled operational environments. The Helmet-Mounted Sensory Technologies project develops and demonstrates advanced operator interface technologies for multifunctional helmet-mounted displays and night vision devices. The Logistics Readiness and Sustainment project develops and demonstrates technologies that will enhance logistics operations, and improve the design, deployability, performance, and support of current and future weapon systems. The Warfighter Readiness Technology project develops and demonstrates advanced training, simulation, and mission rehearsal technologies. The Bioeffects and Protection Technology project develops and demonstrates advanced technologies to provide laser eye protection, assure the safety of personnel involved with test, deployment, and operation of high-energy laser weapons, and enable detection/identification and neutralization of threat agents for counterproliferation. Note: In FY 2005, Congress added $1.1 million for Virtual Warriors. 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 2005
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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	42.822	32.794	32.525	33.129
(U)	Current PBR/President's Budget	40.873	33.595	29.775	31.726
(U)	Total Adjustments	-1.949	0.801		
(U)	Congressional Program Reductions		-0.001		
	Congressional Rescissions		-0.298		
	Congressional Increases		1.100		
	Reprogrammings	-0.826			
	SBIR/STTR Transfer	-1.123			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **2830 Decision Effectiveness Technology**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2830 Decision Effectiveness Technology	10.507	7.403	20.583	21.899	22.656	24.893	25.330	25.456	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, Helmet-Mounted Sensory Technologies and Logistics Readiness and Sustainment efforts will move from Projects 3257 and 4923, respectively, to Project 2830.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates warfighter capability enhancing technologies and information operations technologies that promote effective decision-making, control, and mission execution in the emerging network-enabled operational environment. Included are advanced technologies that improve the ability of battlefield airmen to rapidly assimilate critical information and make timely and correct decisions, display technologies and decision aids that enhance time-critical strikes, and warfighter interface technologies that simplify and speed critical operations in air operation centers and battle management platforms. The project also develops technologies that enhance logistics functions, improve the fidelity and accuracy of large-scale military simulations, protect deployed personnel, improve human effectiveness during information operations and information warfare, and support counterproliferation. The ultimate goal is to assure warfighter decision effectiveness in Air Force operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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. Note: Effort completes in FY 2005.	3.323	1.484	0.000	0.000
(U) In FY 2004: Developed 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. Integrated this tool into next-generation planning and combat assessment tools to demonstrate enhanced information warfare planning. Developed 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate advanced audio technologies to enhance security force	0.992	0.000	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **2830 Decision Effectiveness Technology**

situational awareness and threat response time using acoustic sensors. Note: Technology transitioned to Special Operations Forces in FY 2004 for testing.

(U) In FY 2004: Demonstrated 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. Demonstrated, 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.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U)	MAJOR THRUST: Develop and demonstrate human-centered tools for the Air Force Information Warfare (IW) community. 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.	1.914	2.050	3.029	2.854

(U) In FY 2004: Developed technologies to provide human-centered alternatives to current IW architectures, systems, processes, and operations. Technologies are focused on predictive battlespace awareness and tailored decision support systems and tools to augment human operators' performance. Finalized intelligence operations center process study and developed 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 IW capabilities for enhancement by exemplar technologies and methods. Develop, demonstrate, and evaluate IW support tools and technologies to assess operational impact.

(U) In FY 2006: Continue to develop and demonstrate tools, methods, and technology to gain, exploit, defend, and attack information. Develop IW capabilities for enhancement by exemplar technologies and methods. Begin research to develop tools and techniques to improve operator performance for Intelligence, Surveillance, and Reconnaissance planning and analysis.

(U) In FY 2007: Complete development of tools, methods, and technology to gain, exploit, defend, and attack information. Complete development of IW capabilities enhancement technology. Develop and demonstrate tools and techniques to improve operator performance for ISR planning and analysis. Begin research to develop ISR optimal displays and exploitation for ISR operators using all senses.

(U)

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	MAJOR THRUST: Develop and demonstrate human effectiveness technologies to improve combat effectiveness reporting, situation assessment updates, and decision support for Combined Air Operations Centers (CAOC).	1.373	1.369	2.608	2.600
(U)	In FY 2004: Performed cognitive task analysis of key CAOC positions and developed measures of performance and effectiveness. Began to develop visualization tools promoting battlespace situational awareness.				
(U)	In FY 2005: Develop user-tailorable visualization tools 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)	In FY 2006: Develop initial decision-centric visualization tools focused on the areas of strategy planning, assessment of operational effectiveness, and battle predictions. Integrate these visualization tools with other tools relevant to strategy planning and operational assessment.				
(U)	In FY 2007: Commence field tests of the visualization tools in an operational environment or exercise. Develop additional tools to allow more advanced collaboration within the strategy division and with other groups in the air operations center.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate technologies to interface between ground controllers and multiple machine components through unified visual and auditory displays. Technologies address ground controller-specific requirements leading to faster mission execution timelines, reduced targeting and fratricide errors, and increased situational awareness through positional awareness of friend and foe in the combat zone.	1.549	1.400	2.800	2.900
(U)	In FY 2004: Developed battlefield knowledge management concept to address specific mission requirements for operational ground controllers. Demonstrated the terminal attack communications earplug concept, including comfortable hearing protection, restoration of natural hearing via external hearing aid microphones, and in-the-ear-canal radio communications. Began to develop operator interface concepts for unmanned aerial vehicle (UAV)-augmented vision to improve ground controller awareness of UAV imagery with overlays that blend UAV imagery with cultural and targeting information. Began to develop head-mounted display concepts and sensors for ground controllers including night vision goggles and computer displays. Began to develop user independent speech recognition, using customer-specific software and terminal attack communications (TAC) earplug microphones.				
(U)	In FY 2005: Demonstrate operator-augmented vision interfaces for ground controller-specific UAV platforms. Begin to develop intelligent UAV search patterns for improved target location. Demonstrate user independent speech recognition in high-noise environments.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	In FY 2006: Continue to develop intelligent UAV search patterns for improved target location. Begin to develop UAV display tools that speed the delivery of UAV imagery integrated with cultural and targeting information to special operations forces. Continue to develop user independent speech recognition and language translation customized for ground controller equipment and TAC earplug microphones.				
(U)	In FY 2007: Complete development and demonstration of advanced interface technologies between ground controllers and multiple machine components through unified visual and auditory displays. Demonstrate UAV interfaces featuring intelligent agent search patterns in the ground controller operational environment. Demonstrate operator headgear incorporating basic operator status reporting and wearable displays. Demonstrate user independent speech recognition and language translation customized for ground controller equipment and TAC earplug microphones.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate decision-aiding technologies that assist the Joint Forces Commander (JFC)/Joint Forces Air Component Commander (JFACC) to rapidly assess the battlefield situation, predict the most likely adversary behaviors, and select and prioritize the appropriate courses of action. Note: In FY 2006, this increase in funding is due to greater emphasis in commander's predictive environment (CPE).	0.000	0.000	0.500	1.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Develop a scenario-based cognitive work analysis based on global strike and global persistent attack missions as a command and control knowledge base for the CPE. Begin developing an initial CPE decision aid and visually interactive simulation.				
(U)	In FY 2007: Begin first spiral development cycle of a decision aid that will support global military operations by providing a common global picture, fully integrating military planning, operations, and supporting intelligence, and enabling real-time reachback to operational and intelligence knowledge sources.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate advanced visual display technologies to provide integrated day/night capability to reduce pilot workload and enhance mission performance. Note: In FY 2006, this effort moved from Project 3257.	0.000	0.000	2.182	2.412
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Develop lightweight, ruggedized displays that operate in demanding special operations environments. Perform a laboratory evaluation to determine the optimal configuration to present information to special operations personnel. Investigate the utility of incorporating day and night sensors				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	into a single helmet-mounted display.				
(U)	In FY 2007: Demonstrate in an operational environment that lightweight, ruggedized displays can be successfully integrated into Air Force special operations equipment. Begin to develop an integrated helmet display prototype that includes day and night sensors and provides the operational capabilities identified by the completed utility investigation.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate counterproliferation technologies for large-scale threat neutralization applications. This will enhance force protection, enable air operations commanders to maintain operations tempo, and minimize weapons system attrition due to agent contamination. Note: In FY 2006, this increase in funding is due to greater emphasis in counterproliferation technologies.	0.000	0.000	0.485	1.171
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Define parameters of biological warfare agent identification and neutralization. Design new agent identification technologies and appropriate testing methods and conditions to perform operational field evaluations.				
(U)	In FY 2007: Evaluate the capabilities of emerging technologies to identify and neutralize biological warfare agents. Begin development of DNA-based identification technologies that will lead to affordable and reliable techniques to locate, identify, track, and engage enemy held biological warfare agents.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate intelligent software agents, realistic human and organizational behavior models, and advanced job performance aiding technologies. Computer agents and models add realism and fidelity to large-scale synthetic environments and war games, and provide intelligence analysts a way to model collected data. Job aiding technologies provide command and control operators with automated access to a manageable amount of multi-source critical information to avoid operator overload and to support fast and accurate decision-making during mobility operations. Note: In FY 2006, this effort moved from Project 4923.	0.000	0.000	4.111	3.999
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Evaluate methods to improve validating human performance models. Begin to develop a human performance model that can represent behavioral variations due to cultural differences. Begin to transition to an Air Mobility Command program office a set of work-centered collaborative planning and decision-making software tools. Begin to develop composable human computer interface elements that can be assembled via computer network into a rapidly reconfigurable command and control system.				
(U)	In FY 2007: Demonstrate in the laboratory a human performance model that can represent behavioral				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	variations due to cultural differences. Begin a series of critical experiments toward modeling a society as a complex systems of systems. Complete the transition of work-centered collaborative planning and decision-making software to the Air Mobility Command. Continue to develop composable command and control (C2) human computer interface elements that can be assembled via computer network into a rapidly reconfigurable C2 system. Conduct initial laboratory experiments on composable C2 modules.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate logistics technologies for improved deployment operations and improved system supportability. These technologies will improve the efficiency and effectiveness of Air Force deployments and mobility operations in support of Agile Combat Support initiatives and Air Expeditionary Force concepts. Note: In FY 2006, this effort moved from Project 4923.	0.000	0.000	4.289	2.019
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Continue to develop and apply technology to automatically collect and update critical information required to effectively manage logistics resources in support of combat operations. Continue to design and develop very fast, easy-to-use dynamic planning/replanning capabilities for adaptive logistics. Continue work define coalition command and control information requirements to support cross-cultural planning and coordination.				
(U)	In FY 2007: Complete development and application of technology to automatically collect and update critical information required to effectively manage logistics resources in support of combat operations. Complete design and development of very fast, easy-to-use dynamic planning/replanning capabilities for adaptive logistics. Continue work to define coalition command and control information requirements to support cross-cultural planning and coordination. Begin work on defining requirements for emergency response logistics needs.				
(U)					
(U)	MAJOR THRUST: Develop collaborative interfaces for advanced C2 aircraft that will improve human/machine shared operational understanding of the battlespace. Develop human-centered specifications for a prototype workstation and optimize the physical layout of the workstations. Note: In FY 2006, this increase in funding is due to greater emphasis in collaborative interfaces.	0.000	0.000	0.217	2.273
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Define the concept of a collaborative toolkit for battle management C2. Establish and document requirements for an advanced C2 workstation that integrates the battle management visualization and collaborative tools.				
(U)	In FY 2007: Begin to develop the temporal and spatial interface. Begin to develop a collaborative				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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		FY 2004	FY 2005	FY 2006	FY 2007
	toolkit that provides a shared understanding of the C2 battlespace. Refine the requirements and begin to develop an air battle management workstation that eliminates physical obstructions to team communication, supports team reconfiguration, supports in-place crew rest, and integrates the tools developed both to help warfighters assimilate information and to execute the sensor-shooter cycle more efficiently and effectively.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate human protective system technologies for extended missions. Technologies will improve aircrew comfort, resulting in increased performance. Note: In FY 2006, this increase in funding is due to greater emphasis in human protective system technologies.	0.000	0.000	0.362	0.671
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Begin development of aircrew safety technologies to support long duration missions. Initiate development of optimized seat system technologies to improve safety, comfort and performance.				
(U)	In FY 2007: Continue research on optimizing seat system technologies to improve safety, comfort, and performance. Develop and evaluate candidate seat system optimization technologies that reduce aircrew fatigue and discomfort, while maintaining spinal alignment. Extend design concepts to ensure accommodation of the full aircrew population.				
(U)					
(U)	CONGRESSIONAL ADD: Virtual Warriors.	1.356	1.100	0.000	0.000
(U)	In FY 2004: Integrated 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: Integrate a virtual model of 3-D human and workspace into distributed simulation of an air operations center's time critical targeting (TCT) team, demonstrate the model's interactions with human TCT operators, and demonstrate the technical potential to revolutionize team design and team training.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	10.507	7.403	20.583	21.899

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602202F, Human										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603231F Crew Systems and Personnel Protection Technology**	**3257 Helmet-Mounted Sensory Technologies**

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3257	Helmet-Mounted Sensory Technologies	6.485	4.746	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, Helmet-Mounted Sensory Technologies efforts will move from Project 3257 to Project 2830.

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced technologies for ejection-safe, multifunctional 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 technologies will enhance aerial combat capabilities at night.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and demonstrate advanced 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.	2.313	1.858	0.000	0.000
(U) In FY 2004: Demonstrated 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. Demonstrated and assessed utility of advanced head tracker that improves tracker accuracy, reduces system latency, and reduces mobility footprint.				
(U) In FY 2005: Assess capability of integrated symbology sets and advanced head tracker to reduce target acquisition and engagement timelines at night. 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) MAJOR THRUST: Develop and demonstrate advanced visual display technologies to provide integrated day/night capability for optimizing display of information, reducing pilot workload, and enhancing mission performance.	2.431	2.888	0.000	0.000
(U) In FY 2004: Assessed capabilities of emerging night vision devices and investigated head-mounted, multi-channel displays. Developed 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: Investigate the utility of miniature digital night vision devices and head-mounted displays				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	for providing imagery and video, both to aircrew and to Air Force combat controllers, including night vision goggles and computer displays. Assess leading edge display technologies to support fielding of laser eye protection and laser hardening technologies with advanced HMT/Ds and night vision goggles.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: This effort completed in FY 2004.	0.094	0.000	0.000	0.000
(U)	In FY 2004: Identified candidate lift-reducing concepts and integrated helmet design with emerging HMD designs.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Helmet Cueing System Technology.	1.647	0.000	0.000	0.000
(U)	In FY 2004: Transitioned the advanced head tracker and related helmet cueing technologies from the laboratory environment to the operational environment. Developed and packaged 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 capability.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	6.485	4.746	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602202F, Human Effectiveness Applied Research.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

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

(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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4923	Logistics Readiness and Sustainment	9.992	10.439	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2006, Logistics Readiness and Sustainment efforts will move from Project 4923 to Project 2830.

(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, C2, and force protection.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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.	2.777	2.076	0.000	0.000
(U) In FY 2004: Demonstrated software architecture for behavior modeling that can be readily tuned to different personality types. The models that were developed simulate potential enemy C2 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 C2 echelons and that better represent logistics functions in synthetic exercises.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(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.	2.817	3.048	0.000	0.000
(U) In FY 2004: Completed development of 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. Began to assess and develop technology to automatically collect and update critical information				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	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 dynamic planning/replanning capabilities for adaptive logistics. Begin defining coalition and control information requirements to support cross-cultural planning and coordination.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate advanced job performance aiding technologies to enhance the utility of global air mobility C2 systems. These technologies will provide C2 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.	1.712	2.613	0.000	0.000
(U)	In FY 2004: Developed artificial intelligence software, work-centered collaborative planning tools, and advanced decision support technologies to augment global air mobility C2 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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.	1.717	2.702	0.000	0.000
(U)	In FY 2004: Began to develop cognitive decision technologies, new information fusion techniques, and algorithms to determine failure trends for improved maintenance troubleshooting. Developed 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 the development of revolutionary formats for presenting technical information and software tools that support collaborative problem solving during aircraft maintenance.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: The Logistics Institute.	0.969	0.000	0.000	0.000
(U)	In FY 2004: 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 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	9.992	10.439	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)**

Reliance process to
harmonize efforts and
eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603231F Crew Systems and Personnel Protection Technology**	**4924 Warfighter Readiness Technology**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4924	Warfighter Readiness Technology	6.764	7.156	6.473	6.930	6.604	7.114	7.265	7.401	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

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

This project 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, C2, 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 the global battlespace requires advances in training systems and in interconnection, information, visual, and representation technologies. The resulting mission training and rehearsal capabilities will enhance the mission essential competencies of combat and combat support individuals and teams that comprise the aerospace force.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Advance aerospace and organizational behavior models for integrated warfighter training and rehearsal. These computer agents and models will add realism operations, C2, force protection, and air base defense warfighters. Technologies will increase training effectiveness and efficiency, and decrease time to mission qualification.	1.755	0.999	2.251	2.984
(U)	In FY 2004: Developed 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. Developed specifications for virtual and live training performance assessment and measurement to enable deployed personnel to maintain mission essential skills, and developed training and simulation technologies that enabled integrated C2 training within the Distributed Mission Training environment. Demonstrated competency-based design of a simulator performance measurement and tracking system, and developed 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 C2 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 development, assessment, and decay study for combat air forces.				
(U)	In FY 2006: Demonstrate the Performance Evaluation and Tracking System. Integrate the current				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4924 Warfighter Readiness Technology**

	Battlefield Air Operations toolkit training devices into an immersive, DMO compatible training system, capable of mission training and rehearsal. Develop a preliminary mission planning toolset for a deployable, modest fidelity environment that permits training designers to develop tactical scenarios and to employ constructive forces, live players, or other virtual players.				
(U)	In FY 2007: Develop specifications of interfaces between DMO Mission Training Centers and Live Training Ranges. Develop a proof of concept Joint Close Air Support schoolhouse simulation environment. Develop preliminary exercise planning and analysis shells to enable a robust scenario authoring capability that reduces training development time. Develop performance measurement and monitoring tools for a deployable training environment. Perform a small-footprint training demonstration in a persistent wargaming environment.				
(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, C2, and weapons platforms. Note: Technology transitioned to the Distributed Mission Operations Center in FY 2004.	1.345	0.000	0.000	0.000
(U)	In FY 2004: Demonstrated a near-real-time high-level architecture (HLA) based training environment enabling aircrew and C2 training for geographically separated training audiences. Validated performance of an HLA network guard federation operating at multiple security levels and produced documentation to support certification and accreditation.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Demonstrate advances in simulator visual system technologies through the development of ultrahigh resolution projection systems and associated 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, allowing improved air-to-air/ground mission rehearsal capability for the warfighter. Note: This effort completes in FY 2005.	1.865	3.280	0.000	0.000
(U)	In FY 2004: Developed and fabricated Ultra Grating Light Valve (UGLV) spatial light modulator technology capable of presenting 5120 x 4096 ultrahigh resolution projected images. Began development of a 5120 x 4096 pixel low-cost PC-based image generator.				
(U)	In FY 2005: Design and fabricate the frame and display structure and visual system controller for the				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **4924 Warfighter Readiness Technology**

	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 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop a low-cost, helmet-mounted, deployable simulation system with sufficient image resolution and performance capable of supporting the imaging of high-resolution fast-moving targets, high-density terrain, texture, and surround imagery, and helmet-mounted sights. This technology will provide the warfigher realistic air-to-air and air-to-ground visual simulation environments to support aircrew training during expeditionary deployments and at Mission Training Centers. Note: In FY 2006, this increase is due to greater emphasis in visual simulation environments.	0.000	0.000	0.889	0.995
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Design and develop off-boresight targeting simulation for DMO multifaceted simulator displays. Define display design requirements for head-mounted and deployable training devices, define next generation design configurations, and evaluate alternative display concepts.				
(U)	In FY 2007: Begin development of head-mounted and deployable display proof-of-concept training devices. Conduct engineering and human factors analyses of the proof-of-concept display training devices.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate training technologies and techniques to optimize night vision device-aided night operations. These technologies could reduce the cost of Night Vision Goggle (NVG) qualification and increase combat capability.	0.881	1.400	1.731	0.697
(U)	In FY 2004: Developed guidelines for NVG training during pilot training. Transitioned and implemented high-fidelity NVG simulation into Distributed Mission Training and Formal Training Unit facilities. Identified candidate performance metrics for NVG scan, crosscheck, and spatial orientation. Developed two-ship simulator scenarios for NVG initial and continuation training. Developed an annual NVG refresher course suitable for use in deployed status.				
(U)	In FY 2005: Develop the functional specification for a desktop NVG visualization trainer suitable for initial NVG familiarization training, mission planning/preview, and mishap investigation. Develop eye				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	position monitor for use with simulated NVG to determine spatial orientation awareness. 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)	In FY 2006: Develop desk-top NVG visualization trainer for mission preview and mishap investigation applications. Develop NVG mission brief/debrief technologies. Develop NVG spatial orientation training protocols. Develop and evaluate performance metrics for NVG instrument scan, cross-check, and spatial orientation. Develop formats for reusable and interoperable material properties-coded datasets suitable for NVG and other sensor simulation. Develop and evaluate physics-based simulation approach in a variety of visual displays. Develop virtual terrain board instructional module for introductory NVG academic training.				
(U)	In FY 2007: Develop NVG simulator scenarios and related performance metrics for advanced NVG employment training. Develop geo-specific databases and database modification tools for desk-top NVG visualization training. Test simulated panoramic NVG in DMO test bed. Develop untethered NVG simulation for NVG video and head position by application of broadband wireless technology. Demonstrate head position driven simulated NVG imagery viewable by multiple viewers in an open space.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate a high-fidelity 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.	0.918	1.477	1.602	2.254
(U)	In FY 2004: Developed specifications, strategies, and methods for individual-, team-, and division-level training and rehearsal within an AOC. Developed preliminary guidelines and metrics for assessing mission readiness levels for AOC members. Explored 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. Explore alternative local and DMO training and rehearsal technologies in operational exercises and experiments.				
(U)	In FY 2006: Develop performance indicators to enable performance measurement capability for team- and individual-level AOC operators. Develop initial functional specifications for computer-assisted training scenario for AOC operators. Evaluate and enhance training syllabi and methods for team- and individual-level AOC operators. Develop AOC training and rehearsal capabilities within the larger DMO training and rehearsal environment.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U) In FY 2007: Evaluate multi-level AOC trainers for specific AOC training needs. Utilize performance indicators for progression toward performance measurement capability. Continue incorporation of performance measurement into the AOC Command, Control, Communications, Computers Intelligence, Surveillance and Reconnaissance (C4ISR) Training and Rehearsal Testbed. Continue development of functional specifications for computer-assisted training scenario operators. Continue evaluation of AOC mission and continuation training syllabi and scenarios. Develop training aids for specific training AOC needs.

(U) Total Cost	6.764	7.156	6.473	6.930

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602202F, Human Effectiveness Applied Research.										
(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 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **5020 Bioeffects & Protection Technology**	

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5020	Bioeffects & Protection Technology	7.125	3.851	2.719	2.897	2.986	3.277	3.331	3.380	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project integrates and demonstrates technologies to provide protection against directed energy threats and hazards, without compromising performance, vigilance, or mission effectiveness, and counterproliferation technologies for the detection and neutralization of threat agents. Development and demonstration efforts focus on advanced technologies for laser eye protection (LEP), preventing injurious exposures of personnel involved with test and evaluation of high power microwave or high-energy laser weapons, and enabling operational employment of these systems. It also develops tools and guidelines for testing and deploying high power microwave and high-energy laser systems and technologies to enhance personnel safety and effectiveness in aerospace operations. Fatigue prediction and management capabilities are developed and demonstrated to enable risk management of the effects of sleep loss, circadian disruption, and shiftwork on cognitive readiness in surge, night, global, information warfare, C2, and other operations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and demonstrate multiwavelength LEP technologies for aircrew and ground personnel to provide protection against any laser hazard or threat in a single device.	1.720	1.935	0.819	0.859

(U) In FY 2004: Began evaluation and integration of optical limiters, tunable liquid crystals, photochromic and electrochromic materials, reflective technologies, and advanced dyes toward demonstration of agile LEP. Continued development, integration, and evaluation of LEP spectacles with laser-hardened NVGs. Continued supporting development and evaluation of a Laser Detector and Warning system toward integration into aircraft cockpits and agile LEP. Completed evaluation of human performance of second mini-band clip-on device to provide selected, multi-wavelength LEP.

(U) In FY 2005: Initiate development of direct-view LEP technologies for improved detection of targets. Continue development of next generation LEP goggles for Air Force Special Operations Command (AFSOC) air and ground forces for use in night operations with visible laser designators and illuminators. Complete development of LEP mini-band lenses for use with the Improved Aircrew Spectacle. Complete support for development and evaluation of a Laser Detector and Warning system for integration into aircraft cockpits and agile LEP. Complete demonstration and aircrew evaluations of peripheral LEP protection for wear with laser-hardened NVGs.

(U) In FY 2006: Begin developing an integrated LEP and hypervision (visual acuity better than 20/20) demonstration system to provide full-spectrum laser protection while restoring vision degraded by the LEP to better than normal. Begin development of wrap-around laser eye protection (LEP) spectacle technology with prescription capabilities.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	In FY 2007: Continue development of integrated eye protection technologies with hypervision technologies. Demonstrate and deliver second-generation LEP goggles for AFSOC air and ground forces.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate technologies that permit safe testing, deployment, and use of high energy laser weapons and systems.	0.950	1.429	0.399	0.544
(U)	In FY 2004: Released version 2.0 of Laser Range Safety Tool (LRST) and completed integration with laser test range personnel to permit rapid analysis of high energy laser test operations. Integrated laser bioeffects data to refine laser safety parameters for computer code supporting LRST. Refined 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 airborne lasers. Demonstrate Probabilistic Risk Assessment as an approach to high energy laser range safety. Present initial recommendations for revisions to national consensus standards for near infrared wavelengths.				
(U)	In FY 2006: Integrate existing models of airborne laser wavelength-specific dose-response curves to the initial Probabilistic Risk Assessment software library.				
(U)	In FY 2007: Combine modeling and experimental measurement of additional multiple-wavelength exposures to airborne laser wavelength and other near-infrared laser beams to define the relative damage thresholds of the combined exposures when compared to their single-wavelength counterparts.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate technologies to support testing of counterforce technologies and to enable neutralization of threat agents during military operations. These technologies will enhance agent defeat capabilities while minimizing collateral damage. Note: Technology from PE 0602202F will transition to this major thrust in FY 2005.	0.000	0.487	0.499	0.509
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Define performance parameters and develop technologies for threat neutralization, focusing on special operations needs. Conduct testing of breadboard man-portable neutralization technologies for counterproliferation.				
(U)	In FY 2006: Enhance neutralization technologies to optimize performance for specific operational conditions. Conduct laboratory tests to assess performance under simulated operational conditions.				
(U)	In FY 2007: Continue enhancement/assessment of agent neutralization devices and integrate with threat detection technologies. Demonstrate most promising man-portable threat neutralization technologies in simulated environments. Begin development of technologies to identify sources of biological warfare agents and ability to track, capture or destroy agents.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **5020 Bioeffects & Protection Technology**

(U)					
(U)	MAJOR THRUST: Develop a fatigue management capability to alleviate the negative effects of fatigue on human performance in aerospace operations. Results will extend and enhance human performance and survivability in sustained and continuous (24/7) mission environments for all aviation, C2, special operations, maintenance, and space operators. Note: In FY 2006, this increase is due to greater emphasis in fatigue management technologies.	0.000	0.000	1.002	0.985
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Integrate modeling of specific fatigue effects and interventions into model-based fatigue management capability. Improve and demonstrate operational usability of fatigue management capability. Expand fatigue model capability to predict operational task performance and address shiftwork applications.				
(U)	In FY 2007: Integrate fatigue model for selected military tasks into force simulations and wargaming exercises, thereby eliminating erroneous simulation outcomes based on current human performance models. Demonstrate operational counter-fatigue strategies and associated delivery mechanisms to improve human performance in specific operational military environments.				
(U)					
(U)	CONGRESSIONAL ADD: Laser Eye Protection (LEP) Research.	1.356	0.000	0.000	0.000
(U)	In FY 2004: Began design and development of a laser protective visor compatible with NVGs. Continued demonstration and evaluation of LEP for air-based platforms. Transitioned technology for vision corrective prescription LEP, and for wide-band, near-infrared, and two visible laser line protection. Demonstrated and delivered LEP in each of three formats to Air Force Special Operations Command for Special Tactics Teams. Demonstrated LEP spectacles for airborne laser and advanced tactical laser wavelengths ahead of baseline schedule. Transitioned technology for vision corrective prescription LEP, and for wide-band, near-infrared, and two visible laser line protection.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Total Atmospheric Liquefaction for Oxygen and Nitrogen (TALON).	1.356	0.000	0.000	0.000
(U)	In FY 2004: Continued development of component technologies for the palletized TALON technology demonstrator. Technology increased the availability of high-purity nitrogen gas for fuel tank inserting; provided high-purity oxygen for aircrew, paratrooper, and patient life support; and reduced aircraft dependency on the costly and extensive deployment footprint of liquid oxygen. Fabricated full-scale				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT NUMBER AND TITLE **5020 Bioeffects & Protection Technology**

	oxygen and nitrogen distillation columns and integrated columns with cryocooling technologies. Refined aircraft integration plans for flight-testing the palletized technology demonstrator on-board a heavy aircraft.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Crew Systems Personnel Protection.	1.743	0.000	0.000	0.000
(U)	In FY 2004: Developed and demonstrated technologies and tailored guidelines to improve warfighter performance for Special Operations Forces.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	7.125	3.851	2.719	2.897

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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.

Exhibit R-2, RDT&E Budget Item Justification

DATE: **February 2005**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603270F Electronic Combat Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	32.347	39.234	23.923	24.159	24.489	26.562	27.162	27.665	Continuing	TBD
2432	Defensive System Fusion Technology	9.031	7.590	5.540	5.124	5.192	5.632	5.751	5.859	Continuing	TBD
431G	RF Warning & Countermeasures Tech	10.496	14.734	8.030	8.292	8.405	9.116	9.352	9.526	Continuing	TBD
691X	EO/IR Warning & Countermeasures Tech	12.820	16.910	10.353	10.743	10.892	11.814	12.059	12.280	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to support Air Force electronic combat (EC) warfighting capabilities. 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 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 2005, Congress added $1.0 million for Receiver and Processing Concepts Evaluation Program, $1.4 million for Detect and Avoid for UAVs, $5.6 million for Lightweight Modular Support Jammer, and $3.3 million for Affordable Visible Missile Warning Systems. 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	34.597	28.282	26.555	26.318
(U)	Current PBR/President's Budget	32.347	39.234	23.923	24.159
(U)	Total Adjustments	-2.250	10.952		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.348		
	Congressional Increases		11.300		
	Reprogrammings	-0.915			
	SBIR/STTR Transfer	-1.335			

(U) Significant Program Changes:
Not Applicable.

C. Performance Metrics

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**

Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2432	Defensive System Fusion Technology	9.031	7.590	5.540	5.124	5.192	5.632	5.751	5.859	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technologies for integrating 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 warfare (C2W), stand off 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and investigate offensive counter information warfare technologies to disrupt and deny hostile command and control nodes and networks.	3.823	2.949	1.376	0.031
(U) In FY 2004: Finalized the detailed flight test plan based on the results of exhaustive ground tests. Flight tested the Electronic Attack/Electronic Support (EA/ES) countermeasures system to counter adversary communication and navigation systems. Documented system design and ground/flight test results in a final report. Designed hardware and software for the EA/ES system to counter high-speed, wideband data/communication links utilized by multiple ground-based and airborne platforms. Fabricated hardware to process and attack the threat network.				
(U) In FY 2005: Integrate 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) In FY 2006: Complete the EA/ES support system integration. Conduct laboratory and field tests of the countermeasure system to verify the capability to counter high-speed, wideband data communication links utilized by multiple ground-based and airborne platforms.				
(U) In FY 2007: Develop an integrated, networked approach to disrupt and deny current and future Integrated Air Defense Systems (IADS). This approach will integrate Radar EA and C2W into a distributed EA Sensor Management System.				
(U)				
(U) MAJOR THRUST: Develop and integrate advanced sensor receiver and processing technologies.	2.033	2.027	0.236	0.444
(U) In FY 2004: Conducted evaluations and risk reduction demonstrations of defensive sensors and the fusion of multiple information sources for situational awareness in the Integrated Demonstrations and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **2432 Defensive System Fusion Technology**

	Applications Laboratory (IDAL). Continued conducting IDAL laboratory risk reduction evaluations and demonstrations that evolve and optimize sensor fusion algorithms.				
(U)	In FY 2005: Conduct further evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness in the 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)	In FY 2006: Perform risk reduction for defensive sensors using multiple information sources for situational awareness in the IDAL. Conduct IDAL laboratory risk reduction evaluations and demonstrations that evolve and optimize network electronic attack techniques on disparate platforms. Conduct IDAL laboratory demonstrations of 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)	In FY 2007: Continue risk reduction for defensive sensors using multiple information sources for situational awareness in the IDAL. Continue IDAL laboratory risk reduction evaluations and demonstrations that evolve and optimize network electronic attack techniques on disparate platforms. Perform demonstrations of advanced multiplatform 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.	3.175	2.614	3.928	4.649
(U)	In FY 2004: Developed affordable threat alert and jamming techniques generator technologies for combat aircraft to increase survivability against advanced, integrated RF, EO, and infrared (IR) air defense systems, including trade study analyses for techniques to defeat future threat radar guided missile systems. Completed 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 IR 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				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **2432 Defensive System Fusion Technology**

complex emitter signals.

(U) In FY 2006: Design and initiate demonstration of advanced threat alert and jamming subsystem for combat aircraft to increase survivability against advanced, integrated RF, EO, and IR air defense systems. Perform initial flight tests to select advanced jamming techniques for a significantly improved digital threat warning and response capability.

(U) In FY 2007: Complete engineering model demonstration of advanced threat alert and jamming subsystem for combat aircraft to increase survivability against advanced, integrated RF, EO, and IR air defense systems. Perform final flight tests to validate advanced jamming techniques for a significantly improved digital threat warning and response capability.

(U) Total Cost	9.031	7.590	5.540	5.124

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

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

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
431G	RF Warning & Countermeasures Tech	10.496	14.734	8.030	8.292	8.405	9.116	9.352	9.526	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced technologies for RF 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 2004	FY 2005	FY 2006	FY 2007
(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).	1.699	3.262	1.386	0.959
(U) In FY 2004: Fully characterized adaptive, wideband, conformal phased arrays that have been structurally integrated into future unmanned aerial vehicle (UAV) 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) In FY 2006: Design and fabricate critical aperture and receiver subsystems for an efficient, low frequency, wide band aperture compatible with UAV platforms.				
(U) In FY 2007: Test critical subsystems of an efficient, low frequency, wide band aperture, and fabricate array compatible with UAV platforms.				
(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.	4.897	4.872	6.644	7.333
(U) In FY 2004: Developed and initiated testing of next generation monopulse countermeasure systems for Air Force aerospace platforms. Performed laboratory testing of innovative RF countermeasure techniques for aerospace platforms against future RF threat systems. Developed innovative electronic protection techniques in advanced radar systems. Laboratory and field tested these techniques.				
(U) In FY 2005: Develop self-protection countermeasures effective against fourth generation surface-to-air missile systems. Conduct laboratory evaluations of countermeasures to defeat an advanced integrated air				

defense system. Laboratory and field-test innovative, networked RF countermeasure techniques against advanced target engagement radars. Develop anti-jam technologies for advanced RF sensor systems.

(U) In FY 2006: Further develop self-protection countermeasures effective against fourth generation surface-to-air missile systems. Begin development and conduct laboratory evaluations of advanced countermeasures techniques and technology to defeat an advanced integrated air defense system. Continue laboratory and field-testing of innovative, networked RF countermeasure techniques against advanced target engagement radars. Further develop anti-jam techniques and technologies for advanced RF sensor systems. Demonstrate a lightweight, low-profile, multi-function, active electronically scanned array on an airborne test bed. Analyze data from flight test and predict system performance using advanced computational techniques.

(U) In FY 2007: Continue developing self-protection countermeasures effective against advanced future surface-to-air missile systems. Conduct further laboratory and field-testing of innovative, networked RF countermeasure techniques against advanced target engagement radars. Continue development of advanced countermeasures techniques and technology to defeat an advanced integrated air defense system. Continue developing anti-jam techniques and technologies for advanced RF sensor systems. Demonstrate electronic support cross-cueing capabilities of a multi-intelligence sensor suite including the effects of electromagnetic interference and platform compatibility to provide precision location and identification with increased probability of intercept.

(U)

(U) CONGRESSIONAL ADD: Lightweight Modular Support Jammer.	3.400	5.600	0.000	0.000

(U) In FY 2004: Designed, fabricated, and tested 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: Develop and demonstrate a special capability high band antenna array aperture with wide bandwidth solid state power amplifiers. Develop and demonstrate a wide bandwidth jamming techniques generator. Implement needed hardware modifications and upgrades to the system to provide high band exciter coverage. Implement software modifications to the software system needed for demonstration of the high band EA jamming subsystem. Perform an electronic combat battle management study for distributed and networked EA.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Receiver and Processing Concepts Evaluation Program.	0.500	1.000	0.000	0.000

(U) In FY 2004: Expanded research in advanced RF receiver and processing algorithms using state-of-the art

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603270F Electronic Combat Technology**	PROJECT NUMBER AND TITLE **431G RF Warning & Countermeasures Tech**

concepts and modern technologies.

(U) In FY 2005: Further expand research in advanced RF receiver and processing algorithms using state-of-the art concepts and modern technologies.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	10.496	14.734	8.030	8.292

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602204F, Aerospace Sensors.										
(U) PE 0604270F, Electronic Warfare (EW) Development.										
(U) PE 0603500F, Multi-disciplinary Advanced Space Technology.										
(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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
691X	EO/IR Warning & Countermeasures Tech	12.820	16.910	10.353	10.743	10.892	11.814	12.059	12.280	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

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

This project 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Analyze the vulnerabilities of current IR missile systems and future imaging IR sensors. Note: Increased funding in FY 2006 supports field demonstration of cooperative techniques and expendable decoys with modified spatial and kinematic properties for countering IR missiles.	1.925	2.357	4.464	1.262
(U) In FY 2004: Conducted in-house analyses on vulnerabilities of current and future IR imaging sensors and missiles. Demonstrated and evaluated countermeasure techniques for countering multiple types of imaging IR sensors used for target acquisition. Developed low-cost, cooperative techniques to counter imaging IR sensors.				
(U) In FY 2005: Continue in-house analyses on current IR-guided missile susceptibilities and future imaging IR sensors. Further evaluation of countermeasure (CM) 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.				
(U) In FY 2006: Further conduct in-house analyses on IR-guided missile and future imaging IR sensor susceptibilities. Continue evaluating CM techniques for countering multiple types of missiles and imaging IR sensors.				
(U) In FY 2007: Continue conducting in-house analyses on IR guided missiles and future imaging IR sensor susceptibilities. Further evaluation of CM techniques for countering multiple types of missiles and imaging IR sensors. Conduct digital simulations to assess the effectiveness of spatial decoy techniques against imaging IR missiles under flyout conditions. Assess proposed advanced CM techniques to defeat imaging IR sensors.				
(U)				
(U) MAJOR THRUST: Develop aerospace laser warning sensor technologies for timely alert to advanced	3.559	3.987	1.236	1.324

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser-guided ordnance) signals.				
(U)	In FY 2004: Completed design of an airborne laser warning sensor that can cue agile filter protection for aircrew or sensor protection. Conducted laboratory demonstration of cueing capabilities. Tested and demonstrated 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. Initiate laser warning sensor package for integration into UAVs and NVGs.				
(U)	In FY 2006: Initiate development of advanced laser warning receivers for aircraft. Continue developing a laser warning sensor technologies to address emerging laser threats. Continue laser warning sensor packages for integration into UAVs and NVGs.				
(U)	In FY 2007: Initiate development of an advanced laser warning receiver for integration into tactical aircraft. Continue developing laser warning sensor technologies to address emerging laser threats. Initiate miniature laser warning for personnel protection.				
(U)					
(U)	MAJOR THRUST: Develop a countermeasure technology to defeat passive EO and IR aircraft tracking sensors and ordnance guidance.	3.899	4.652	3.703	7.256
(U)	In FY 2004: Completed designing a sensor system that can locate and counter passive threats beyond kinematic launch boundaries. Completed assessment of multiple threats and threat surrogates. Developed 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)	In FY 2006: Complete development of testbed to locate and counter passive threats before threats can develop a fire control solution. Conduct field demonstration over extended ranges to demonstrate capability. Initiate testbed integration on aircraft for flight demonstrations over full required range.				
(U)	In FY 2007: Complete integration of testbed on aircraft. Conduct flight test demonstration of the capability to locate and counter passive threats over required range before threats can develop a fire control solution.				
(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.	0.937	1.214	0.950	0.901

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2004: Established spatial, spectral, and temporal trade space for advanced missile warning sensors optimized for detecting low contrast missile threats in high clutter backgrounds. Performed 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)	In FY 2006: Perform integration of subsystem components into affordable visible missile warning system (AVMWS). Perform test and evaluation of AVMWS. Coordinate AVMWS development with the Affordable Laser Infrared Survivability System countermeasure system.				
(U)	In FY 2007: Complete test and evaluation of AVMWS.				
(U)					
(U)	CONGRESSIONAL ADD: Detect and Avoid for UAV. Note: In FY 2003, this Add was titled Test Detect and Avoid Technology for Federal Aviation Administration (FAA).	2.500	1.400	0.000	0.000
(U)	In FY 2004: Implemented an interim see and avoid system UAVs that meets with FAA approval to do limited flying in national airspace without a chase aircraft.				
(U)	In FY 2005: Integrate and demonstrate see and avoid wide field of regard sensor subsystem, high performance field programmable gate array processors, and detection algorithms.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Affordable Missile Warning Systems	0.000	3.300	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate fabrication of passive, visible band missile warning subsystems to provide a system to provide timely countermeasure initiation with high declaration probability and low false alarm rate. Subsystems to be fabricated include the sensor, data processor, and detection algorithms.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	12.820	16.910	10.353	10.743

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

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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) C. Other Program Funding Summary ($ in Millions)

(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.

PE NUMBER: 0603311F
PE TITLE: Ballistic Missile Technology

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DATE: **February 2005**

BUDGET ACTIVITY: **03 Advanced Technology Development (ATD)**

PE NUMBER AND TITLE: **0603311F Ballistic Missile Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	11.104	11.597	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.294
4091 Missile Electronics	11.104	11.597	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.294

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 for range safety instrumentation. In FY 2005, Congress added $10.0 million for Ballistic Missiles Technology Common Advanced Guidance Technology and $1.7 million for Pacific Ballistic Missile Technology Program. 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 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	11.402	0.000	0.000	0.000
(U) Current PBR/President's Budget	11.104	11.597	0.000	0.000
(U) Total Adjustments	-0.298	11.597		
(U) Congressional Program Reductions				
Congressional Rescissions		-0.103		
Congressional Increases		11.700		
Reprogrammings				
SBIR/STTR Transfer	-0.298			

(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.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603311F Ballistic Missile Technology**	PROJECT NUMBER AND TITLE **4091 Missile Electronics**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4091 Missile Electronics	11.104	11.597	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.294
Quantity of RDT&E Articles	0	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 for range safety instrumentation. In FY 2005, Congress added $10.0 million for Ballistic Missiles Technology Common Advanced Guidance Technology and $1.7 million for Pacific Ballistic Missile Technology Program. 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 2004	FY 2005	FY 2006	FY 2007
(U) CONGRESSIONAL ADD: Ballistic Missile Technology Common Advanced Guidance Technology.	8.208	9.912	0.000	0.000
(U) In FY 2004: Developed, integrated, and demonstrated critical ballistic missile technologies related to advanced guidance, range safety instrumentation, and guidance sensors. Extended testing of innovative accelerometer, gyroscope, and flight computer instrumentation to strategic radiation levels. Integrated the instruments with guidance architectures that provide a robust system applicable in the most demanding missile applications. Demonstrated integrated sensors in highly flexible and mobile range safety instrumentation.				
(U) In FY 2005: Continue development, integration, and demonstration of ballistic missile technologies related to advanced guidance, range safety instrumentation, and guidance sensors. Conduct development testing and evaluate the capability of innovative accelerometer, gyroscope, and flight computer instrumentation to meet performance goals at strategic radiation levels. Evaluate the performance of instruments integrated with guidance architectures that provide a robust system applicable in the most demanding missile applications. Conduct acceptance testing of existing and future integrated sensors in highly flexible and mobile range safety instrumentation.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Common Aerospace Vehicle (CAV), Small Launch Vehicle (SLV), Minuteman III (MMIII) Critical Technology Development.	2.896	0.000	0.000	0.000
(U) In FY 2004: Initiated ground testing of critical advanced vehicle preliminary hardware designs and structures required for CAV control. Initiated ground testing of accurate and robust guidance hardware designed for future small launch vehicles and MMIII critical technology development. Verified that critical elements and components are capable of meeting accuracy requirements over extended ranges,				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603311F Ballistic Missile Technology**	PROJECT NUMBER AND TITLE **4091 Missile Electronics**

while reducing maintenance costs and increasing mean time between failures.

(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Pacific Ballistic Missile Technology Program.	0.000	1.685	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate development, demonstration, acceptance testing, and environmental assessment of ballistic missile range safety technologies at the Pacific Missile Range Facility in support of Air Force Space Command requirements.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	11.104	11.597	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602204F, Aerospace Sensors.										
(U)	This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.										

(U) D. Acquisition Strategy

Not Applicable.

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Exhibit R-2, RDT&E Budget Item Justification

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BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603333F Unmanned Air Vehicle Dev/Demo

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	0.000	8.425	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5067	Unmanned Combat Air Vehicle Tech Demo	0.000	8.425	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: The Air Force transferred efforts in this program to PE 0604731F in FY 2003. However, in FY 2005, Congress added $8.4 million for Protector Unmanned Air Vehicle for AC-130 Aircraft.

(U) A. Mission Description and Budget Item Justification

Prior to FY 2004 , this project developed, demonstrated, and transitioned unmanned combat air vehicle (UCAV) technologies. 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	0.000	0.000	0.000	0.000
(U)	Current PBR/President's Budget	0.000	8.425		
(U)	Total Adjustments	0.000	8.425		
(U)	Congressional Program Reductions				
	Congressional Rescissions				
	Congressional Increases		8.425		
	Reprogrammings				
	SBIR/STTR Transfer				

(U) Significant Program Changes:

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5067	Unmanned Combat Air Vehicle Tech Demo	0.000	8.425	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	0		

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

Prior to FY 2004 , this project developed, demonstrated, and transitioned unmanned combat air vehicle (UCAV) technologies. 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.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U)	CONGRESSIONAL ADD: Protector unmanned air vehicle (UAV) for AC-130 aircraft.	0.000	8.425	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Initiate Congressionally-directed effort for the Protector UAV for AC-130 aircraft.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	0.000	8.425	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	PE 0603313A, Missle and Rocket Advaced 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: 0603400F
PE TITLE: J-UCAS Joint Program Office

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BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603400F J-UCAS Joint Program Office

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	0.000	0.000	77.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5067	Unmanned Combat Air Vehicle Tech Demo	0.000	0.000	77.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: In FY06, the Joint Unmanned Combat Air Systems (J-UCAS) program was transferred from the Defense Advanced Research Projects Agency (DARPA) to be a joint program led by the Air Force with Navy representation. The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PE 0603400D8Z to PE 0603400F.

(U) A. Mission Description and Budget Item Justification

The Joint Unmanned Combat Air Systems (J-UCAS) program is a joint effort to develop and demonstrate unmanned combat capabilities for high-threat Suppression of Enemy of Air Defense (SEAD), Information Operations/ Electronic Attack, Persistent Intelligence, Surveillance, Reconnaissance (ISR), and persistent ground attack missions within the emerging global command and control architecture for the warfighting community. The program is focused on demonstrating capabilities that support both Services and enable an operational system development decision by the end of the decade.

FY04 program guidance established the J-UCAS Program Office and funding for both Air Force (PEs 0207256F and 0604731F) and Navy (PE 0603114N) programs. Efforts previously conducted under the DARPA/Air Force and DARPA/Navy programs were combined into the J-UCAS program. FY05 program guidance directed FY05 and outyear funding for DARPA and both Services be transferred into Defense-wide Program Elements (0603400D8Z and 0604400D8Z). FY06 program guidance directed a reduction of funds in FY06-FY09, an increase in FY10/11, and realignment of funds from OSD to Air Force (PEs 0603400F and 0604400F).

The J-UCAS program combines and expands the efforts that were previously conducted under the DARPA/Air Force Unmanned Combat Air Vehicle (UCAV) program and the DARPA/Navy Naval UCAV (UCAV-N) program. Although these efforts were targeted towards service-specific needs, the Department recognized the potential for significant synergy by combining the programs. The accomplishments and ongoing efforts of the X-45A technology demonstrator, as well as the development of the X-47A demonstrator, are reducing the risk of the "operationalized" demonstration system being developed for a joint early operational assessment (OA) planned for the FY07-10 timeframe. The J-UCAS concept incorporates the next generation family of demonstrator air vehicles, together with common subsystems (e.g. sensors, payloads, communications) and a Common Operating System to achieve the system's diverse mission functionality. These common system elements will maximize mission flexibility and operational versatility while reducing overall costs and maintaining schedule toward a joint early OA.

This is a BA 03 program, Advanced Technology Development, for completion of demonstrations of the X-45A technology demonstrator, continued development of the Boeing and Northrop Grumman demonstrator programs, and the development of common systems technology elements.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603400F J-UCAS Joint Program Office**

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget			0.000	0.000
(U)	Current PBR/President's Budget	0.000	0.000	77.800	0.000
(U)	Total Adjustments	0.000	0.000		
(U)	Congressional Program Reductions				
	Congressional Rescissions				
	Congressional Increases				
	Reprogrammings				
	SBIR/STTR Transfer				

(U) Significant Program Changes:

FY06: The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PE 0603400D8Z to PE 0603400F.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603400F J-UCAS Joint Program Office**	**5067 Unmanned Combat Air Vehicle Tech Demo**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5067	Unmanned Combat Air Vehicle Tech Demo	0.000	0.000	77.800	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	0		

In FY06, the Joint Unmanned Combat Air Systems (J-UCAS) program was transferred from the Defense Advanced Research Projects Agency (DARPA) to be a joint program led by the Air Force with Navy representation. The program is undergoing a restructure and will realign the adjusted resources in the next budget cycle to advance the J-UCAS program. Funding is being realigned from PE 0603400D8Z to PE 0603400F.

(U) A. Mission Description and Budget Item Justification

The Joint Unmanned Combat Air Systems (J-UCAS) program is a joint effort to develop and demonstrate unmanned combat capabilities for high-threat Suppression of Enemy of Air Defense (SEAD), Information Operations/ Electronic Attack, Persistent Intelligence, Surveillance, Reconnaissance (ISR), and persistent ground attack missions within the emerging global command and control architecture for the warfighting community. The program is focused on demonstrating capabilities that support both Services and enable an operational system development decision by the end of the decade.

FY04 program guidance established the J-UCAS Program Office and funding for both Air Force (PEs 0207256F and 0604731F) and Navy (PE 0603114N) programs. Efforts previously conducted under the DARPA/Air Force and DARPA/Navy programs were combined into the J-UCAS program. FY05 program guidance directed FY05 and outyear funding for DARPA and both Services be transferred into Defense-wide Program Elements (0603400D8Z and 0604400D8Z). FY06 program guidance directed a reduction of funds in FY06-FY09, an increase in FY10/11, and realignment of funds from OSD to Air Force (PEs 0603400F and 0604400F).

The J-UCAS program combines and expands the efforts that were previously conducted under the DARPA/Air Force Unmanned Combat Air Vehicle (UCAV) program and the DARPA/Navy Naval UCAV (UCAV-N) program. Although these efforts were targeted towards service-specific needs, the Department recognized the potential for significant synergy by combining the programs. The accomplishments and ongoing efforts of the X-45A technology demonstrator, as well as the development of the X-47A demonstrator, are reducing the risk of the "operationalized" demonstration system being developed for a joint early operational assessment (OA) planned for the FY07-10 timeframe. The J-UCAS concept incorporates the next generation family of demonstrator air vehicles, together with common subsystems (e.g. sensors, payloads, communications) and a Common Operating System to achieve the system's diverse mission functionality. These common system elements will maximize mission flexibility and operational versatility while reducing overall costs and maintaining schedule toward a joint early OA.

This is a BA 03 program, Advanced Technology Development, for completion of demonstrations of the X-45A technology demonstrator, continued development of the Boeing and Northrop Grumman demonstrator programs, and the development of common systems technology elements.

(U)	**B. Accomplishments/Planned Program ($ in Millions)**	FY 2004	FY 2005	FY 2006	FY 2007
(U)	Continue development of J-UCAS systems, specifically the Boeing and Northrop Grumman demonstrator programs as well as the common operating system and sensors			77.800	
(U)	Prepare for joint Operational Assessment (OA)				
(U)					

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603400F J-UCAS Joint Program Office**	**5067 Unmanned Combat Air Vehicle Tech Demo**

(U)	Total Cost	0.000	0.000	77.800	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	DARPA (PE0603285E)	41.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
(U)	NAVY RDT&E (PE0603114N)	117.865	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
(U)	AF RDT&E (PE0604731F)	160.551	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
(U)	AF RDT&E (PE0207256F)	2.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
(U)	Defense-Wide RDT&E (PE0603400D8Z)	0.000	354.794	0.000	0.000	0.000	0.000	0.000	0.000		
(U)	Defense-Wide RDT&E (PE0604400D8Z)	0.000	217.401	0.000	0.000	0.000	0.000	0.000	0.000		
(U)	AF RDT&E (PE0604400F)	0.000	0.000	272.300	400.100	554.100	780.500	955.200	1064.100	Continuing	TBD

(U) **D. Acquisition Strategy**

The J-UCAS program blends the advantages of both the Advanced Technology Demonstration (ATD) and the Advanced Concept Technology Demonstration (ACTD) concepts to facilitate rapid development and integration of advanced technologies in an experimental system that addresses operational needs. Using the next generation demonstrator air vehicle families, together with common subsystems and a Common Operating System, this nontraditional approach also incorporates key acquisition considerations (i.e., user requirements, comprehensive system lifecycle perspective, and rigorous risk mitigation processes) to provide the necessary insights, operational data and identified options for the services to make an informed decision for accelerated acquisition near the end of the decade. This effort is tightly coupled with PE 0604400F (J-UCAS Advanced Component and Prototype Development), which complements the work under this program element to deliver systems for the joint operational assessment.

Exhibit R-2, RDT&E Budget Item Justification

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BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603401F Advanced Spacecraft Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	105.557	89.839	60.915	67.221	78.736	84.120	92.445	94.141	Continuing	TBD
2181	Spacecraft Payloads	32.515	26.787	18.966	18.891	25.562	28.339	30.106	30.663	Continuing	TBD
3834	Integrated Space Technology Demonstrations	30.160	23.376	21.958	26.272	29.101	32.266	35.480	36.138	Continuing	TBD
4400	Space Systems Protection	6.534	6.913	3.310	3.410	3.457	3.747	4.117	4.193	Continuing	TBD
5021	Space Systems Survivability	3.992	4.733	4.583	4.769	4.830	5.239	5.350	5.449	Continuing	TBD
5083	Ballistic Missiles Technology	6.274	6.798	5.491	3.859	3.928	4.248	4.327	4.397	Continuing	TBD
682J	Spacecraft Vehicles	26.082	21.232	6.607	10.020	11.858	10.281	13.065	13.301	Continuing	TBD

(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 2005, Congress added $4.5 million for Robust Aerospace Composite Materials and Structures, $1.5 million for Intelligence Free Space Optical Communications, $1.0 million for Boron Energy Cell System Development, $4.0 million for Vehicle Risk Reduction (RSLV), $1.0 million for Advanced Life Cycle Cost/Risk Model for Space Concepts Development, $1.0 million for Integrated Spacecraft Engineering Tool (ISET), $1.5 million for Systematic Hierarchical Approach to Radiation Hardened Electronics, $1.4 million for Radiation Hardening Electronics, $7.5 million for Thin Film Amorphous Solar Arrays, $1.5 million for Intelligent Free Space Optical Satellite Communications Node, $3.5 million for Hardening Technologies for Satellite Protection, $1.2 million for Magnetoresistive Random Access Memory (MRAM) Innovative Communications Materials, and $1.0 million for Alternating Current (AC) Coupled Interconnect. In FY 2005, Congress also added: $3.0 million for Streaker - Small Launch Vehicle and $3.3 million for Vortex Cold Wall Low Cost Rocket Engines to this PE however, the Air Force has requested these be moved to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, for execution. Finally, Congress also added $4.9 million for Geosynchronous Laser Imaging Testbed, which the Air Force has requested moved to PE 0603605F, Advanced Weapons Technology, for execution. 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 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	96.912	60.124	65.892	72.085
(U)	Current PBR/President's Budget	105.557	89.839	60.915	67.221
(U)	Total Adjustments	8.645	29.715		
(U)	Congressional Program Reductions		-0.087		
	Congressional Rescissions		-0.798		
	Congressional Increases		30.600		
	Reprogrammings	9.415			
	SBIR/STTR Transfer	-0.770			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2181 Spacecraft Payloads	32.515	26.787	18.966	18.891	25.562	28.339	30.106	30.663	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	8.733	9.744	9.507	10.822
(U) In FY 2004: Demonstrated functional elements for general-purpose processor at 500 million instructions per second and digital signal processors at one million operations per second. Developed architectures and designed electronics circuits in support of adaptable, self-repairing processors and memories. Demonstrated functional elements of chalcogenide-based field programmable logic and analog microelectronics. Developed hardened-by-design primitive cell libraries enabling the use of state-of-the-art commercial manufacturing plants for high performance, low-cost digital and mixed signal electronics. Built MEMS and chalcogenide-based switches supporting multi-switch box applications to smart-wiring manifolds. Designed the functional hardened by design and architecture elements of the miniaturized military global positioning system receiver.				
(U) In FY 2005: Initiate the development of a general-purpose processor at 500 million instructions per second and digital signal processors at one million 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				

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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. Validate performance and environmental ruggedness of the miniaturized military global positioning system (GPS) receiver through initial logic block engineering model.

(U) In FY 2006: Develop and validate the building blocks for a general-purpose processor at 500 million instructions per second and digital signal processors at one million operations per second. Provide the set of design tools for integrating hardening by design into commercial design tools. Fabricate a 16 megabyte chalcogenide-based nonvolatile memory. Fabricate the first design hardened structured application specific integrated circuit (ASIC) to implement increased ASIC performance on low cost devices. Design and fabricate the initial test vehicle to demonstrate the miniaturized military GPS receiver performance on low-cost devices.

(U) In FY 2007: Complete engineering model of the high performance 500 million instruction per second general-purpose processor. Fabricate a high performance design hardened analog-to-digital converter (ADC) for use in space and fabricate a very low-power ADC using advanced design cells and design hardening. Fabricate the miniaturized military GPS receiver for use on terrestrial, aero, and space platforms. Fabricate the building blocks for a very high performance ten million-gate design hardened field programmable gate array.

(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.	2.803	2.783	2.607	2.685

(U) In FY 2004: Expanded the development of command, control, and navigational capability for high fidelity spacecraft proximity operations with application to counterspace operations. Completed development of automated planning and scheduling software for multiple satellites and the spacecraft and simulation data archiving and storage system. Expanded development of guidance, navigation, and control algorithms for proximity operations and large deployable systems. Developed initial command and telemetry simulation for mission operations center testing. Enhanced development of 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 counterspace operations. 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

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telemetry simulations, and begin mission ops center testing. Refine autonomous software technologies for responsive space systems. Design integrated distributed aperture sensor analysis tool for engineering level, mission/engagement and campaign level analyses, identifying modules required for implementing unique distributed aperture sensor features to be incorporated into existing modeling and simulation tools.

(U) In FY 2006: Validate command and control capabilities and guidance, navigation, and control algorithms for proximity operations with flight experiment data. Refine command, control, guidance, and navigational capabilities for counterspace to apply to space situational awareness and offensive/defensive operations. Complete command and telemetry simulation development for mission ops center testing. Complete integration of hardware-in-the-loop engineering development unit into testbed, interface with spacecraft command and telemetry simulations, and conduct mission ops center testing. Build unique distributed aperture sensor simulation modules for engineering level, mission/engagement and campaign level analysis tool.

(U) In FY 2007: Continue to refine command, control, guidance, and navigational capabilities for counterspace to apply to space situational awareness and offensive/defensive operations. Begin to integrate autonomous flight software technologies with command, control, guidance, and navigation technologies to support responsive space systems. Extend hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops center to development and testing of responsive and tactical space systems. Integrate modules and complete distributed aperture sensor analysis tool for engineering level, mission/engagement and campaign level analyses.

(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. Note: In FY 2006, reduction due to higher Air Force priorities.	0.965	0.923	0.692	1.199

(U) In FY 2004: Refined models for radio frequency (RF) system simulation to support systems engineering. Further developed models of RF signal processing. Refined simulation models of space-based surveillance systems for military utility analysis. Developed initial modeling, simulation, and analysis tools for technical assessment of space capability protection and access/mobility technologies. Developed first generation of 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 RF system simulation. Complete development of RF signal processing models. Expand development of simulations of space-based surveillance systems for

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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) In FY 2006: Further expand development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Initiate model development of responsive and reconfigurable technologies. Refine development of physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis for flight experiments in tactical and responsive satellites.

(U) In FY 2007: Complete development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Continue to develop models of responsive and reconfigurable technologies. Apply physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.

(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.	3.257	2.286	2.175	2.638

(U) In FY 2004: Characterized higher operating temperature, mid-wave infrared focal plane arrays (FPA). Completed fabrication and characterization of higher operating temperature, mid-wave infrared FPAs. Completed fabrication and characterization of first-ever dual band (mid-wave, long-wave) FPAs having an extended long-wave infrared response. Investigated radiation hardened-by-design (RHBD) development for long wavelength infrared FPAs for space-based passive surveillance applications. Explored 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 plan for insertion into a potential hyperspectral demonstration. Investigate detector array and cryogenic detector multiplexer interfacing concepts that lead to improved, larger-format, space hyperspectral imaging capabilities. Extend performance of single and dual color FPAs from moderate background levels to more stressing lower background levels needed for operation in space sensing.

(U) In FY 2006: Initiate assessment of large format Read Out Integrated Circuits, designed through RHBD, and fabricated on existing foundries. Investigate the readout and greater focal plane array performance enhancements needed for emerging detector array technologies.

(U) In FY 2007: Initiate studies for detectors and readouts needed for laser-based surveillance. Continue

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	investigation into readouts fabricated on existing foundries and radiation hard design principles.				
(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. Note: This work was terminated at the end of FY 2004 due to higher priorities.	1.430	0.000	0.000	0.000
(U)	In FY 2004: Delivered flight-ready multi-beam, wide-bandwidth antenna modules for airborne multi-mode flight experiment. Redesigned baseline antenna module tiles using advanced substrate material to reduce antenna module weight by 25%. Developed and demonstrated ten milliwatt advanced low power, octave-wide bandwidth, low noise amplifier. Applied Application Specific Integrated Circuit technology to achieve a higher level of integration for the transmit-receive cells, reducing discrete components by 25%. Redesigned antenna tile architecture to incorporate next generation miniaturized phased array components to support eight simultaneous beams. Designed multi-decade-bandwidth antenna architecture.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop technologies for multi-access laser communications space terminals with reduced weight, power, and cost for transformational communications. Note: In FY 2004, there was an increased emphasis on laser communications space terminal development.	10.709	1.846	2.124	1.334
(U)	In FY 2004: Investigated component integration issues and identified technical challenges for potential space experiments of multi-access laser communications systems. Developed initial ground breadboard testbed. Completed 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)	In FY 2006: Start development of components toward space-qualification and brassboard integration. Continue development of multi-access laser communications terminal brassboard. Start testing of components/system in relevant environmental.				
(U)	In FY 2007: Finalize brassboard integration. Begin identification and design of suitable space experiments. Begin development and qualification testing of flight hardware.				
(U)					
(U)	MAJOR THRUST: Develop satellite payload subsystem technologies to exhibit revolutionary	1.982	0.000	0.000	0.000

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	capabilities in operability, responsiveness, and cost-effectiveness. Note: In FY 2005, this effort has been moved to Project 682J.				
(U)	In FY 2004: Developed 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop spectral/polarimetric sensing and data exploitation demonstrations for military imaging and remote sensing applications. Note: In FY 2005, advanced efforts from PE 0602601F, Space Technology.	0.000	0.185	1.861	0.213
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop concepts for electro-optical/infrared spectral polarimetric space demonstrations. Examine hardware issues and begin technology development plan. Begin development of polarimetric FPA technology.				
(U)	In FY 2006: Complete polarimetric FPA test article and validate performance. Integrate FPA into laboratory camera and collect high quality data in the laboratory of relevant materials.				
(U)	In FY 2007: Conduct field collection with polarimetric focal plane camera. Demonstrate feasibility of hardware design for transition to acquisition system.				
(U)					
(U)	CONGRESSIONAL ADD: Alternating Current (AC) Coupled Interconnect.	1.172	0.991	0.000	0.000
(U)	In FY 2004: Using previously established and proven principles, provided a system level demonstration of a non-conductive interconnection technology, in a form suitable for transfer to industry. Built 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: Demonstrate the ability of an AC-coupled interconnect approach to be used in connecting two different parts of a complex system (i.e., third-level packaging.) Under this assumption, optimize the design of the interconnect to maximize signal transport efficiency and minimize the bit error rate due to misalignment and multiple mating cycles.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Magnetoresistive Random Access Memory (MRAM) Innovative	1.464	1.189	0.000	0.000

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	Communications Materials.				
(U)	In FY 2004: Developed and characterized 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 memory for embedded and reconfigurable spacecraft computing systems.				
(U)	In FY 2005: Integrate MRAM cells, which are intrinsically radiation-hard, with RHBD microelectronics, leading to embedded memories for spacecraft systems that are more immune to single event upset effects from high energy particles. Support an unlimited number of read-write cycles with ten nanoseconds access time, while consuming less than a nonowatt per bit.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Life Cycle Cost (LCC)/Risk Model for Space Concept Development.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Incorporate Space concept cost modeling processes and methodologies into a software modeling and simulation code, the Advanced LCC/Risk Estimating Tool, which will then be incorporated into an existing modeling and simulation tool to provide integrated design, analysis, and LCC/risk estimating.				
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Systematic Hierarchical Approach to Radiation Hardened Electronics.	0.000	1.487	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop RHBD process design kits (PDKs). PDKs are targeted at commercial, on-shore integrated circuit (IC) fabrication processes. Verify proper operation of PDKs against RHBD ICs generated for DoD space applications such as GPS receiver ICs. Fabricate and characterize radiation response of RHBD IC test chips and validate radiation characterization data versus simulated results. Provide standardized PDKs for the design phase of radiation hardened ICs. Provide accelerated potential for qualified, automated generation of hardened ICs during production phase.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Radiation Hardening Microelectronics.	0.000	1.388	0.000	0.000
(U)	In FY 2004: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **2181 Spacecraft Payloads**

(U)	In FY 2005: Develop and demonstrate next-generation electronics technology for DoD space systems applications using both design and process hardening techniques. Show that an emerging commercial electronics design can be rapidly transitioned to DoD space applications by taking advantage of the improved hardened fabrication industrial infrastructure and by modifying the design to harden against both natural and man-made radiation. Demonstrate sizes as low as 0.15 microns.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADDS: Intelligence Free Space Optical Communications and Intelligent Free Space Optical Satellite Communications Node.	0.000	2.974	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop engineering model intra-satellite fiber optic communications network components, high speed, multi-channel, gimble-less inter-satellite free space optical communications transceivers, and intelligent/adaptive intra-satellite switching and routing components with initial space pre-qualification testing.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	32.515	26.787	18.966	18.891

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads

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

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.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	0603401F Advanced Spacecraft Technology	3834 Integrated Space Technology Demonstrations

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3834	Integrated Space Technology Demonstrations	30.160	23.376	21.958	26.272	29.101	32.266	35.480	36.138	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop microsatellite (10-100Kg) technologies for integrated, robust, flexible, microsatellite demonstrations building on previous work and leveraging investments by other organizations. Applications include space-based space situational awareness and/or tactical satellite concepts.	21.861	18.420	21.958	26.272

(U) In FY 2004: Developed and tested a laser range finder subsystem. Developed and tested the ground control system for real-time planning and flight operations of proximity operations microsatellite. Tested autonomous operations software against simulated faults and anomalies. Completed system level integration of microsatellite and completed functional testing. Performed environmental testing and launch vehicle integration preparation and planning. Integrated ground control system and satellite software simulations. Performed 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 environmental testing. Complete development of autonomous proximity operations microsatellites ground control interface system. Perform real-time hardware-in-the-loop and software-in-the-loop mission experiments and testing beyond spacecraft envelope. Complete satellite/launch vehicle integration and launch. Perform mission operations around several 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) In FY 2006: Complete autonomous flight demonstration. Perform de-orbit maneuver. Complete satellite design(s). Initiate procurement of bus and payload hardware. Begin fabrication of payload and bus. Develop and test ground control system for real-time planning of flight operations of situational

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **3834 Integrated Space Technology Demonstrations**

	awareness missions. Develop and test flight software. Perform simulated missions against simulated faults and anomalies.				
(U)	In FY 2007: Complete payload and bus fabrication. Perform functional and environmental tests of payload and bus. Complete system level integration of payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with launch vehicle. Integrate ground control system and satellite software simulations. Perform simulated mission operations for missions operations training.				
(U)					
(U)	CONGRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch Vehicle Technology.	2.050	0.000	0.000	0.000
(U)	In FY 2004: Fabricated and tested 30,000 pound thrust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30,000 pound, 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET).	1.660	0.991	0.000	0.000
(U)	In FY 2004: Expanded 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: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Vehicle Risk Reduction.	4.589	3.965	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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) In FY 2004: Validated the cost and performance of a rocket engine module used in the RSLV main propulsion system. Validated cost, mass properties, and structural performance of the RSLV segmented tanks through hardware fabrication and destructive testing. Demonstrated integrated operation of a segmented pair through ground hot fire testing.

(U) In FY 2005: Complete fabrication of all tank body component and assembly tools, fabrication of all tank body sections, fabrication of the structural test fixture, structural testing of the bodies, and fabrication of the tank dome component tools. Initiate completion of fabrication of both the remaining tank assembly tools and the remaining tanks.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	30.160	23.376	21.958	26.272

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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) <u>D. Acquisition Strategy</u>

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4400 Space Systems Protection	6.534	6.913	3.310	3.410	3.457	3.747	4.117	4.193	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 RF 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Use multi-threat assessment tools to assess space-based electro-optical, communication, and other responses to various candidate RF and laser countermeasures and directed energy threats.	0.977	1.002	0.889	0.935
(U) In FY 2004: Enhanced existing satellite subsystem response data collection through laboratory test beds of satellite electro-optical sensor effects. Assessed electro-optical designs of planned space systems for RF and laser susceptibility and potential mitigation techniques. Assessed directed energy threat susceptibility and potential for mitigation techniques for key satellite subsystems, such as communications.				
(U) In FY 2005: Investigate models for RF 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) In FY 2006: Perform predicative analysis of laboratory data to validate models being developed for the satellite constellation analysis tool. Begin modeling of mitigation techniques and incorporate into constellation analysis tool.				
(U) In FY 2007: Verify mitigation models against test data and commence predictive analysis of technique effectiveness.				
(U)				
(U) MAJOR THRUST: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites.	1.355	2.006	2.043	2.076
(U) In FY 2004: Completed plasma shield design and define potential system applications. Refined selected design trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Investigated mitigation technologies such as deployable shields and triggered automatic gain control for RF threats.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **4400 Space Systems Protection**

(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)	In FY 2006: Develop prospective threat technologies and initiate comprehensive testing for space application.				
(U)	In FY 2007: Integrate protection into space experiment for demonstration and validation.				
(U)					
(U)	MAJOR THRUST: Develop visible and near-infrared laser protection technologies.	0.785	0.435	0.378	0.399
(U)	In FY 2004: Investigated image interpretation processing techniques, Image Quality Measurement verse the National Image Interpretation System. Performed calibration of laser laboratory systems. Performed analysis of Thompson array testing in laser laboratory. Enhanced investigation of laser interference effects on readout electronics for new Kodak focal plane array sensor subsystem components.				
(U)	In FY 2005: 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 or other developed limiters to deflect incoming laser energy from the focal plane array.				
(U)	In FY 2006: 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. Coordinate space simulation testing of prospective protection technology.				
(U)	In FY 2007: Coordinate space demonstration of protective technology. Identify technology transfer opportunities and report findings to major commands.				
(U)					
(U)	CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection.	3.417	3.470	0.000	0.000
(U)	In FY 2004: Examined, evaluated, and summarized 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. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Completed Version 1 of the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toolkit framework.				
(U)	In FY 2005: Continue evaluation of possible protection techniques that are acceptable to systems designers with a goal of minimum impact of additional weight and power, integration issues, and performance loss. Maintain relationship with commercial systems designers to explore acceptable				

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603401F Advanced Spacecraft Technology**	**4400 Space Systems Protection**

approaches for application to commercial systems. Expand laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Develop promising protection techniques emerging from FY 2004 effort. Begin development of field tests of the most promising protection techniques. Incorporate test results and feed back from commercial systems designers into the Satellite Survivability Module code.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)	Total Cost	6.534	6.913	3.310	3.410

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602102F, Materials.										
(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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5021 Space Systems Survivability	3.992	4.733	4.583	4.769	4.830	5.239	5.350	5.449	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	2.538	3.263	3.261	3.643
(U) In FY 2004: Validated solar disturbance forecast algorithms derived from all-sky heliospheric imager. Designed instrument and data plan for joint-agency mission to map the high-intensity region of the radiation belt that limits choices for spacecraft orbits. Expanded space weather forecasting system conceptual design to include interplanetary in situ plasma and magnetic field sensors in addition to miniaturized white-light camera. Developed 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 initial all-sky image based solar disturbance forecast algorithms and transition to military/civilian operational forecasters. Continue development of relativistic particle sensor for Air Force radiation belt mapping satellite. Investigate joint-agency 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) In FY 2006: Calibrate and integrate relativistic particle sensor onto Air Force radiation belt mapping satellite. Complete concept design for joint-agency space-based coronagraph and heliospheric imager for next-generation solar hazard detection system. Initiate concept design of micro- and nano-technology sensors for energetic particle, neutral density, low-energy plasma space weather characterization.				
(U) In FY 2007: Complete integration of relativistic particle sensor onto Air Force radiation belt mapping satellite. Identify space test opportunity and begin construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Complete concept design of next-generation miniaturized				

	space weather sensors and begin development of engineering models.				
(U)					
(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.	0.481	0.349	0.358	0.367
(U)	In FY 2004: Enhanced testing of miniaturized charge control system and began design of space experiment for the hazardous geosynchronous environment. Developed a space experiment concept to validate on-orbit electrical power generation and particle scattering capabilities of space tether. Developed 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. Investigated 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: Complete design and laboratory testing of miniaturized geosynchronous charge control system and explore options for on-orbit demonstration of hazard mitigation. Refine space tether experiment concept and finalize space hardware requirements. 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)	In FY 2006: Develop space plasma control experiment plan combining satellite charge control and tether propulsion and particle remediation concepts. Begin integration of dynamic space particle climatology and radiation belt forecast models into spacecraft environment effect tool suite. Continue fabrication of payload to demonstrate radiation belt remediation technologies using electromagnetic wave technologies.				
(U)	In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for spaceflight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Complete radiation belt remediation payload and begin calibration and integration onto Air Force test satellite.				
(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.	0.973	1.121	0.964	0.759
(U)	In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5021 Space Systems Survivability**

development. Refined 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 of sensor inputs to improve accuracy and timeliness. Complete laboratory demonstrations of distributed space hazard sensors needed for space situational awareness. Complete design of active wave experiment to remediate severe radiation environments. Plan for space test flight of active wave and distributed sensor technologies.

(U) In FY 2006: Develop filter-based optimization algorithms to determine full particle energy spectra utilizing complete inputs available from compact environment anomaly sensor. Determine impact sensor design and finalize requirements and conceptual design of radiation, plasma, chemical, and impact effect distributed anomaly resolution and spacecraft effects sensor suite. Complete construction of compact environment anomaly sensor to diagnose severe radiation environments expected during active wave radiation belt remediation experiment.

(U) In FY 2007: Employ full energy spectra algorithms to convert entire compact environment anomaly sensor data bases into dynamic climatological model for anomaly resolution and space system design. Commence construction of hardware for space demonstration of the distributed anomaly resolution sensor. Calibrate and integrate compact environment anomaly sensor for diagnosing severe radiation environment on Air Force test satellite.

(U)	Total Cost	3.992	4.733	4.583	4.769

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5083 Ballistic Missiles Technology	6.274	6.798	5.491	3.859	3.928	4.248	4.327	4.397	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

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

This project 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 2004	FY 2005	FY 2006	FY 2007
(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.	3.137	3.399	2.746	1.930
(U) In FY 2004: Evaluated the most promising navigation instrumentation technologies and integrated 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) In FY 2006: Explore further laboratory proof-of-concept of the most promising next generation missile navigation instrumentation designs. Initiate fabrication of navigation instruments and engineering demonstration units. Initiate engineering development tests. Evaluate instrument performance and provide improvements to meet established performance goals.				
(U) In FY 2007: Develop and integrate engineering design next generation missile navigation systems and ground test in environments relevant to subsequent flight test conditions. Evaluate system performance and provide improvements to meet established performance goals. Initiate flight test demonstration planning.				
(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.	3.137	3.399	2.745	1.929
(U) In FY 2004: Integrated advanced thermal materials into long-glide vehicles to provide greater controllability and selective targeting. Demonstrated lower-cost, robust leading edge, and control surface				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5083 Ballistic Missiles Technology**

materials in a test flight to validate improved properties for future vehicle designs. Demonstrated that robust on-board navigation instruments and range safety devices can withstand loads greater than 100 times the gravitational force in all axes in laboratory tests.

(U) In FY 2005: Complete advanced thermal materials design integrated with long-glide vehicles to provide greater controllability and selective targeting. Evaluate demonstration results of advanced leading edge and control surface 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 on-board navigation instruments and range safety devices to withstand loads greater than 100 tiems the gravitational force in all axes in flight test demonstrations.

(U) In FY 2006: Initiate long-term plan for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Characterize instrumentation performance in quiescent environments. Initiate system level design interfaces with experimental test bed.

(U) In FY 2007: Continue long-term planning and initiate long-lead hardware acquisition and coordination with test facilities in preparation for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Measure performance of navigation instrumentation and range safety devices with associated platform hardware, power sources, support software, and communication interfaces in 100 times the gravitational force flight-like vibration environments. Continue system level design interfaces experimental test bed.

(U)	Total Cost	6.274	6.798	5.491	3.859

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5083 Ballistic Missiles Technology**

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

(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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
682J Spacecraft Vehicles	26.082	21.232	6.607	10.020	11.858	10.281	13.065	13.301	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Developed and evaluated 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.	2.655	2.146	1.606	2.238
(U) In FY 2004: Demonstrated integration methods for thin-film solar cells on polymer substrates into full arrays. Completed full space qualification testing of 28% efficient solar cells. Integrated 28% efficient lattice mismatch multi-junction solar cells into test coupons.				
(U) In FY 2005: Demonstrate methods for interconnecting thin-film solar modules into array-sized thin-film blankets. Develop balloon-flight calibration samples for lattice mismatch solar cells.				
(U) In FY 2006: Complete space environmental testing of thin-film solar cells and modules. Perform radiation testing of lattice mismatch multi-junction solar cells.				
(U) In FY 2007: Perform radiation testing of five to six junction solar cells. Construct flight hardware for thin-film solar array. Demonstrate roll-to-roll production of thin-film solar cells on polymer substrates.				
(U)				
(U) MAJOR THRUST: Develop technologies for long life, efficient, low-vibration, lightweight mechanical cryocoolers and integration components for space applications.	1.633	1.263	1.046	1.470
(U) In FY 2004: Investigated development of high capacity, multi-stage, low temperature cryocooler system. Developed and characterized performance of second-generation designs model high capacity ten Kelvin cryocooler for advanced space surveillance and tracking sensor. Explored development of component cryocooler technologies for regenerative and recuperative cycle devices to transition enabling technology to cryocooler designs..				
(U) In FY 2005: Refine 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				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

	recuperative cycle devices to transition enabling technology to cryocooler designs. Demonstrate cryogenic integration technologies, including thermal switches, in a relevant environment.				
(U)	In FY 2006: Complete development of low temperature flight qualified high capacity cryocooler and demonstrate performance of cryocooler and control electronics integrated with focal plane in a relevant environment. Improve performance of key critical components including compressor, electronics, and heat exchangers.				
(U)	In FY 2007: Assess various advanced technologies such as micro-electro-mechanical, optical cooling, and other concepts to further reduce cryocooler mass and improve performance for space based situational awareness applications. Initiate advanced concept development program to support multi-temperature and large focal plane cooling requirements for space-based space surveillance and other mission applications.				
(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.	5.212	2.335	1.973	3.327
(U)	In FY 2004: Refined spacecraft to demonstrate multi-functional structures technologies. Completed fabrication of multi-functional spacecraft bus components for small satellites. Flight qualified full-scale Evolved Expendable Launch Vehicle secondary payload adapter. Explored the design and characterized linerless composite cryogenic tanks. Developed large deployable optics structures using nanotechnology-enhanced materials.				
(U)	In FY 2005: Further refine spacecraft to demonstrate multi-functional structures technologies. Ground demonstrate sub-scale linerless composite cryogenic tanks. Fabricate and characterize components for large deployable optics systems using nanotechnology-enhanced materials.				
(U)	In FY 2006: Develop ultra-lightweight, high-structural efficiency mirror support structures for space mirrors. Demonstrate qualification-level performance of all-composite payload adapters and fairing structures for Evolved Expendable Launch Vehicles.				
(U)	In FY 2007: Demonstrate space qualification-level performance for large diameter launch vehicle fairing. Transition multi-functional structures technology to unmanned aerial vehicle and launch vehicle community. Demonstrate space qualification-level performance for 25-meters long ultralightweight deployable structures.				
(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.	5.841	2.602	1.982	2.985
(U)	In FY 2004: Refined launch vibration isolation and primary and secondary payload isolation systems to				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

	meet specific launch vehicle requirements. Flight demonstrated operational active acoustic attenuation systems. Flight demonstrated low-shock multiple payload adapter technologies. Built deployment and isolation mechanisms for large free-flying solar array and integrated with thin film solar cell components. Designed flight hardware to demonstrate smart docking and deployment mechanisms. Developed micro-electro-mechanical attitude control components.				
(U)	In FY 2005: 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. Integrate micro-electro-mechanical attitude control components with conventional attitude control systems.				
(U)	In FY 2006: Develop rapid-slew, fast tracking gimbal technology to allow sub-orbital space situational awareness missions. Demonstrate space qualification-level performance for miniaturized vibration isolation systems for optical payloads.				
(U)	In FY 2007: Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Demonstrate space qualification-level performance for passive vibro-acoustic damping devices to mitigate launch vehicle acoustic loads. Flight demonstrate on-orbit docking and fluid transfer mechanisms.				
(U)					
(U)	CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays.	4.590	7.434	0.000	0.000
(U)	In FY 2004: Developed monolithic integration technology for the low-cost interconnection of thin film amorphous silicon solar cells. Developed lightweight solar array support structures and deployment mechanisms enabled by the thin film solar cells. Demonstrated the reproducible manufacture of large-area amorphous silicon cells necessary for population of the thin film solar arrays.				
(U)	In FY 2005: Demonstrate monolithic integration of amorphous silicon solar cells in roll-to-roll processing. Demonstrate process capable of high volume, roll-to-roll production of amorphous silicon solar cells on polymer substrates.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures.	2.734	4.461	0.000	0.000
(U)	In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined 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: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

	supporting Small Business Innovation Research contracts for new structure fabrication processes and fairing/adapter configurations. Demonstrate large scale out-of-autoclave component fabrications. Investigate influence on practical controlled flaws and performance. Test structures to failure to demonstrate degree of conservatism in current design practices. Fairing designs up to ten meters in diameter to support large optics experiments will be considered for this demonstration program.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Boron Energy Cell Development.	3.417	0.991	0.000	0.000
(U)	In FY 2004: Increased energy conversion efficiency of the Boron Energy Cell, which converts radioisotope beta emissions into electric current. Quantified mission impacts for Department of Defense applications.				
(U)	In FY 2005: Integrate Boron Energy Cell with battery and capacitor storage device to provide Boron Energy Cell Storage Packs capable of supplying burst power for selected high value Air Force applications.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	26.082	21.232	6.607	10.020

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

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

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 2005**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603444F MAUI SPACE SURVEILLANCE SYSTEM

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD
4868	Maui Space Surveillance System	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds space situational awareness technology development and demonstration at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2005, Congress added $33.9 million for the MSSS, $8.5 million for High Accuracy Network Determination System, and $10.0 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	51.581	6.306	6.323	6.405
(U)	Current PBR/President's Budget	50.208	58.189	5.848	6.005
(U)	Total Adjustments	-1.373	51.883		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.517		
	Congressional Increases		52.400		
	Reprogrammings	-0.107			
	SBIR/STTR Transfer	-1.266			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
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**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4868 Maui Space Surveillance System	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds space situational awareness technology development and demonstration at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2005, Congress added $33.9 million for the MSSS, $8.5 million for High Accuracy Network Determination System, and $10.0 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate space situational awareness technology at the MSSS in Hawaii, as well as operate and upgrade the facility.	32.142	39.852	5.848	6.005

(U) In FY 2004: Enhanced MSSS 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. Provided automatic frame selection for daylight imagery that is post-processed using advanced algorithms for increased timeliness. Implemented data dissemination architecture with secure, near-real-time, web-based connectivity for release of MSSS sensor information. Conducted technology development efforts using active laser illumination including high precision range rate data collection and demonstrated high precision laser pointing to increase measurement accuracy. Characterized and upgraded the adaptive optics system by implementing a tracker upgrade to improve sensitivity and implement diagnostic software capabilities improving resolution. Refurbished MSSS sensors such as the radiometer, long-wave imager, spectrograph, and daylight acquisition sensor for increased sensitivity and resolution. 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 2005: Enhance MSSS 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. Research current and new, advanced technologies for improving active track of satellite and missile tests. Refine active imaging technology along with adaptive optics and image post-processing algorithms as well as techniques to assess when further processing is no longer productive. Pursue non-imaging space object identification techniques to

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	determine how shape and size information can be extracted from non-imaging signature information.				
(U)	In FY 2006: Continue MSSS operations, research, and development supporting various operational customers and experimenters. Procure additional critical sensor and telescope spares, continue to refurbish the control rooms and upgrade computers for increased efficiency, while maintaining requirements for safety and security in accordance with Air Force regulations.				
(U)	In FY 2007: Continue MSSS operations, research, and development supporting various operational customers and experimenters. Continue refurbishing and upgrading MSSS, 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)	9.854	9.912	0.000	0.000
(U)	In FY 2004: Completed preliminary design review and began development for telescope system to include: 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. Designed and developed data archiving to support future data collection.				
(U)	In FY 2005: Perform site selection and ground-breaking activities. Fabricate and assemble first PanSTARRS telescope which will be located on Haleakala, HI. Investigate satellite streak issue for dim object detections. Evaluate the PanSTARRS system for its military utility and complete development of focal plane arrays for use in the 4-telescope system.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: High Accuracy Network Determination System (HANDS).	8.212	8.425	0.000	0.000
(U)	In FY 2004: Deployed additional HANDS sensors in areas of high interest in the Space Surveillance Network and studied use of system for detecting and tracking objects in low-earth orbit. Developed large field of view acquisition telescope.				
(U)	In FY 2005: Deploy additional HANDS sensors, both narrow field of view and wide field of view, to expand global coverage of the geosynchronous earth orbit belt, advancing state-of-the-art space situation awareness technology. Continue development in the areas of improving satellite metrics accuracy, low earth orbit sensors, and meter-class sensors.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	50.208	58.189	5.848	6.005

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602605F, Directed Energy Technology.										
(U) PE 0603605F, Advanced Weapons Technology.										
(U) 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 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	58.192	56.908	53.437	68.586	69.507	72.502	77.919	82.779	Continuing	TBD
5031	Advanced Optics & Laser Space Tech	18.144	18.989	20.871	21.168	22.183	22.046	28.188	28.707	Continuing	TBD
5032	Advanced Space Materials	10.030	0.000	0.000	5.058	4.575	3.274	3.338	3.395	Continuing	TBD
5033	Rocket Propulsion Demonstration	21.161	28.484	25.347	27.543	29.159	33.880	37.992	39.159	Continuing	TBD
5034	Advanced Space Sensors	6.112	9.435	7.219	12.049	12.767	12.843	7.915	8.058	Continuing	TBD
5062	Advanced Structures for Space Vehicles	2.745	0.000	0.000	2.768	0.823	0.459	0.486	3.460	Continuing	TBD

Note: In FY 2005, efforts in Projects 5032 and 5062 will be delayed until FY 2007 due to higher Air Force priorities.

(U) A. Mission Description and Budget Item Justification

This program develops and demonstrates multi-disciplinary space technologies focusing on separate technology areas including: 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; and 5) advanced structures for space vehicles develop space unique requirements for a horizontally launched transatmospheric vehicle operating in an extreme environment. In FY 2005, Congress added $3.0 million for Streaker - Small Launch Vehicle and $3.3 million for Vortex Cold Wall Low Cost Rocket Engines to PE 0603401F, Advanced Space Technology; the Air Force has requested these funds be moved to this PE. 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 2005
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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	62.077	51.114	59.564	76.337
(U)	Current PBR/President's Budget	58.192	56.908	53.437	68.586
(U)	Total Adjustments	-3.885	5.794		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.506		
	Congressional Increases		6.300		
	Reprogrammings	-1.684			
	SBIR/STTR Transfer	-2.201			

(U) Significant Program Changes:
Not Applicable.

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5031	Advanced Optics & Laser Space Tech	18.144	18.989	20.871	21.168	22.183	22.046	28.188	28.707	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project provides for the demonstration and detailed assessment of space unique technologies needed for advanced optical systems and high-energy laser weapons.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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.	4.828	3.638	3.051	1.801
(U) In FY 2004: Developed laser relay mirror concepts and designed technology demonstrations to advance global strike, global presence, and ballistic missile defense capabilities for the warfighter. Further developed modeling and simulation tools for relay mirrors.				
(U) In FY 2005: Demonstrate dual line-of-sight tracking technology by tracking a satellite with a relay mirror. Complete the construction of and test the optical quality of a two kilogram per square meter ultra-lightweight mirror.				
(U) In FY 2006: Plan a demonstration to actively track a cruise missile by relaying both the illuminator and the scoring beam through the relay and differentially pointing them at the output. Demonstrate the ability to apply advanced high energy laser (HEL) optical coatings on a three-meter diameter substrate such as lightweight SiC primary mirrors. Design and build a lightweight mirror/micro electro-mechanical system integration test bed for the evaluation of advanced optical components.				
(U) In FY 2007: Begin investigations in support of a high power demonstration to kill a missile through a relay mirror. Apply a dielectric coating on and test an HEL, meter-class, SiC primary mirror. Complete the closed-loop performance of selected advanced wavefront control devices for imaging and beam control from space.				
(U)				
(U) MAJOR THRUST: Perform atmospheric compensation/beam control experiments for applications including antisatellite weapons, relay mirror systems, satellite tests and diagnostics, and high-resolution satellite imaging.	3.948	4.577	4.929	5.074
(U) In FY 2004: Completed integration and began testing of sodium-beacon laser on Starfire Optical Range (SOR) 3.5 meter telescope. This will enable full aperture point-ahead atmospheric compensation for low-power laser projection to satellites on weapons-class beam director.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2005: Complete integration and begin testing of sodium-beacon adaptive optics system including compensated infrared imaging of low earth orbit (LEO) satellites.				
(U)	In FY 2006: Begin testing of advanced laser-beacon adaptive optics system on SOR 3.5 meter telescope to increase imaging resolution/laser beam control. Perform high-resolution satellite imaging at short wavelengths. Demonstrate and characterize performance of point-ahead compensated laser propagation to LEO satellites using sodium-beacon adaptive optics.				
(U)	In FY 2007: Demonstrate fully compensated laser propagation to LEO satellites; measure beam profile and intensity on target. Begin development of precision aimpoint stabilization through turbulence.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate optical technologies for high bandwidth ground-to-air communications.	9.368	0.000	0.000	0.000
(U)	In FY 2004: Developed advanced modular deformable mirrors and adaptive optical control systems. Developed advanced optical filters, infrared sensors, and signal processing systems. Began design of communications breadboard for automated ground stations.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate advanced optical beam control technologies for laser propagation through severe and/or extended atmospheric turbulence.	0.000	10.774	12.891	14.293
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Begin fabrication of ground test equipment for field characterization of laser propagation through atmospheric turbulence. Begin development of advanced adaptive optical and tracking technologies for reliable operation in stressing atmospheric conditions.				
(U)	In FY 2006: Complete integration of first phase ground test system for characterization of laser propagation through atmospheric turbulence. Complete laboratory experiments and begin field testing of advanced adaptive optical and tracking technologies in stressing atmospheric conditions.				
(U)	In FY 2007: Begin integration of advanced ground test system for characterization of laser propagation through atmospheric turbulence. Demonstrate and characterize operation of advanced adaptive optical and tracking technologies for laser propagation to space targets in stressing atmospheric conditions.				
(U)	Total Cost	18.144	18.989	20.871	21.168

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5032 Advanced Space Materials	10.030	0.000	0.000	5.058	4.575	3.274	3.338	3.395	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: 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. Sub-scale 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 2004	FY 2005	FY 2006	FY 2007
(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.	10.030	0.000	0.000	5.058
(U) In FY 2004: Developed 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. Initiated materials and design concept study on durable reusable high-temperature protection systems for launch vehicles. Developed, characterized, and evaluated 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. Developed and assessed metallic materials (monolithic and composite) for space access structures and propulsion system components emphasizing increased operating temperature, environmental compatibility, and durability. Demonstrated 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. Developed analytical modeling tools to predict material behavior in cryogenic and hydrocarbon environments for air-breathing and rocket-based vehicles. Developed and assessed jamming and damage protection for sensors and payloads in space systems and initiate research for agile infrared filters.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Develop advanced materials approaches to provide durable, maintainable high-temperature				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

protection systems for leading edge applications on high-speed, reusable launch, and future reentry vehicle concepts. For management of the thermal and structural loads, combinations of candidate materials, including organic matrix composites, ceramics, metals, carbon foams, aerogels, heat pipes, and phase change materials, will be investigated. Develop advanced ceramic materials and processing technologies for load bearing structures designed for high-temperature, multi-cycle applications in an oxidizing environment. Develop rocket propulsion materials for liquid and solid rocket engine components and validate performance in scaled component demonstrations.

(U)	Total Cost	10.030	0.000	0.000	5.058

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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 duplication.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5033 Rocket Propulsion Demonstration	21.161	28.484	25.347	27.543	29.159	33.880	37.992	39.159	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 could improve the performance of expendable systems' payload capabilities by ~20 percent, and reduce launch, operations, and support costs by ~30 percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Technology advances could 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop liquid rocket propulsion technology for current and future space launch vehicles. Note: In FY 2007, increase in funding is due to greater emphasis on the upper stage technology efforts.	14.528	14.206	14.093	20.927
(U) In FY 2004: Completed integration of components for the Integrated Powerhead Demonstration of advanced, long life, hydrogen-based engine technologies.				
(U) In FY 2005: Complete Integrated Powerhead Demonstration test series. Begin scale-up of advanced lightweight thrust chamber and nozzle technologies. Start scale-up of advanced cryogenic upper stage technologies including higher efficiency energy conversion systems.				
(U) In FY 2006: Continue scale-up and begin testing of advanced lightweight thrust chamber and nozzle technologies. Continue scale-up of advanced cryogenic upper stage technologies including higher efficiency energy conversion systems.				
(U) In FY 2007: Complete testing of advanced lightweight thrust chamber and nozzle technologies. Continue scale-up of advanced cryogenic upper stage technologies including higher efficiency energy conversion systems.				
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	MAJOR THRUST: Develop solar electric propulsion technologies for existing and future upper stage, orbit transfer vehicles, and satellite formation flying, station keeping, and repositioning.	4.072	2.620	3.792	4.023
(U)	In FY 2004: Developed electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of low earth orbit (LEO) to geosynchronous earth orbit (GEO) transfer. Prepared for delivery of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration supporting improved capability for Air Force imaging requirements				
(U)	In FY 2005: Continue development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of LEO to GEO transfer. Begin component integration for a high-power Hall thruster demonstration. Complete delivery of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration.				
(U)	In FY 2006: Continue development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of LEO to GEO transfer. Continue component development for the high-power Hall thruster demonstration. Support test flight of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration.				
(U)	In FY 2007: Continue development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of LEO to GEO transfer. Begin component integration for the high-power Hall thruster demonstration. Complete support of test flight of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration. Initiate hardware scale-up for an advanced hybrid propulsion system for satellites.				
(U)					
(U)	MAJOR THRUST: Develop missile propulsion, aging, and surveillance technology for intercontinental ballistic missiles to include demonstration of missile propulsion technology and Post Boost Control Systems (PBCS). Note: Efforts complete in FY 2006.	1.413	4.528	6.615	0.000
(U)	In FY 2004: Fabricated final PBCS components for test and demonstration. Fabricated 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 PBCS demonstration and conduct test. Continue fabrication and begin integration and test for the interim strategic sustainment demonstration motors. Commence assessment and fabrication of the final strategic sustainment demonstration motors.				
(U)	In FY 2006: Complete fabrication of final components for the final strategic sustainment demonstration motors and prepare for test. Complete assessment and fabrication of the final strategic sustainment demonstration motors.				
(U)	In FY 2007: Not Applicable.				
(U)					

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	MAJOR THRUST: Develop electric and advanced chemical based monopropellant propulsion technologies for future satellite propulsion systems.	1.148	0.885	0.847	2.593
(U)	In FY 2004: Demonstrated pulsed plasma thruster. Completed development of propulsion system for Air Force small satellites. Developed advanced monopropellant and began vehicle propulsion ground demonstration.				
(U)	In FY 2005: Continue demonstration of pulsed plasma thruster. Continue development of advanced monopropellant and vehicle propulsion ground demonstration.				
(U)	In FY 2006: Continue demonstration of pulsed plasma thruster. Complete advanced monopropellant thruster demonstration.				
(U)	In FY 2007: Complete demonstration of pulsed plasma thruster. Initiate development of an advanced space storable bi-propellant engine.				
(U)					
(U)	CONGRESSIONAL ADD: Streaker - Small Launch Vehicle.	0.000	2.974	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop core boosters and payload interfaces for possible use in the small launch vehicle to be used for rapid and affordable deployment of small satellite payloads.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Vortex Cold Wall Low Cost Rocket Engines.	0.000	3.271	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Mature technologies for an advanced low-cost, low-weight, high-performance hydrocarbon vortex thrust chamber to integrate and test in flight-type engines.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	21.161	28.484	25.347	27.543

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) PE 0602102F, Materials.										
(U) PE 0602203F, Aerospace Propulsion.										
(U) PE 0602500F,										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

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 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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5034 Advanced Space Sensors	6.112	9.435	7.219	12.049	12.767	12.843	7.915	8.058	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates space sensor technologies, including radio frequency sensors; intelligence, surveillance, and reconnaissance sensors (ISR); 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 2004	FY 2005	FY 2006	FY 2007
(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. Note: Efforts complete in FY 2005.	0.306	0.193	0.000	0.000
(U) In FY 2004: Developed a forward predictive capability validated with empirical measurements. Performed chemical analyses of an expanded target set and continue developing an enhanced surface scattering model. Assessed environmental influences on spectral signatures.				
(U) In FY 2005: Complete 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(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.	0.965	2.341	2.234	1.321
(U) In FY 2004: Designed direction finding technologies to maximize navigation warfare exploitation techniques for enhanced offensive and defensive combat capabilities. Developed assured reference technologies to provide precise time, position, and velocity for on-board and off-board platform applications. Developed antenna wavefront simulation technology to assess anti-jam 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) In FY 2006: Design space-based distributed position, navigation, and time (PNT) technologies to				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	achieve optimal sensor fusion for a Common Operation Picture (COP). Design multi-ship virtual flight test simulation technology to assess networked clusters of "mini" unmanned aerial vehicles, ISR, and space-based platforms.				
(U)	In FY 2007: Develop space-based distributed PNT technologies to achieve optimal sensor fusion for a COP. Develop multi-ship virtual flight test simulation technology to assess networked clusters of "mini" unmanned aerial vehicles, ISR platforms, and space-based platforms.				
(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.	0.529	1.101	1.653	1.640
(U)	In FY 2004: Completed designs and initiated fabrication of false alarm package hardware for space flight. Coordinated on-orbit experimental testing. Developed initial concept for space-hardened geolocation, spectrometer, and processor modules. Developed breadboard for geolocation, spectrometer, and algorithm processor modules.				
(U)	In FY 2005: Initiate characterization of space-qualified false-alarm sensor modules. Fabricate and integrate space-qualified components for false-alarm sensor space flight engineering test units. Develop mechanical, electrical, and functional interfaces to a host satellite. Plan for on-orbit testing, data collection, and system evaluation. Downselect designs for space-qualified laser warning sensors for rapid detection and characterization of laser designators, trackers, dazzlers, and weapons.				
(U)	In FY 2006: Integrate false alarm package space-flight components onto space flight host. Continue planning and coordinating for on-orbit testing, data collection, and system evaluation. Develop risk-reduction technology for space-qualified laser warning sensors for rapid detection and characterization of laser designators, trackers, dazzlers, and weapons. Complete development of a space-based laser threat scenario testbed for satellite-as-a-sensor technology evaluations				
(U)	In FY 2007: Space flight of false alarm package space-flight components. Initiate on-orbit testing, data collection and system evaluation with false alarm phenomenology suite. Initiate fabrication of advanced space-qualified laser warning sensors for rapid detection and characterization of laser designators, trackers, dazzlers, and weapons. Initiate testing with space-based laser threat scenario testbed for satellite-as-a-sensor technology evaluations.				
(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).	4.312	5.800	3.000	5.000
(U)	In FY 2004: Integrated and tested electro-optical communication component technology into an airborne communication testbed, and evaluate performance with ground terminals under simulated				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

space-to-ground, low elevation angle path lengths. Defined requirements for laser communication channelization to develop multiple user access capability. Developed 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) In FY 2006: Continue development of an integrated electro-optical communication terminal for evaluation and testing of AISR links between an airborne communication testbed and ground terminals. Continue development of shared radio frequency/electro-optical apertures to service high bandwidth communication needs. Test applicability of shared apertures to maintaining air network link connectivity under in weather conditions. Install 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. Demonstrate a combined radio frequency/ optical communication air to air to ground high bandwidth network.

(U) In FY 2007: Begin development of an integrated wideband radio frequency/electro-optical communication terminal and shared aperture antenna for evaluation and testing in an air network layer. Continue development of technologies for shared radio frequency/electro-optical apertures to service high bandwidth communication needs. Continue testing applicability of shared apertures to maintaining air network link connectivity under in weather conditions. Expand flight demonstrations of air network layer technologies radio frequency, optical and combined radio frequency/optical communication terminals.

(U)

(U) MAJOR THRUST: Develop, demonstrate, and evaluate spectral-temporal sensing technologies for detection and identification of transient and moving targets for battlespace surveillance and space situational awareness. Note: In FY 2006, spectral sensing technology efforts from PE 0603203F, Advanced Aerospace Sensors, are extended to the space environment.	0.000	0.000	0.332	1.088

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

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**

(U) In FY 2006: Design a testbed sensor to evaluate the performance potential of spectral-temporal sensing for battlespace surveillance missions. Model expected performance for a variety of targets, including muzzle flashes, artillery and tank fire, and battlefield explosions

(U) In FY 2007: Finalize design of a testbed sensor to evaluate the performance potential of spectral-temporal sensing for battlespace surveillance missions and begin sensor system fabrication. Perform supporting laboratory and field experiments, as necessary, and develop a performance characterization plan.

(U)

(U)	MAJOR THRUST: Reduce technology risk for space sensor platform payload components and exploitation of infrastructure integration. Note: In FY 2007, spectral platform and integration efforts from PE 0603203F, Advanced Aerospace Sensors, are extended to the space environment.	0.000	0.000	0.000	3.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Initiate integration of space-sensor technologies into a complete payload simulation test bed with selected hardware in the loop and demonstrate system design feasibility.				
(U)	Total Cost	6.112	9.435	7.219	12.049

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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 Reliance process to harmonize efforts and										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)**

eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5062	Advanced Structures for Space Vehicles	2.745	0.000	0.000	2.768	0.823	0.459	0.486	3.460	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: 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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST: Develop the airframe and payload technologies required to enable horizontal launch of reusable high altitude aerospace vehicles.	2.745	0.000	0.000	2.768
(U)	In FY 2004: Further 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.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: 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)	Total Cost	2.745	0.000	0.000	2.768

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	PE 0602500F, Multi-Disciplinary Space Technology.										
(U)	This project has been coordinated through the										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)**

Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603601F Conventional Weapons Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	35.441	27.255	18.660	19.094	19.922	21.294	21.485	21.584	Continuing	TBD
670A	Conventional Weapons Development	20.275	18.759	18.660	19.094	19.922	21.294	21.485	21.584	Continuing	TBD
670B	Guidance Technology	15.166	8.496	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2005, the funding was reduced as the Low-Cost Autonomous Attack System (LOCAAS) Advanced Technology Demonstration (ATD) transitioned from the initial powered flight test phase of the ATD to the second phase of the ATD. In FY 2006, the efforts covered under Project 670B were moved to Project 670A.

(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 development of conventional ordnance technologies including warheads, fuzes, and explosives; and development of advanced guidance technologies including seekers, navigation and control, and guidance. Note: In FY 2005, Congress added $1.0 million for High Speed Strike Weapon; $3.0 million for BLU-109 Bunker Buster - Heavy; and $1.1 million for Fuze Air-to-Surface Technology. This program is in the 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	37.198	22.398	22.594	23.024
(U)	Current PBR/President's Budget	35.441	27.255	18.660	19.094
(U)	Total Adjustments	-1.757	4.857		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.243		
	Congressional Increases		5.100		
	Reprogrammings	-0.731			
	SBIR/STTR Transfer	-1.026			

(U) Significant Program Changes:
Not Applicable.

C. Performance Metrics
(U) Under Development.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603601F Conventional Weapons Technology**	**670A Conventional Weapons Development**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
670A	Conventional Weapons Development	20.275	18.759	18.660	19.094	19.922	21.294	21.485	21.584	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

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

This project develops, demonstrates, and integrates ordnance and affordable, autonomous, and adverse weather resistant guidance technologies for enhancing the effectiveness of air-launched conventional weapons delivered from manned and unmanned aerospace vehicles. The project develops conventional ordnance including warheads, fuzes, explosives, carriage and release, munition integration technologies, terminal seekers, midcourse navigation sensors for stand off delivery weapons, and target detection and identification processing algorithms for reducing target location error to improve target kill probability. This project improves the capability for conventional munitions supporting an Air Expeditionary Force.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(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. Note: In FY 2007, funding will be reduced as fuze efforts go to a single demonstration.	7.108	5.350	4.062	2.119
(U)	In FY 2004: Completed cooperative program with the United Kingdom to ground test an integrated fuze, an improved target detection device, and a directional warhead package. Enhanced 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. Began designing a hard target influence fuze capable of denying hard and deeply buried facilities access.				
(U)	In FY 2005: Complete 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)	In FY 2006: Continue designing a hard target influence fuze capable of denying hard and deeply buried facilities access. Begin developing fuzes that can transmit bomb damage information to an aircraft platform.				
(U)	In FY 2007: Continue designing a hard target influence fuze capable of denying hard and deeply buried facilities access. Complete developing fuzes that can transmit bomb damage information to an aircraft platform.				
(U)					

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Conventional Weapons Development**

(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 load-outs and improve sortie effectiveness for current and future strike aircraft, while reducing munition airlift requirements.	2.349	3.301	3.000	2.000
(U)	In FY 2004: Completed initial design that integrated components and technologies for a weapon that can neutralize hardened chemical and biological warfare facilities. Developed an initial concept to demonstrate a multi-mode ordnance package effective against a broad range of unhardened ground targets.				
(U)	In FY 2005: Demonstrate a weapon that can neutralize hardened chemical and biological warfare facilities. Completed an initial effort to develop a multi-mode ordnance package effective against a broad range of unhardened ground targets.				
(U)	In FY 2006: Integrate a miniaturized datalink into a weapon system to perform retargeting in-flight. Begin planning a datalink flight demonstration. Begin planning a low-cost miniature cruise missile demonstration. Begin planning a miniature persistent munition demonstration that will provide area dominance with a multiple-shot capability.				
(U)	In FY 2007: Complete planning a miniaturized datalink flight demonstration. Enhance plans and begin design of a low-cost miniature cruise missile. Mature plans and begin design of a miniature persistent munition that will provide area dominance with a multiple-shot capability. Note: Datalink flight test will be conducted in the navigation and control technologies activity in this project.				
(U)					
(U)	MAJOR THRUST: 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: In FY 2004, Air Force shifted ~$6.0M to this thrust from other projects to accelerate the high penetrator demonstration.	10.818	5.053	5.257	6.375
(U)	In FY 2004: Improved the design and fabrication of 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. Demonstrated a Tantalum warhead to provide attack capability against armored targets employing 'Active Protection Systems'.				
(U)	In FY 2005: Demonstrate a weapon capable of high-speed penetration of extremely hard targets by integrating new warhead case technology, insensitive explosive, and a multiple-event fuze. Begin				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Conventional Weapons Development**

	improving insensitive explosive warhead fills with a goal to significantly reduce the fill volume completing the intended ordnance mission.				
(U)	In FY 2006: Continue to improve insensitive explosive warhead fills with a goal to significantly reduce the fill volume completing the intended ordnance mission. Commence developing an ordnance package that will significantly improve counter-air lethality against cruise missiles and manned aircraft. Initiate design of a multi-mode warhead package designed for precision-guided submunitions. Begin developing a weapon system capable of dispensing payloads within a target for counterforce applications.				
(U)	In FY 2007: Complete insensitive explosive warhead fills that significantly reduce fill volume requirements. Continue developing an ordnance package that will significantly improve counter air lethality against cruise missiles and manned aircraft. Continue developing a multi-mode warhead package designed for precision-guided submunitions. Continue developing a weapon system capable of dispensing payloads within a target for counterforce applications.				
(U)					
(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. Note: Prior to FY 2006, these efforts were covered under Project 670B in this Program Element. In FY 2007, the Miniature Navigator Demonstration (in another thrust in this project) will be completed allowing seekers for two different munition concepts to be initiated.	0.000	0.000	0.905	7.600
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Continue design and fabrication of low-cost laser detection and ranging seeker that will increase data rate and reduce moving parts compared to earlier generation laser seeker technologies. Initiate planning for a small, multiple-mode radar demonstration for air-to-surface weapon applications.				
(U)	In FY 2007: Continue design and fabrication, and commence ground and flight test a low-cost laser detection and ranging seeker that reduces moving parts compared to earlier generation seekers. Mature plans and begin designing a small multiple-mode radar for an air to surface weapon demonstration.				
(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. Note: Prior to FY 2006, these efforts were covered under Project 670B in this Program Element. In FY 2007, the Miniature Navigator	0.000	0.000	5.436	1.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Conventional Weapons Development**

	Demonstration will be completed allowing seekers for two different munition concepts to be initiated (in another thrust in this project).				
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Finish developing and demonstrate a munition navigation system that provides accurate (less than a meter), miniature (less than 25 cubic inch), and affordable (less than $6000 per unit) global positioning management system. Develop a capability for weapons to datalink information to a communications grid.				
(U)	In FY 2007: Complete design and fabrication of a weapon datalink and integrate datalink into a guided munition for commencement of flight testing.				
(U)					
(U)	CONGRESSIONAL ADD: High Speed Strike Weapon.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Perform preliminary design of a high-speed weapon to provide a quick strike capability against time-critical targets.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: BLU-109 Bunker Buster - Heavy.	0.000	2.973	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Improve and test the penetration performance of a BLU-109 (with a tungsten metal ballast in the warhead and a Joint Direct Attack Munition (JDAM) tailkit) seeking performance similar to BLU-113.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Fuze Air-to-Surface Technology.	0.000	1.091	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop and demonstrate, in breadboard fashion, a cost-effective integrated height-of-burst fuze, Global Position Satellite/Inertial Navigation System (GPS/INS) altitude error correction, and in-flight retargeting receiver capability for precision air delivered munitions.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	20.275	18.759	18.660	19.094

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670A Conventional Weapons Development**

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
670B	Guidance Technology	15.166	8.496	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: After FY 2005, these efforts will be covered under Project 670A in this Program Element.

(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 stand off 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 2004	FY 2005	FY 2006	FY 2007
(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. Note: In FY 2006, these efforts will be moved to Project 670A in this Program Element.	2.417	1.500	0.000	0.000
(U) In FY 2004: Evaluated 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: Commence design and 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) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(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. Note: In FY 2006, these efforts will be moved to Project 670A in this Program Element.	2.175	3.792	0.000	0.000
(U) In FY 2004: Furthered development of 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) In FY 2005: Continue developing a munition navigation system using micro-electromechanical system				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT NUMBER AND TITLE **670B Guidance Technology**

	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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(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. Note: In FY 2006, this effort will be completed. Further guidance integration efforts will be executed under Project 670A in this Program Element.	3.802	3.204	0.000	0.000
(U)	In FY 2004: Designed a data link for Low Cost Autonomous Attack System (LOCAAS) to provide a capability to perform re-targeting in-flight 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Develop technologies in support of the Low Cost Autonomous Attack System (LOCAAS) program.	0.968	0.000	0.000	0.000
(U)	In FY 2004: Complemented 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Maverick Missile Upgrade Lock-On After Launch (LOAL) - Live Testing.	5.804	0.000	0.000	0.000
(U)	In FY 2004: Conducted an operational utility evaluation of a Maverick Missile enhanced with a communication subsystem. Tested a Maverick missile with a data communication system proving it could be targeted/retargeted after launch.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603601F Conventional Weapons Technology**	**670B Guidance Technology**

(U)	Total Cost	15.166	8.496	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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.

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Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603605F Advanced Weapons Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	59.529	56.877	26.955	29.542	28.150	30.483	31.085	31.624	Continuing	TBD
3150	Advanced Optics Technology	24.418	17.645	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
3151	High Power Solid State Laser Technology	19.001	23.376	14.423	14.879	15.074	16.339	16.678	16.983	Continuing	TBD
3152	High Power Microwave Technology	8.058	11.402	10.684	12.795	11.118	12.063	12.316	12.544	Continuing	TBD
3647	High Energy Laser Technology	8.052	4.454	1.848	1.868	1.958	2.081	2.091	2.097	Continuing	TBD

(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 electric laser devices and arrays of electric laser 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 2005, Congress added $4.9 million for Geo Light Imaging National Testbed (GLINT), $2.1 million for Advanced Technology for Infrared Countermeasure Component Improvement, $8.0 million for Applications of Lidar to Vehicles with Analysis, $2.1 million for Laser Illuminated Viewing and Ranging Sensor Development, $3.4 million for the Low Speed Air Data Sensor for Special Operations Aircraft, $2.8 million for the Near Earth Space Initiative, and $3.0 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.

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	61.221	31.103	29.168	31.667
(U)	Current PBR/President's Budget	59.529	56.877	26.955	29.542
(U)	Total Adjustments	-1.692	25.774		
(U)	Congressional Program Reductions		-0.020		
	Congressional Rescissions		-0.506		
	Congressional Increases		26.300		
	Reprogrammings	-0.783			
	SBIR/STTR Transfer	-0.909			

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**		PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3150 Advanced Optics Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3150 Advanced Optics Technology	24.418	17.645	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(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 2004	FY 2005	FY 2006	FY 2007
(U) CONGRESSIONAL ADD: Aerospace Relay Mirror System Demonstration.	2.437	0.000	0.000	0.000
(U) In FY 2004: Acquired 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. Tested and integrated components into a laboratory demonstration that will verify scaleable system performance. Determined platform integration costs and identified potential field demonstration options. The cost, applicability, and manufacturability of lightweight telescopes and high energy optics was researched for future testbed upgrades.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Mobile Active Tracking Resource for Integrated Experiments (MATRIX).	4.191	0.000	0.000	0.000
(U) In FY 2004: Developed/enhanced ground-based and airborne beam control and fire control testbeds to demonstrate various active and passive sensors for high energy laser beam control. Concentrated on beam control and fire control enhancements for the Advanced Tactical Laser, but also supported risk reduction decisions for other future laser weapons. Performed ground testing in New Mexico and Hawaii.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U) CONGRESSIONAL ADD: Applications of Lidar to Vehicles with Analysis.	8.286	7.930	0.000	0.000
(U) In FY 2004: Demonstrated 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. Investigated novel concepts for using laser radars to provide detailed information on satellites. Investigated laser radars to provide a range of battlefield information such as battle damage assessment and camouflage penetration. Investigated the ability of eye-safe airborne laser				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3150 Advanced Optics Technology**

	radars to provide battlefield information such as combat identification, battle damage assessment, and camouflage penetration.				
(U)	In FY 2005: Develop use of vibrometry for space situational awareness. Upgrade tracking ability by a factor of three 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. Demonstrate novel concepts that use laser radars to increase information gathering capability. Demonstrate laser radars capability to provide a range of battlefield information such as battle damage assessment and camouflage penetration. Investigate eye-safe laser radars and show increased battlefield information in combat identification, battle damage assessment, and camouflage penetration. Integrate an laser radar and sensors into an operational airborne turret ball for transition to the warfighter.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Laser Illuminated Viewing and Ranging Sensor Development.	3.899	2.082	0.000	0.000
(U)	In FY 2004: Developed eye-safe laser sensors and subsystems technologies and demonstrated the subsystems utility for obtaining battlefield intelligence such as target imagery, target identification, and battle damage assessment. Completed development of a gated electron bombarded active pixel sensor mated with an advanced imaging chip. Completed design of a sensor subsystem (sensor and optics) for applications to an unmanned air vehicle ball turret imaging system.				
(U)	In FY 2005: Develop full wafer eye-safe laser sensors and integrate and test in field demonstrations to show applicability to Air Force programs for obtaining battlefield intelligence. Refine and improve the current airborne gated electron bombarded active pixel sensor and mate it with an advanced processing chip to form a laser-sensing imaging subsystem. Demonstrate the achieved weight and power improvement of this delivered sensor subsystem, followed by preliminary integration of the new sensor subsystem into an operational imaging system.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Texas-New Mexico Sky Survey/Near Earth Space Initiative.	3.168	2.776	0.000	0.000
(U)	In FY 2004: Developed technologies to enhance the ability to detect, track, and characterize Earth orbiting satellites. Redesigned the prime focus corrector of the Hobby-Eberly Telescope. Completed the optical design for a wide-field search telescope.				
(U)	In FY 2005: Complete designs and initial fabrication of a second generation prime focus spectrograph. Formulate detailed designs and costs of the complete spectrograph. Complete improvements to the high				

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603605F Advanced Weapons Technology**	**3150 Advanced Optics Technology**

	resolution spectrograph of the Hobby-Eberly Telescope. Install mirror coating facility and continuous cleaner to support fabrication efforts.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Geosynchronous Light Imaging National Testbed (GLINT).	2.437	4.857	0.000	0.000
(U)	In FY 2004: Evaluated and demonstrated concepts and components for active imaging of space objects with continued development and integration of hardware. Built one heliostat demonstration unit and one mini-receiver. Performed a field experiment to test hardware performance and demonstrated imaging concept under controlled conditions.				
(U)	In FY 2005: Complete partial ground field demonstration of the GLINT imaging technique to test optical components. Complete an analytical and simulation based assessment of the viability of using the GLINT imaging technique on low earth orbit satellites and compare estimated performance with other low earth orbit active imaging techniques. Develop, and/or modify, and test optical transmitting and receiving components in the laboratory and in the field, traceable to a low earth orbit imaging system and a geosynchronous earth orbit system in the out years. Continue exploration of methods for enhanced characterization of space targets, including microsats, using advanced concepts for laser illumination and sensing.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	24.418	17.645	0.000	0.000

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0603444F, Maui Space Surveillance Systems.										
(U)	PE 0602102F, Materials.										
(U)	PE 0602605F, Directed Energy Technology.										
(U)	PE 0603883C, Ballistic Missile Defense Boost Phase Segment.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

(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) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3151	High Power Solid State Laser Technology	19.001	23.376	14.423	14.879	15.074	16.339	16.678	16.983	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project provides revolutionary breakthroughs in efficient, robust, and affordable solid state laser technologies for a wide range of military applications requiring small, high power laser sources. This includes slab, semiconductor, fiber, ceramic, disk, and ultra-short pulse lasers. 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Demonstrate scalability of solid state laser architectures for high power tactical directed energy applications such as next generation weapon components for applications such as advanced gunship weapons and long range airborne laser illuminators.	7.793	8.664	10.622	10.770

(U) In FY 2004: As part of the Joint High Power Solid State Laser program, demonstrated 10 kilowatts using a modular approach. Began design for 25 kilowatt demonstrator laser. Investigated 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 slab approach that has scalability to 100 kilowatts. Address systems-level issues such as weight, volume, power, and thermal management requirements between various approaches funded by the Army, Air Force, and High Energy Laser Joint Technology Office to determine the next step for the Air Force.

(U) In FY 2006: Benchmark technologies in an effort to obtain architectures that are favorable in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability environmental acceptability (air, land and maritime), and ruggedness for tactical weapon applications. Begin development of a solid state laser that is scalable to the weapons-class level.

(U) In FY 2007: Continue scaling solid state lasers with a goal of reaching the weapons-class power, beam

	quality, run time, etc levels. Focus on architectures that are favorable in terms of size, weight, efficiency, affordability, reliability, maintainability, supportability, operational environmental acceptability, and ruggedness for tactical weapon applications.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate solid state laser technologies for moderate power airborne tactical applications, focusing on aircraft self-defense with integrated detection and tracking of targets in clutter.	2.567	6.208	3.801	4.109
(U)	In FY 2004: Investigated technologies such as lasers for long-range detection of targets in clutter; efficient compact lasers; and associated beam control to compensate for platform vibration, atmospheric jitter, and aero-optic effects. Completed laser effects testing using surrogate laser sources. Completed development and began installation of a multi-kilowatt solid state laser testbed to confirm previous test results at appropriate power levels and wavelengths.				
(U)	In FY 2005: Investigate technologies to detect and track tactical targets in clutter. Demonstrate scalable efficient compact lasers and associated beam control to control platform vibration, atmospheric jitter, and aero-optic effects. Perform laser effects testing to determine required energy levels for tactical applications that address defeating next generation air-to-air threats. Build and test a pulsed laser with a wavelength of one micron against surrogate optics. Design and build an optical system incorporating lasers operating at several wavelengths. Design and build laser source and laboratory hardware to evaluate ultra-short pulse laser technology.				
(U)	In FY 2006: Enhance laser sources to detect and track tactical targets. Begin development of a laser for eventual use on an airborne tactical platform to defeat next generation air-to-air threats. Demonstrate a beam director that has the capability of handling a sensor-killer laser, while retaining all of the functions of infrared countermeasures and search functions. Prepare lasers and their gimbal for a day-night electro-optical tracker countermeasures advanced technology demonstration.				
(U)	In FY 2007: Complete development of a laser for eventual use on an airborne tactical platform. Investigate integrating the laser technology with tactical platform sub-systems such as power, thermal management, avionics, sensors, and fire control to increase the potential for successful transition. Evaluate high-power ultra-short laser technologies developed for long-range tactical applications.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate laser source technologies needed to counter current air-to-air and surface-to-air missile threats.	3.279	0.079	0.000	0.000
(U)	In FY 2004: Completed 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: Finalize technology for transition to warfighters.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Low Speed Air Data Sensor for Special Operations Aircraft.	3.314	3.370	0.000	0.000
(U)	In FY 2004: Developed 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: Develop mature technology which will provide fiber optic laser-based rotorcraft airspeed data. This advanced technology will increase the operational safety of fixed wing and rotary aircraft, such as MV/CV-22 and HH-60, during hovering maneuvers and landing.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Technology for Infrared Countermeasures Component Improvement.	0.975	2.081	0.000	0.000
(U)	In FY 2004: Accelerated the potential deployment of the previously developed mid-infrared semiconductor laser brassboard for infrared countermeasures applications. Initiated a risk reduction effort to investigate the environmental survivability issues for the laser transmitter. Demonstrated that a mid-infrared semiconductor laser transmitter can survive operational military random vibration and temperature environments. Conducted a series of rapid design/test iterations 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: Mature mid-infrared semiconductor laser for infrared countermeasures applications with demonstration of laser performance in operational military environments. Conduct testing with the pointer/tracker to validate integration with infrared countermeasures system. Conduct reliability engineering and component testing to quantify the reliability and lifetime of the technology.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Wafer Integrated Semiconductor Laser.	1.073	2.974	0.000	0.000
(U)	In FY 2004: Improved the reliability and lowered the cost of high power laser diode arrays. Developed 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: Further develop novel surface emitting structures for semiconductor laser arrays. Refine the				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

basic technology developed in the previous year using 45-degree turning mirrors by testing and improving reliability, and improving yield to reduce overall cost. Etch integrated fast-axis collimation lenses into the semiconductor material. Explore other technologies for producing surface emitting semiconductor laser arrays.

(U) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.
(U)

(U)	Total Cost	19.001	23.376	14.423	14.879

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602102F, Materials.										
(U)	PE 0603270F, Electronic Combat Technology.										
(U)	PE 0602605F, Directed Energy 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 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603605F Advanced Weapons Technology**	**3152 High Power Microwave Technology**

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3152	High Power Microwave Technology	8.058	11.402	10.684	12.795	11.118	12.063	12.316	12.544	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and demonstrate HPM technologies to disrupt, degrade, damage, or destroy an adversary’s electronic systems.	3.346	1.321	1.255	1.309
(U) In FY 2004: Demonstrated an integrated repetitively pulsed gigawatt-class HPM breadboard. Conducted wideband field experiments with integrated compact devices to demonstrate effectiveness of wideband HPM for munitions and airborne electronic attack. Conducted additional ground-based, field experiments demonstrating effectiveness of air-delivered HPM munitions. Conducted an integrated short-range wideband hidden 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 short-range wideband hidden weapon identification concept.				
(U) In FY 2006: Integrate a repetitively pulsed gigawatt-class HPM source and antenna that will be installed into an airborne platform. Conduct integration experiments that include investigating electromagnetic interference issues. Examine the interactions of the HPM source, antenna, and pulse power to increase functionality. Demonstrate short-range wideband hidden weapon identification in a real world environment.				
(U) In FY 2007: Demonstrate the performance of the integrated repetitively pulsed gigawatt-class HPM source and antenna system. Demonstrate that the HPM system does not interfere with the flight controls of the airborne platform. Perform system diagnostics on integrated platform to ensure proper source operation. Demonstrate enhanced portable short-range wideband hidden weapon identification.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)					
(U)	MAJOR THRUST: Conduct effects experimentation to expand and refine data library and support susceptibility predictions.	1.315	0.775	0.738	0.834
(U)	In FY 2004: Predicted high power microwave (HPM) coupling to targets with enhanced computer codes and validated code prediction accuracy. Further refined models to quantify the effectiveness of HPM waveforms against electronic targets of interest applicable to munitions or airborne applications. Enhanced 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)	In FY 2006: Transition HPM engagement lethality modeling and simulation capability into Air Force Standard Analysis Toolkit and to additional users. Execute high power microwave effects tests to improve HPM system design and lethality. Identify and mitigate vulnerabilities of US infrastructure to HPM attack.				
(U)	In FY 2007: Model real targets and predict probability of kill for various HPM scenarios. Continue high power microwave effects tests to improve HPM system design and lethality. Identify and mitigate additional vulnerabilities of US infrastructure to HPM attack.				
(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.	2.559	4.603	4.354	6.331
(U)	In FY 2004: Acquired knowledge and capabilities critical for future active denial systems via field support of operation/testing/demonstration of the first ground-based system. Began 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. Improved active denial system specific computational physics simulations capability for millimeter wave sources. Completed conceptual design study for mobile ground-based test stand for future airborne level radiating system demonstration. Updated subsystem approaches based on original airborne technical feasibility study. Provided 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 and glean data relevant to airborne applications.

(U) In FY 2006: Complete support of user 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. Complete computational physics simulations of millimeter-wave sources against the draft detailed design drawings for the coaxial source approach. Perform cold testing for conventional source hardware followed by progression towards final source assembly. Provide technical expertise and background to external organizations tailoring Active Denial concepts and capabilities to their needs and glean data relevant to airborne applications.

(U) In FY 2007: Develop and evaluate technologies for non-lethal weapons applications. Continue the development of millimeter wave source for airborne applications. Perform manufacturer test of first phase conventional source approach. Identify deficiencies and begin rebuild. Complete critical design review for coaxial source design. Investigate updated subsystem approaches based on the original airborne technical feasibility study. Begin hardware development for full power source test stand including award of test stand contract. Provide technical expertise and background to external organizations tailoring Active Denial concepts and capabilities to their needs and glean data relevant to airborne applications.

(U)

(U) MAJOR THRUST: Develop the technology to integrate high power microwave (HPM) devices on aerial platforms and investigate specific target sets of interest.	0.838	4.703	4.337	4.321

(U) In FY 2004: Continued airborne electronic attack specific target identification efforts for individual targets and cluster of targets. Conducted additional HPM experiments in the transverse electromagnetic cell anechoic chamber and the upgraded smaller anechoic chamber. Began investigation of source to aircraft integration issues (e.g., electrical and physical interface and thermal control). Defined aircraft alterations and source shielding required to mount an HPM source on an aircraft. Began 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 and cluster targets. Perform target lethality assessments. Maintain and upgrade the test facilities. Investigate source to aircraft integration issues such as electrical and physical interface, thermal control, center of mass, antennas, and electromagnetic interference/electromagnetic compatibility. Test determined source

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3152 High Power Microwave Technology**

shielding requirements for mounting a source on an aircraft. Investigate the feasibility of using ultra-wideband high power microwave (HPM) to geolocate and identify targets of interest and perform battle damage assessment.

(U) In FY 2006: Proceed with maturation and miniaturization of HPM subsystem technologies, and begin their integration. Begin integration of all HPM subsystem components in preparation for stand-alone field demonstration. Refine HPM subsystem to ensure required energy levels are produced. Integrate the HPM subsystem with the command and control device to demonstrate operation at threshold operating parameters. Begin hardening of chosen platform against HPM subsystem predicted electromagnetic interference/coupling. Continue integration and test activities to determine the least risky path forward to transitioning technologies for an HPM Airborne Electronic Attack system.

(U) In FY 2007: Continue miniaturization, integration and ruggedization of HPM system for field experimentation. Perform HPM system testing and diagnostics on hardware developed and integrated in FY 2006 for efficiency and to determine any potential electromagnetic interference/coupling issues. Improve HPM system command and control systems for pulsed operation greater than threshold levels.

(U)	Total Cost	8.058	11.402	10.684	12.795

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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 duplication.										

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3647 High Energy Laser Technology	8.052	4.454	1.848	1.868	1.958	2.081	2.091	2.097	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 long-range 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 2004	FY 2005	FY 2006	FY 2007
(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.	2.060	2.525	1.848	1.868
(U) In FY 2004: Demonstrated optimized high pressure ejector nozzles performance for airborne laser systems. Demonstrated advanced iodine generation, iodine injection, and chemical oxygen iodine test sequence utilizing a laboratory test stand. Investigated 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 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 demonstrations of closed-cycle chemical approaches for use on tactical airborne platforms.				
(U) In FY 2006: Identify overall device-level performance and issues based on the integration of the iodine generation and ejector nozzle concept into a laser device. Perform field demonstrations of closed-cycle chemical approaches for use on tactical airborne platforms. Use deuterated chemicals to improve device performance. Begin work to extend the range of high power airborne chemical lasers.				
(U) In FY 2007: Continue working with new, advanced subsystems and technological concepts for future use on tactical and strategic platforms. Provide technical expertise and background to external organizations tailoring high energy laser concepts and capabilities to their needs.				
(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	1.801	1.929	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT NUMBER AND TITLE **3647 High Energy Laser Technology**

	airborne platforms.				
(U)	In FY 2004: Demonstrated advanced tracking methods and adaptive optics compensation techniques that double the Strehl ratio (peak laser intensity on target) in stressing atmospheric turbulence environments. Completed evaluation of the compensated beacon illumination technique. Completed initial evaluations using physics level wave optics simulations of several advanced concepts designed to improve performance of the Airborne Laser. These included a compensated beacon approach, several advanced tracking algorithms, and an adaptive reconstructor concept. Designed low absorption coatings for Airborne Laser deformable mirrors to be fabricated using magnetron sputtering technology.				
(U)	In FY 2005: Complete beam control technology demonstration and transition of these technologies to the Airborne Laser System program. Complete concept evaluations using the Airborne Laser wave optics code that includes more detailed models of the Airborne Laser beam control system. Complete field testing of advanced tracking algorithms and adaptive optics techniques at the North Oscura Peak propagation range. Mature advanced beam control technologies. Fabricate and test low absorption deformable mirror coating and compare to existing deformable mirror coating. Transition to the Airborne Laser program.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Laser Spark Countermeasure Program.	4.191	0.000	0.000	0.000
(U)	In FY 2004: Performed laboratory effects tests and modeling to resolve measured differences in the damage threshold of different focal plane arrays and expanded the database to include additional pulse length data and at least one additional focal plane array type. Performed laboratory effects testing to extend previous results into the ultra short pulse length regime. Performed and documented a countermeasure effectiveness study for selected operational scenarios. Designed, fabricated, and used a brassboard countermeasure laser system in a field demonstration test to show the effectiveness of the laser 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	8.052	4.454	1.848	1.868

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 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 PE that are supporting future enhancements to airborne lasers have been coordinated with the Airborne Laser program office.										

(U) D. Acquisition Strategy

Not Applicable.

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Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603723F Environmental Engineering Technology

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	1.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
2103	Environmental Quality Technology	1.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In FY 2000, the Air Force terminated this program. However, Congress has added funds for special interest projects since FY 2000.

(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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	1.190	0.000	0.000	0.000
(U)	Current PBR/President's Budget	1.163	0.000	0.000	0.000
(U)	Total Adjustments	-0.027	0.000		
(U)	Congressional Program Reductions				
	Congressional Rescissions				
	Congressional Increases				
	Reprogrammings				
	SBIR/STTR Transfer	-0.027			

(U) Significant Program Changes:

In FY 2000, the Air Force terminated this program. However, Congress has added funds for special interest projects since FY 2000.

C. Performance Metrics

Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE
February 2005

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603723F Environmental Engineering Technology**	**2103 Environmental Quality Technology**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2103 Environmental Quality Technology	1.163	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2000, the Air Force terminated this program. However, Congress has added funds for special interest projects since FY 2000.

(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 2004	FY 2005	FY 2006	FY 2007
(U) CONGRESSIONAL ADD: Bioreactor Technologies Evaluation and Testing.	1.163	0.000	0.000	0.000
(U) In FY 2004: Continued Congressionally-directed effort to demonstrate bioreactor technologies to treat dilute aqueous waste streams and reduce the toxicity of wastewater.				
(U) In FY 2005: Not Applicable.				
(U) In FY 2006: Not Applicable.				
(U) In FY 2007: Not Applicable.				
(U) Total Cost	1.163	0.000	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:
Not Applicable.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2, RDT&E Budget Item Justification

DATE February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603789F C3I Advanced Development

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	43.305	35.774	30.125	37.365	30.713	37.728	37.821	42.869	Continuing	TBD
4072	Dominant Battlespace Awareness	23.923	16.211	8.233	12.214	9.507	10.032	10.304	10.556	Continuing	TBD
4216	Battlespace Information Exchange	8.944	9.385	7.790	8.447	8.909	10.585	10.135	14.700	Continuing	TBD
4872	Aerospace Information Dominance	7.966	8.315	14.102	16.704	12.297	17.111	17.382	17.613	Continuing	TBD
4925	Collaborative Info Superiority	2.472	1.863	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

Note: In Fy 2005, efforts in Project 4925, Collaborative Info Superiority, move into Project 4216 in this PE. In FY 2006, efforts in Project 4925, Collaborative Info Superiority, move into Project 4872 in this PE. Increased funding in FY 2006 and out in Project 4872, Aerospace Information Dominance, reflects increased emphasis on applying high payoff applications of information technology to meet command and control (C2) needs.

(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 Info 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 2005, Congress added $1.0 million for Collaboration Archive Server, $1.0 million for Cyber Security - Advanced Course in Engineering, $1.5 million for Dynamic Targeting Capability, $2.1 million for RIVET JOINT Advanced Wideband Processor, and $2.0 million for Massively Parrallel Optical Interconnects (origonally appropriated to PE 0603605F, Advanced Weapons Technology.) An additional $1.0 million was appropriated to this PE for J-P Coal-based Jet Fuel, but it has been moved to PE 0601102F, Defense Research Sciences, for execution.

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 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**

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

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	44.917	28.524	30.832	38.144
(U)	Current PBR/President's Budget	43.305	35.774	30.125	37.365
(U)	Total Adjustments	-1.612	7.250		
(U)	Congressional Program Reductions		-0.031		
	Congressional Rescissions		-0.319		
	Congressional Increases		7.600		
	Reprogrammings	-0.407			
	SBIR/STTR Transfer	-1.205			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4072 Dominant Battlespace Awareness	23.923	16.211	8.233	12.214	9.507	10.032	10.304	10.556	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project 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 Concept of Operations (CONOPS) and the Space and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance CONOPS. 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 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 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop and demonstrate advanced data handling, event visualization technologies, and distributed data fusion to enable a more effective utilization of the vast amounts of data available to intelligence analysts to provide optimized situation awareness, as well as to support all phases of combat operations.	3.976	3.341	4.471	5.076

(U) In FY 2004: Developed and delivered probabilistic approaches for accumulation of data/information to support target/activity identification and situational awareness, in support of PBA. Completed development of the interface required to feed fused sensor information and derive 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. Developed tools for timeline, event, and motion pattern recognition to support analysis, visualization, and decision aids to detect enemy activity. Developed an operations-based approach for intelligent and adaptive intelligence, surveillance, and reconnaissance management based upon quantified information deficiencies in the fused data-space. Developed a fusion evaluation environment and provided 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, and motion pattern recognition to support analysis, visualization, and decision aids to detect enemy activity. Continue to develop an operations-based approach for intelligent

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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and adaptive intelligence, surveillance, and reconnaissance (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) In FY 2006: Continue to develop and deliver a fusion evaluation environment, providing simulation and modeling capability, measures of performance, and operator focused transition products to support the warfighter. Develop an automated process to visualize the overlaying of disparate information domains on a single screen and provide an optimal means of fusing all source intelligence data. Develop and demonstrate advanced fusion tools to enhance the capability for PBA. Use operator focused techniques to evaluate the effectiveness of the fusion tools. Perform feature aided tracking to monitor, assess, and predict possible courses of action. Initiate development of reasoning algorithms and evidence accrual techniques for continuous knowledge development of the battlespace.

(U) In FY 2007: Continue to enhance the evaluation environment for assessing the state-of-the-art and maturity of algorithms for transition to the warfighter. Demonstrate an automated process to visualize the overlaying of disparate information domains on a single screen and provide an optimal means of fusing all source intelligence data. Complete demonstration of feature aided tracking to monitor, assess, and predict possible courses of action. Complete development and demonstrate operator focused dynamic resource allocation algorithms and techniques for optimization and collaboration of information products.

(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 $3.0 million in FY 2004 Congressional Add funding.	7.293	2.948	1.763	2.695

(U) In FY 2004: Completed the development of tools to extract information from data derived from image, and measurement and signature intelligence. Developed and demonstrated 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. Developed an exploitation toolkit for advanced ISR platforms that provide the detection and tracking of air and ground targets. Investigated tools for the exploitation of High Range Resolution, Identification Friend or Foe, and Synthetic Aperture Radar sensor characteristics for feature-aided tracking and targeting. Developed 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

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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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 ISR platforms that provide the detection and tracking of air and ground targets. Deliver tools for the exploitation 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 Air Vehicle/Manned/Space ISR collectors) based upon the exploitation and fusion of multi-source and multi-platform information, in order to provide timely dissemination of useable intelligence to allied/coalition forces.

(U) In FY 2006: Develop a baseline capability to perform advanced text exploitation of Human Intelligence (HUMINT) reports and correlate and fuse the information with information from other sources. Develop and assess the ability to extract actionable information from voluminous textual data.

(U) In FY 2007: Complete and demonstrate a baseline capability to perform advanced text exploitation of HUMINT reports and correlate and fuse the information with information from other sources. Complete development and assessment of prototype that is able to extract actionable information from voluminous textual data.

(U)

(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate advanced data and information fusion capabilities to support multi-source capabilities, new sensor types, cognitive models, and automated fusion process management. Note: The funding profile reflects the completion of multi-INT fusion efforts and shifting to fusion driven ISR management research in FY 2006. The funding profile in FY 2007 reflects demonstrations of multi-platform tracking and ISR management. This effort includes $4.8 million in FY 2004 Congressional Add funding.	12.654	5.322	1.999	4.443

(U) In FY 2004: Demonstrated and delivered an all-source advanced capability for the detection and tracking of time-critical targets that employ camouflage, concealment, and deception techniques. Demonstrated fusion system architectures capable of exploiting multiple sources of data to provide situational awareness, indications and warnings, and time-critical target identification and tracking. Developed 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. Completed the collaborative collection and fusion of ISR information to improve accuracy and timeliness for situational awareness and targeting. Developed and demonstrated a capability for fusing signal intelligence, moving target indicator, foliage penetrating radar, and imagery data for the detection and tracking of time-critical targets.

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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(U)	In FY 2005: Develop and demonstrate multiple intelligence source 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.				
(U)	In FY 2006: Develop interoperable exploitation technologies for real-time ISR management. Enhance ISR resource management development through incorporation of information sharing and network centric operations. Develop tools for mission/task based priority and quality of service utilization of assets and fusion focused ISR tasking, and explore the synergy between the two. Perform a multi-platform interoperability and limited tracking demonstration, which integrates resource management, information management, and communications management capability.				
(U)	In FY 2007: Complete development of interoperable exploitation technologies for real-time ISR management, which incorporates non-traditional ISR into the management algorithms for find, fix, track, target, engage, and access. Perform a multi-platform tracking demonstration utilizing airborne assets against a variety of advanced military and asymmetric threat scenarios. Demonstrate the capability to dynamically task sensors and assure timely, prioritized transport of information for purpose of tracking high value ground targets for long durations and potentially engaging them.				
(U)					
(U)	CONGRESSIONAL ADD: Collaborative Archive System.	0.000	1.000	0.000	0.000
(U)	In FY2004: Not Applicable.				
(U)	In FY2005: Develop and demonstrate a collaboration system which applies modern collaboration tools and technologies towards the problem of information discovery and information sharing between the Air Force and other organizations. The ability to collaborate across security boundaries using instant messaging, shared whiteboard, and audio teleconferencing tools, and to quickly discover pertinent information from prior collaborative sessions will be emphasized.				
(U)	In FY2006: Not Applicable.				
(U)	In FY2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Dynamic Targeting Capability.	0.000	1.500	0.000	0.000
(U)	In FY04: Not Applicable.				
(U)	In FY2005: Develop and demonstrate an enhanced capability for the Air Force to identify, plan, and attack emerging threats as it operates in a Network Centric architecture. This capability will possess the tools necessary to discover, translate, and share metadata and products from intelligence databases,				

Exhibit R-2a, RDT&E Project Justification

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE	DATE
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		FY 2004	FY 2005	FY 2006	FY 2007
	weapons evaluation, image exploitation, and target visualization systems, as well as non-traditional ISR sources to quickly assist in identifying threats or propose a course of action.				
(U)	In FY2006: Not Applicable.				
(U)	In FY2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Wideband Processor and HF Geo-Processor (AWP/HGP) for RIVET JOINT Aircraft.	0.000	2.100	0.000	0.000
(U)	In FY2004: Not Applicable.				
(U)	In FY2005: Complete development, integration, flight testing, and installation of an AWP/HGP on a RIVET JOINT aircraft with the AWP providing theater-wide detection and processing of high-interest signals in dense, co-channel environments typical of commercial communications, and the HGP adding direction finding and geo-location of HF signals to RIVET JOINT capabilities.				
(U)	For 2006: Not Applicable.				
(U)	For 2007: Not Applicable.				
(U)	Total Cost	23.923	16.211	8.233	12.214

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	Related Activities:										
(U)	PE 0602702F, Command, Control, and Communications.										
(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 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4216 Battlespace Information Exchange	8.944	9.385	7.790	8.447	8.909	10.585	10.135	14.700	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2005, an effort from Project 4925 moves to this Project.

(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 (e.g., 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 2004	FY 2005	FY 2006	FY 2007
(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.	1.306	1.772	0.807	0.534
(U) In FY 2004: Finalized and demonstrated advanced expert system decision algorithms to prioritize and control resources for global reach in the AMC environment. Completed and demonstrated an intelligent information manager agent that will autonomously throttle and regulate mission information flow among AMC components based on changing system capabilities. Completed 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 capability to the Joint Tactical Radio System clusters.				
(U) In FY 2006: Transition the combined Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller to jumpstart Network Centric communications.				
(U) In FY 2007: Complete the transition of the combined Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller to jumpstart Network Centric communications.				

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(U)					
(U)	MAJOR THRUST: Develop advanced network protocols and commercial management technologies to provide communications from deployed aircraft and ground elements to the AMC Tanker Airlift Control Center (TACC), as well as in-transit visibility at the TACC of all aircraft, personnel, and cargo.	1.625	0.000	0.000	0.000
(U)	In FY 2004: Completed 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. Completed 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. Integrated and demonstrated 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 completed in FY 2004.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate improved global networking and resource management technologies that provide reliable efficient, secure, interoperable, and dynamic deployable communications.	1.532	0.000	0.000	0.000
(U)	In FY 2004: Completed 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. Developed and demonstrated 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. Developed and demonstrated 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 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 completed in FY 2004.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate secure wideband assured networking for munitions (e.g.,	0.000	2.264	3.380	3.837

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	Joint Direct Attack Munition, etc.) and integration with the developing airborne segment of the Global Grid. Note: Prior to FY 2005, this effort was in Project 4925.				
(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 miniature munitions. Data networking will support command and control of the munition and cooperative situational awareness and battle damage assessment with other weapon platforms.				
(U)	In FY 2006: Examine and develop or adapt networked communications to support special operations forces (SOF) ground elements connecting them into the Airborne Network to weapon platforms and reachback to globally located command centers.				
(U)	In FY 2007: Continue to develop or adapt networked communications to support SOF ground elements connecting them into the Airborne Network to weapon platforms and reachback to globally located command centers.				
(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.	0.429	0.479	0.000	0.000
(U)	In FY 2004: Developed 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)	In FY 2006: Not Applicable. Effort completes in FY 2005.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop and demonstrate intelligent networking transport and management technology to provide assured, seamless, battlespace connectivity to the aerospace forces with a greatly reduced footprint. Note: This effort includes $2.0 million in FY 2005 Congressional Add funding.	1.104	3.870	3.603	4.076
(U)	In FY 2004: Developed and demonstrated user-friendly, assured wideband wireless intelligent networking capability that automatically senses and adapts to its environment and service demands. Conducted 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				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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	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. Develop and demonstrate an efficient on-board optical interconnectivity solution that addresses, in a uniform manner, all intra-platform communications, to include telemetry/command/control, and payload related data exchange needs of an Unmanned Air Vehicle (UAV) platform.				
(U)	In FY 2006: Develop mechanisms to enable integrated management of communications and sensor resources. Assess communications needed to support ground moving target tracking, multi-intelligence exploitation and fusion, and sensor resource management systems and techniques. Establish a framework for integration and development of a common-coordinated management function for command, control, intelligence, surveillance, and reconnaissance networking. Develop mission/task based priority and quality of service utilization of communications assets to enable fusion-focused ISR tasking, feature-aided tracking, group tracking, and use of Level 3 type fusion information. Investigate the complexities of multi-intelligence exploitation and incorporate enhancements into the development.				
(U)	In FY 2007: Demonstrate multi-platform tracking, employing multiple ISR platforms, that show improved battle management command, control, and communications capabilities and complete assessment of the warfighter effectiveness of integrated ISR sensor management/fusion and communications capability.				
(U)					
(U)	CONGRESSIONAL ADD: Information Protection and Authentication.	2.948	0.000	0.000	0.000
(U)	In FY 2004: 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. Investigated new generation methods for digital security using steganographic techniques and for detection of digital forgeries without watermarks.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Cyber Security - Advanced Course In Engineering.	0.000	1.000	0.000	0.000
(U)	In FY2004: Not Applicable.				
(U)	In FY2005: Develop training program in cyber security through the completion of research topics covering the areas of security policy, computer security, cryptography, steganography, digital forensics,				

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network security, network defense, network attack, wireless security, and next generation security.

(U) In FY2006: Not Applicable.

(U) In FY2007: Not Applicable.

(U) Total Cost	8.944	9.385	7.790	8.447

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 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.

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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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4872 Aerospace Information Dominance	7.966	8.315	14.102	16.704	12.297	17.111	17.382	17.613	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: Increased funding in FY 2006 and out reflects increased emphasis on developing high payoff information distribution and effects-based planning technologies. In FY 2006, efforts from Project 4925 moves to this Project.

(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 (AOC). 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 2004	FY 2005	FY 2006	FY 2007
(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. Note: Yearly increasing funding is due to increased emphasis in developing and demonstrating to the warfighter the baseline functionality of the Advanced Technology AOC.	1.679	2.668	4.132	5.437
(U) In FY 2004: 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. Delivered and demonstrated 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. Completed and transitioned 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. Designed and developed a baseline of critical functionality and supporting infrastructure that will support the evolving Advanced Technology AOC weapon system and its split-operations concept. Defined essential elements of information for the Advanced Technology AOC and developed				

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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 C2 system of the Advanced Technology AOC weapon system. Initiate and develop highly efficient business processes and tools to support information exchange between the AOC and other C2 centers in the Theater Air Control Structure.

(U) In FY 2006: Continue to investigate a core set of functionality and supporting infrastructure of the next generation AOC weapon system enabling the ability to plan, direct, coordinate, and control air forces and operations across security boundaries in a coalition environment. Develop joint Service collaborative planning of mission packages with tailorable and exportable information reports/briefings associated with air space management and deconfliction. Continue developing highly efficient business processes and tools to support information exchange between the AOC and other C2 centers in the Theater Air Control Structure. Explore the integration of intelligent agents that use physics-based modeling to provide accurate, detailed advice necessary to make correct decisions. Apply appropriate system of systems and federation of systems engineering principles to create joint C2 decision-support capabilities.

(U) In FY 2007: Continue to investigate a core set of functionality and supporting infrastructure of the next generation AOC weapon system enabling the ability to plan, direct, coordinate, and control air forces and operations across security boundaries in a coalition environment. Develop execution of the airspace plan and re-planning options with faster than real-time fly out of Air Tasking Orders that can be performed in less time than it takes the aircraft to reach the airspace in question so that it can be dynamically de-conflicted; thus avoiding a possible hazardous condition. Continue developing highly efficient business processes and tools to support information exchange between the AOC and other C2 centers in the Theater Air Control Structure. Prototype and demonstrate intelligent agents that use physics-based modeling to provide accurate, detailed advice necessary to make correct decisions. Continue to develop and apply system of systems and federation of systems engineering principles to create joint C2 decision-support capabilities.

(U)

(U) MAJOR THRUST: Develop and demonstrate the integration of planning tools and information-based	1.468	0.399	2.395	3.958

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intelligent agents for adaptive replanning and decision support tools for aerospace C2 systems.

(U) In FY 2004: Demonstrated 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. Completed the development of tools to continuously update type, location, and status of DoD transportation assets to improve situational awareness. Demonstrated 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, and execution management.

(U) In FY 2006: Continue 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. Continue development of advanced reasoning techniques for mobility courses-of-action development. Apply the use of advanced computer mark-up languages and continue the development of common mobility ontology to improve automation of the decision support tools for increased situational awareness, planning, and execution management. Investigate the feasibility of a capability-centric versus system/program-centric global warfighting response by "bridging the seams" between disparate processes and systems in the Combat Air Force (CAF), Mobility Air Force (MAF), and Civil Air Traffic Management (ATM) domains. Develop improved synchronization among Global Strike and Global Mobility Force participants within multiple theaters and global Civil ATM. Develop the capability to support collaborative C2, including dynamic and intermittent participation of players possibly in a coalition setting. Develop innovative automated machine-to-machine exchange of selected information between CAF aircraft, MAF aircraft, their respective C2 elements, and civil ATM agencies. Explore the feasibility of virtual staff members to maintain a vision of C2 processes during human absences providing a 24/7 coverage.

(U) In FY 2007: Complete development of 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. Complete development of advanced reasoning techniques for

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mobility courses-of-action development. Demonstrate the use of advanced computer mark-up languages and continue the development of common mobility ontology to improve automation of the decision support tools for increased situational awareness, planning, and execution management. Develop and demonstrate a CAF, MAF, civilian shared situational awareness/synchronization to achieve desired "effects" and ensure mission success in a global environment. Continue to develop improved synchronization among Global Strike and Global Mobility Force participants within multiple theaters and global Civil ATM. Demonstrate the capability to support collaborative C2, including dynamic and intermittent participation of players, possibly in a coalition setting. Continue to develop innovative automated machine-to-machine exchange of selected information between CAF aircraft, MAF aircraft, their respective C2 elements, and civil ATM agencies, and demonstrate improved information sharing and interoperability between CAF and MAF mission planning and execution systems for improved velocity, efficiency, safety, and mission success. Develop appropriate virtual staff members to maintain a vision of C2 processes during human absences providing a 24/7 coverage.

(U)

(U)	MAJOR THRUST: Demonstrate how a publish, subscribe, and query information management paradigm can enable horizontal integration of Air Force command, control, communication, computers, intelligence, surveillance, and reconnaissance information systems. Develop more advanced prototypes of a Community Of Interest (COI) infosphere that support information management requirements of various Air Force net-centric COI's. Demonstrate how such an infosphere can interact with and enhance the current net-centric infrastructure.	2.229	2.767	2.836	2.872

(U) In FY 2004: Developed and demonstrated the techniques to manage information objects within the Joint Battlespace Infosphere (JBI) from diverse information sources and data environments. Developed and demonstrated data system wrapper technologies to dynamically integrate disparate and legacy command and control, intelligence, surveillance, and reconnaissance information systems into the JBI. Evaluated and integrated 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. Develop and demonstrate an advanced COI infosphere prototype, with non-real-time pub/sub/query capability, as well as Role-based Access Control and persistence management.

(U) In FY 2006: Initiate development of new next generation COI infosphere prototype to provide real-time

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	performance, security to Air Force standards, and high levels of scalability to meet Air Force net-centric operational needs. Support information engineering efforts allowing various existing and new Air Force systems to utilize these COI infosphere prototypes.				
(U)	In FY 2007: Continue development of new next generation COI infosphere prototype to provide real-time performance, security to Air Force standards, and high levels of scalability. Continue to support information engineering efforts allowing various existing and new Air Force systems to utilize these COI infosphere prototypes.				
(U)					
(U)	MAJOR THRUST: Develop, demonstrate, and integrate a broad range of technologies that have application within embedded information architecture applicable to manned and unmanned vehicles.	0.000	0.000	0.843	0.000
(U)	In FY 2004: Effort performed in Project 4925, first Major Thrust.				
(U)	In FY 2005: Effort performed in Project 4925, first Major Thrust.				
(U)	In FY 2006: Develop a Time Sensititive Target automated decision-aiding capability for an Advanced Technology Aerospace Operations Center type of facility in a spiral fashion. Demonstrate in a real-time scenario such as Joint Expiditionary Force Experiment-2006.				
(U)	In FY 2007: Not Applicable. Effort completes in FY 2006.				
(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 in FY 2004 Congressional Add funding.	2.590	2.481	3.896	4.437
(U)	In FY 2004: Completed 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 managers in time to achieve mission objectives. Completed 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. Developed and completed 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 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				

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advanced information technologies to shorten the current execution timelines, while also allowing significant reductions in the number of personnel required in an AOC.

(U) FY 2006: Continue to develop 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. Continue investigating various capabilities to support AOC personnel in developing and assessing, in near-real-time, various course of action options based upon commander's intent, predictive battlespace awareness tools, and an ability to reason over models of the enemy as a system. Continue to develop technologies to capture, assess, and integrate cause-and-effect (1st, 2nd, and 3rd order) relationships endemic to this "enemy as a system." Continue 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. Develop warfighter-accepted operational concepts and architecture views for a Streaming Air Tasking Order (ATO) generator and dynamic effects-based assessment capability. Begin spiral developments of concept demonstrations of a Streaming ATO generation capability. This will enable more responsive and continuous planning, execution, and assessment within the AOC.

(U) FY 2007: Continue to develop 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. Continue investigating various capabilities to support AOC personnel in developing and assessing, in near-real-time, various course of action options based upon commander's intent, predictive battlespace awareness tools, and an ability to reason over models of the enemy as a system. Continue to develop technologies to capture, assess, and integrate cause-and-effect (1st, 2nd, and 3rd order) relationships endemic to this "enemy as a system." Complete 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. Develop a streaming ATO prototype capability. Develop real-time operational assessment demonstration in a streaming ATO environment that will enable an effects-based approach to operational assessment, which will allow greater visibility into whether or not desired effects are being achieved.

(U) Total Cost	7.966	8.315	14.102	16.704

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602702F, Command,										

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

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

(U) D. Acquisition Strategy

Not Applicable.

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT NUMBER AND TITLE
03 Advanced Technology Development (ATD)	**0603789F C3I Advanced Development**	**4925 Collaborative Info Superiority**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4925 Collaborative Info Superiority	2.472	1.863	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

Note: In FY 2005, an effort in this Project moves to Project 4216. In FY 2006, efforts in this Project move to Project 4872 in this PE.

(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 2004	FY 2005	FY 2006	FY 2007
(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.	0.548	0.594	0.000	0.000
(U) In FY 2004: Developed, demonstrated, and integrated technologies to address a broad range of sensor-to-decisionmaker-to-shooter functions and concepts of operations. Initiated development of a time-critical target (TCT) automated decision-aiding capability to deny the enemy the sanctuary of time, for use in a C2 facility. Initiated 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. Completed and demonstrated 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 AOC 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) In FY 2006: Not Applicable. Effort moves to Project 4872 in this PE.				
(U) In FY 2007: Not Applicable				
(U)				
(U) MAJOR THRUST: Develop communication technologies to increase aerospace platform information transfer capacity.	1.268	0.652	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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 2004: Continued to develop technology to increase aerospace platform information transfer capacity for the exchange of time-critical threat, sensor, and C2 information between aircraft and cooperating space, airborne, and surface communication assets. Completed the fabrication of high-capacity, bandwidth efficient, modem technology for point-to-point and multiple platform connectivity. Initiated 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. Started investigations of the interface of weapon systems to the C2 structure that will implement a high tempo, weapons on target capability. Began 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)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate embedded information system technologies to support a transparent framework for seamless, rapid insertion of battlespace infosphere technology.	0.656	0.617	0.000	0.000
(U)	In FY 2004: Completed development techniques for inserting battlespace infosphere technology that do not require a comprehensive re-test of the entire C2 system. Completed the demonstration of capability for modernization of aerospace and C2 platforms to support system-of-systems interoperability within the battlespace infosphere. Initiated 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 AOC management of unmanned and autonomous systems.				
(U)	In FY 2006: Not Applicable. Effort moves to Project 4872 in this PE.				
(U)	In FY 2007: Not Applicable.				
(U)	Total Cost	2.472	1.863	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602702F, Command, Control, and										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)**

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

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BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603850F Integrated Broadcast Service (DEM/VAL)

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	8.241	2.268	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5151 Blue Force Tracking	8.241	2.268	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

In FY2004, Project Number 635151, Joint Blue Force Situation Awareness (JBFSA) Advanced Concept Technology Demonstration (ACTD), efforts were transferred from PE0207028F, Joint Expeditionary Force Experiment (JEFX), Project Number 674991, Joint Distributed Engineering Plant. Although this PE is entitled "Integrated Broadcast Service (IBS)", this project does not use IBS funding. Description of the IBS program is provided in PE 63850F, Budget Activity 4.

(U) A. Mission Description and Budget Item Justification

Joint Blue Force Situational Awareness (JBFSA) Objectives - Provide, through a collection of systems, a globally responsive Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capability to detect, track, identify and assess all adversary, neutral and friendly (e.g., US, Joint, and Coalition) forces in the assigned areas of responsibility (AORs); increase combat effectiveness by improving air-to-ground time sensitive targeting (TST) and blue force situational awareness to ensure prosecution of the right targets and the reduction of fratricide.

JBFSA ACTD - This JBFSA ACTD, a continuation of an ACTD started in CY2003, will focus on the integration of disparate systems (no single system or mission application exists today), data interoperability and common operating displays. Tasks include the development, integration, validation, and transition of web-enabled Common Operating Picture (COP) and User Defined Operating Picture (UDOP) capabilities for Joint Blue Force Tracking. Specific sub-areas include the integration of current JBFSA devices into the JBFSA architecture, disseminate and display a consistent blue force picture within the Global Command and Control Systems (GCCS) family of systems (FOS) COP and select tactical level display devices, identification of additional JBFSA data dissemination paths (satellite communications (SATCOM), Global Broadcast Service (GBS), Integrated Broadcast Service (IBS), Tactical networks, etc.), integration of line-of-sight (LOS) receivers into the JBFSA architecture including aircraft, unmanned aerial vehicles (UAVs) and aerostats, field an enhanced Mission Management Center (MMC) capability, and serve as the benchmark/set the stage to evaluate multi-level security challenges and the dissemination of select JBFSA data to Coalition COP devices. All candidate solutions will be validated before transitioning to the services for sustainment and extended user evaluation.

Family of Interoperable Operational Pictures (FIOP) - FIOP 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 herein will lead to the underpinnings of Network Centric Operational Warfare. Per OSD Budget Decision, FIOP, PE 0207443F Project # 675137 is terminated for FY06-11.

FIOP 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 (SIGP) programs and the JBFSA ACTD. Note: Per OSD Budget Decision, the SIGP program is also cancelled for FY06-11.

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing systems.

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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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	8.464	2.294	0.000	0.000
(U)	Current PBR/President's Budget	8.241	2.268	0.000	0.000
(U)	Total Adjustments	-0.223	-0.026		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.026		
	Congressional Increases				
	Reprogrammings	-0.223			
	SBIR/STTR Transfer				

(U) Significant Program Changes:

Not Applicable.

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5151 Blue Force Tracking	8.241	2.268	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

In FY2004, Project Number 635151, Joint Blue Force Situation Awareness (JBFSA) Advanced Concepts Technology Demonstration (ACTD), efforts were transferred from PE0207028F, Joint Expeditionary Force Experiment (JEFX), Project Number 674991, Joint Distributed Engineering Plant. Although this PE is entitled "Integrated Broadcast Service (IBS)", this project does not use IBS funding. Description of the IBS program is provided in PE 63850F, Budget Activity 4.

(U) A. Mission Description and Budget Item Justification

Joint Blue Force Situational Awareness (JBFSA) Objectives - Provide, through a collection of systems, a globally responsive Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capability to detect, track, identify and assess all adversary, neutral and friendly (e.g., US, Joint, and Coalition) forces in the assigned areas of responsibility (AORs); increase combat effectiveness by improving air-to-ground time sensitive targeting (TST) and blue force situational awareness to ensure prosecution of the right targets and the reduction of fratricide.

JBFSA ACTD - This JBFSA ACTD, a continuation of an ACTD started in CY2003, will focus on the integration of disparate systems (no single system or mission application exists today), data interoperability and common operating displays. Tasks include the development, integration, validation, and transition of web-enabled Common Operating Picture (COP) and User Defined Operating Picture (UDOP) capabilities for Joint Blue Force Tracking. Specific sub-areas include the integration of current JBFSA devices into the JBFSA architecture, disseminate and display a consistent blue force picture within the Global Command and Control Systems (GCCS) family of systems (FOS) COP and select tactical level display devices, identification of additional JBFSA data dissemination paths (satellite communications (SATCOM), Global Broadcast Service (GBS), Integrated Broadcast Service (IBS), Tactical networks, etc.), integration of line-of-sight (LOS) receivers into the JBFSA architecture including aircraft, unmanned aerial vehicles (UAVs) and aerostats, field an enhanced Mission Management Center (MMC) capability, and serve as the benchmark/set the stage to evaluate multi-level security challenges and the dissemination of select JBFSA data to Coalition COP devices. All candidate solutions will be validated before transitioning to the services for sustainment and extended user evaluation.

Family of Interoperable Operational Pictures (FIOP) - FIOP 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 herein will lead to the underpinnings of Network Centric Operational Warfare. Per OSD Budget Decision, FIOP, PE 0207443F Project # 675137 is terminated for FY06-11.

FIOP 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 (SIGP) programs and the JBFSA ACTD. Note: Per OSD Budget Decision, the SIGP program is also cancelled for FY06-11.

Exhibit R-2a, RDT&E Project Justification

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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)	Demonstration/Exercise Support		0.556		
(U)	CONOPS/Tactics, Techniques, and Procedures (TTP) & Documentation Development	0.180	0.262		
(U)	Purchase/Lease and Installation of BFT Devices, Training, and Purchase of SATCOM air time	0.500			
(U)	Transition Support		0.780		
(U)	Maintain a Program Management Office, including financial and demonstration supervision	0.230	0.074		
(U)	FIOP JBFSA Integrated Architecture Development and Interoperability enhancements	5.636	0.000		
(U)	Total Cost	8.241	2.268	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Not Applicable										

(U) D. Acquisition Strategy

The Acquisition Strategy for this effort will be to use existing precompeted contracts and add task/delivery orders to them.

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0603924F High Energy Laser Advanced Technology Program

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	10.473	9.760	5.801	3.671	3.725	4.043	4.137	4.207	Continuing	TBD
5095	High Energy Laser Advanced Technology Program	10.473	9.760	5.801	3.671	3.725	4.043	4.137	4.207	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 Joint Technology Office.

(U) A. Mission Description and Budget Item Justification

This program funds high energy laser (HEL) advanced technology development through the HEL Joint Technology Office (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 Department of Defense (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. Note: In FY 2005, Congress added $1.3 million for the Joint High Power Solid State Laser program.

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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	10.818	8.547	6.136	3.826
(U)	Current PBR/President's Budget	10.473	9.760	5.801	3.671
(U)	Total Adjustments	-0.345	1.213		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.087		
	Congressional Increases		1.300		
	Reprogrammings				
	SBIR/STTR Transfer	-0.345			

(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 High Energy Laser (HEL) Joint Technology Office (JTO).

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603924F High Energy Laser Advanced Technology Program**

C. Performance Metrics
Under Development.

Exhibit R-2a, RDT&E Project Justification

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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**

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5095	High Energy Laser Advanced Technology Program	10.473	9.760	5.801	3.671	3.725	4.043	4.137	4.207	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This program funds high energy laser (HEL) advanced technology development through the HEL Joint Technology Office (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 Department of Defense (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. Note: In FY 2005, Congress added $1.3 million for the Joint High Power Solid State Laser program.

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 2004	FY 2005	FY 2006	FY 2007
(U)	MAJOR THRUST/CONGRESSIONAL ADD: Develop solid state lasers that have potential as future 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.	5.336	6.113	4.165	2.845
(U)	In FY 2004: Participated in the Joint High Power Solid State Laser (JHPSSL) project to demonstrate 25 kilowatt lasers. Continued development of a design for a 100 kilowatt laser. Continued development of high-power laser component technology addressing all elements of the laser (e.g., diode pump lasers, wavefront control technology, thermal control, beam combining, etc.).				
(U)	In FY 2005: Participate in the JHPSSL project and demonstrate three 25 kilowatt lasers. Develop test hardware for and conduct independent, government testing of these lasers. Factors such as performance, cost, etc. will be evaluated between the various approaches funded by the Army, Air Force, and HEL JTO. Continue development of a design for a 100 kilowatt laser. Conduct a proposal call for the 100 kilowatt JHPSSL, perform the selection process, and initiate funding to one or more contractors. Continue development of high-power laser component technology addressing all elements of the laser (e.g., diode pump lasers, wavefront control technology, thermal control, beam combining technology, etc.). Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.				
(U)	In FY 2006: Continue to participate in the Joint High Power Solid State Laser (JHPSSL) effort to				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

	demonstrate 100 kilowatts. Assess advanced configurations for power scaling such as combined fiber lasers. Conduct necessary studies to understand and improve fieldability of solid state lasers. Continue to assemble successful pieces from individual applied research projects (e.g., long-life diode-laser drivers, thin-disk amplifiers, phase-conjugate mirrors, mist cooling) into an advanced demonstration of solid state laser sub-systems. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.				
(U)	In FY 2007: Continue to participate in the JHPSSL project to demonstrate a 100 kilowatt laser. The 100 kilowatt demonstration(s) will occur during this period. Provide for independent, government-sponsored measurement of the 100 kilowatt laser(s). Explore the need for other high value experiments to follow the 100 kilowatt program and begin planning as appropriate. Continue the component development program with emphasis on improvement of existing power-scaling architectures as well as next generation components and architectures. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(U)					
(U)	MAJOR THRUST: Develop beam-control technologies for surface, air, and space mission areas, as well as develop supporting technologies.	1.236	2.247	0.436	0.326
(U)	In FY 2004: Demonstrated beam control component technology, including high power optical components (windows, coatings, etc), wavefront sensors, wavefront control algorithms, pointing and tracking technology, and atmospheric characterization.				
(U)	In FY 2005: Maintain the component development program. Begin planning for a high-value integrated beam control demonstration that would use successful pieces from individual applied research projects (e.g., deformable mirrors, wavefront sensors, advanced tracking and compensation algorithms) and specifically address tactical applications. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.				
(U)	In FY 2006: Continue component development program and pursuit of an integrated beam control demonstration addressing tactical applications. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.				
(U)	In FY 2007: Continue pursuit of an integrated beam control demonstration addressing tactical applications. Address advanced beam control architectures and algorithms that have not already been tested in the integrated beam control demonstration. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(U)					
(U)	MAJOR THRUST: Develop modeling and simulation technologies that support an end-to-end laser system model. Work in this thrust completed in FY 2004.	0.983	0.000	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)	In FY 2004: Developed the infrastructure for integrating existing and emerging high-fidelity component models into an end-to-end engagement model, thereby allowing improvement of the high energy laser (HEL) systems design and reducing the need for expensive field testing.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop free electron laser (FEL) technologies that scale to high power and permit FELs to be fielded on military platforms.	1.473	1.000	1.200	0.500
(U)	In FY 2004: Demonstrated enabling technologies for scaling FELs to weapon class power levels. Achieved 10 kilowatts. Demonstrated a photocathode model as a tool to design advanced robust long-life photocathodes. Demonstrated radio frequency cavities capable of high current operation. Began laboratory testing to determine if new optical coating methods produce the robustness required for high power applications.				
(U)	In FY 2005: Demonstrate FEL system components for power scaling. A 10 kilowatt laboratory demonstrator will be used as a test bed. Demonstrate a separate photocathode test bed and refine photocathode models as a tools to design robust, long-life photocathodes. Investigate development of a separate injector test stand in conjunction with the photocathode test bed. Begin analysis of ship-board integration requirements. Conduct Service and Agency proposal call for FY 2005 and fund first year of selected efforts.				
(U)	In FY 2006: Develop and demonstrate technologies leading to a 100 kilowatt class demonstrator. Develop end-to-end simulation to develop refined system level technology for power scaling. Continue analysis of shipboard integration requirements. Conduct an industry proposal call for FY 2006, fund first year of selected efforts, and fund second year of FY 2005 Service and Agency efforts.				
(U)	In FY 2007: Examine all system components including compact electron beam lines, optical beam handling outside the laser, shipboard thermal management systems, and compact electrical power conditioning systems. Continue to fund the contract efforts started in FY 2006, conduct Service and Agency proposal call for FY 2007, and fund first year of selected efforts.				
(U)					
(U)	MAJOR THRUST: Develop chemical laser advanced technologies and concepts that allow higher performance and more supportable chemical lasers. Work in this thrust will be completed in FY 2005.	1.445	0.400	0.000	0.000
(U)	In FY 2004: Demonstrated closed-cycle and recyclable chemical lasers, especially chemical oxygen iodine lasers appropriate for tactical applications.				
(U)	In FY 2005: Demonstrate chemical laser generators that are capable of operating in a gravity free				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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**

environment.
(U) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.

(U)	Total Cost	10.473	9.760	5.801	3.671

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

		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U)	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										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
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)**

Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

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Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0207423F Advanced Communications Systems**

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	11.264	13.709	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5084 AJCN	11.264	13.709	0.000	0.000	0.000	0.000	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 (AJCN), 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: assure air-to-air communication interoperability, electronic warfare (EW), signals intelligence (SIGINT), and Information Operations (IO). 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 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	11.951	13.917		
(U) Current PBR/President's Budget	11.264	13.709		
(U) Total Adjustments	-0.687	-0.208		
(U) Congressional Program Reductions		-0.208		
Congressional Rescissions				
Congressional Increases				
Reprogrammings				
SBIR/STTR Transfer	-0.687			

(U) Significant Program Changes:

The funding decrease between FY05 and FY06 due to AJCN ACTD completion

Exhibit R-2a, RDT&E Project Justification	DATE February 2005

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 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5084 AJCN	11.264	13.709	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

The Adaptive Joint Command, Control, Communications and Computing, Intelligence, Surveillance and Reconnaissance (C4ISR) Node (AJCN), 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: assure air-to-air communication interoperability, electronic warfare (EW), signals intelligence (SIGINT), and Information Operations (IO). 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 2004	FY 2005	FY 2006	FY 2007
(U) System Engineering and Integration	10.585	10.443		
(U) Field Evaluation/Military Utitlity Assessment	0.586	2.693		
(U) Concept of Operations (CONOPS)/TTP Development and Test	0.093	0.573		
(U) Total Cost	11.264	13.709	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) N/A										

(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 2005**

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0401840F AMC COMMAND & CONTROL SYSTEM

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
Total Program Element (PE) Cost	8.027	5.985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5085 Agile Transportation	8.027	5.985	0.000	0.000	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 2004	FY 2005	FY 2006	FY 2007
(U) Previous President's Budget	7.757	5.985	0.000	0.000
(U) Current PBR/President's Budget	8.027	5.985	0.000	0.000
(U) Total Adjustments	0.270	0.000		
(U) Congressional Program Reductions	-0.051			
Congressional Rescissions				
Congressional Increases				
Reprogrammings	0.489			
SBIR/STTR Transfer	-0.168			

(U) Significant Program Changes:

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0401840F AMC COMMAND & CONTROL SYSTEM**	PROJECT NUMBER AND TITLE **5085 Agile Transportation**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5085 Agile Transportation	8.027	5.985	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	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.

	B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U)	Continue development of Strategic Transportation Planner (STP) to support optimization, mode determination broker and schedular.	1.720	1.500		
(U)	Continue development of Aircrew Scheduler, Airbase Tactical Transportation Planner, and Aircraft Maintenance Schedular to support the tactical echelon for optimization of assets.	2.912	1.685		
(U)	Continue development of deep Collaboration 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	0.800		
(U)	Continue development of AMC Operational Transportation Planner to support the operational echelon for optimization of assets, mode determination and schedular.	2.493	2.000		
(U)	Total Cost	8.027	5.985	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0401840F AMC COMMAND & CONTROL SYSTEM**	PROJECT NUMBER AND TITLE **5085 Agile Transportation**

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) PE 063750D8Z, DUSD (AS&C)										
(U) PE 0603728D8Z, DUSD (S&T)										
(U) PE 0604764K, DISA (AITS/JPO)										
(U) PE 41119F										
(U) PE 41115F										
(U) PE 0603772A (USA)										

(U) D. Acquisition Strategy

Use spiral development, obtaining Indefinite Delivery and Indefinite Quantity contracts.

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PE NUMBER: 0804757F
PE TITLE: JOINT NATIONAL TRAINING CENTER

Exhibit R-2, RDT&E Budget Item Justification

DATE
February 2005

BUDGET ACTIVITY
03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE
0804757F JOINT NATIONAL TRAINING CENTER

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	2.827	2.913	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
5124	Training Transformation	2.827	2.913	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD

In FY04 84757F, Joint National Training Capability, was a new PE and included new start efforts.
NOTE: This PE transfers to BA07 in FY06 and beyond. All FY06 and beyond funding is identified in the same PE84757F but in BA07.

(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 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 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	2.915	2.939		
(U)	Current PBR/President's Budget	2.827	2.913		
(U)	Total Adjustments	-0.088	-0.026		
(U)	Congressional Program Reductions		-0.026		
	Congressional Rescissions				
	Congressional Increases				
	Reprogrammings				
	SBIR/STTR Transfer	-0.088			

(U) Significant Program Changes:

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0804757F JOINT NATIONAL TRAINING CENTER**	PROJECT NUMBER AND TITLE **5124 Training Transformation**	

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5124 Training Transformation	2.827	2.913	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

NOTE: This PE transfers to BA07 in FY06 and beyond. All FY06 and beyond funding is identified with the same PE84757F but in BA07.

(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 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 2004	FY 2005	FY 2006	FY 2007
(U) Begin Close Combat Tactical Trainer Upgrades for Tactical Air Control Party (TACP) Training	0.893	0.000		
(U) Begin/Continue Air Force Modeling and Simulation Tool Kit (AFMSTT) Air Warfare Simulation (AWSIM) Upgrades	0.865	0.875		
(U) Begin/Continue Test & Evaluation Network Architecture (TENA)	0.500	0.875		
(U) Begin Tactical Air Data Info Link (TADIL) Joint Fix (J Fix)	0.023	0.000		
(U) Begin High Level Architecture (HLA) Transfer	0.040	0.000		
(U) Begin TADIL - J Link-16 Capability	0.182	0.000		
(U) Begin/Continue Theater Battle Management Communications System (TBMCS)	0.227	0.913		
(U) Begin/Continue basic operating support, system acquisition, engineering support and development studies/efforts	0.097	0.250		
(U) Total Cost	2.827	2.913	0.000	0.000

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

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0604735F, Combat Training Ranges RDT&E AF	24.077	21.326							0.000	45.403
(U) PE 0207429F, Combat Training Range Equipment OPAF	81.459	32.569							0.000	114.028
(U) PE 0804757F, Joint National	2.430	0.000							0.000	2.430

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0804757F JOINT NATIONAL TRAINING CENTER**	PROJECT NUMBER AND TITLE **5124 Training Transformation**

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

Training Center, OPAF

(U) **D. Acquisition Strategy**

The acquisition strategy will be competitive, with cost plus fixed fee and firm fixed price contracts.