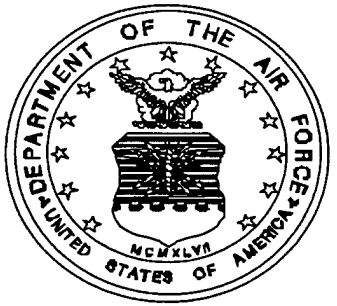
UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE

RDT&E DESCRIPTIVE SUMMARIES FOR

FY 2001 PRESIDENT'S BUDGET

VOLUME I



FEBRUARY 2000

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Endurance Unmanned Aerial Vehicles	0305205F	1,427
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Pollution Prevention	0605854F	973
Precision Attack Systems	0207249F	599
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Space Technology	0602601F	137
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Spacelift Range System	0305182F	1,411
SPACETRACK	0305910F	1,519
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Specialized Undergraduate Pilot Training	0604233F	659
Submunitions	0604604F	767
Support Systems Development	0708611F	1,653
Tactical AIM Missiles	0207161F	1,087
Tactical Terminals	0305158F	1,381
Target Systems Development	0604258F	925
Test and Evaluation Support	0605807F	957
Theater Air Control Systems	0207412F	1,129
Theater Battle Management (TBM) C4I	0207438F	1,157
Theater Missile Defenses	0208060F	1,223
Threat Simulator Development	0604256F	913
Titan Space Launch Vehicles	0305144F	1,375
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Fiscal Year 2001 Budget Estimate Submission
RDT&E Descriptive Summaries, Volume I
February 2000

INTRODUCTION AND EXPLANATION OF CONTENTS

1. (U) GENERAL. 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 FY2001 President's Budget Submission (PB). All formats in this document are in accordance with the guidelines of the DoD Financial Management Regulation, Volume 2B, Chapter 5 with the exception of the R-3 exhibit. The Air Force could not support the format matrix because our programs do not track their programs in the manner required to complete the exhibit.

a. Contents: Exhibits R-2, R-2a and R-3 provide narrative information for all RDT&E program elements and projects within the USAF FY2001 RDT&E program except the classified program elements. The formats and contents of this document are in accordance with the guidelines and requirement of the Congressional committees insofar as possible. The F-22 "P-5" budget exhibit directed by the Authorization Conference Report number 106-371 has been inserted behind the R-3 exhibit for program element 0604239F.

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. The Justification book has been assembled in accordance with DoD Financial Management Regulation 7000.14, Vol. 2B Cpt 5, Sec 050302 with the exception of the R-1; Project Funding Listing which was distributed under a separate cover due to classification.

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.

PROGRAM ELEMENT COMPARISON SUMMARY

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Program Element	Remarks
BUDGET ACTIVITY 1: BASIC RESEARCH	
BUDGET ACTIVITY 2: APPLIED RESEARCH	
0602202F, Human Effectiveness Applied Research	Project 6219 was terminated after FY 1999, but Congress added funding in FY 2000.
0602269F, Hypersonic Technology Program	Project 1025 funding for this program in FY01 is contained in PEs 0602023F Aerospace Propulsion, 0603203F Aerospace Propulsion Subsystems Integration and 0603216F Aerospace Propulsion and Power Technology.
0602601F, Space Technology	Project 1011 all rocket propulsion efforts will be transferred to 0602203F, Project 4847. Project 3326 all lasers and imaging efforts will be transferred to PE 0602605F, Projects 4866 and 4867.
0602605F, Directed Energy Technology	Projects 4866 and 4867 were transferred from PE 0602601F.
0602702F, Command, Control and Communications	Project 4506, Surveillance Technology will be transferred to Project 4594, PE 0602702F and Project 7622, PE 0602204F beginning in FY01.
BUDGET ACTIVITY 3: ADVANCED TECHNOLOGY DEVELOPMENT	
0603726F, Aerospace Information Technology Systems Integration	In FY 2001, the efforts in Project 632863, Integrated Photonics, will be conducted in PE 0603203F, Project 63665A. Prior to FY 2001, the efforts in Project 634850, Collaborative C2, were performed in PE 0603253F, Projects 632735 and 63666A.
BUDGET ACTIVITY 4: DEMONSTRATION AND VALIDATION	
0603441F, Space Based IR Arch (Dem/Val)	SBIRS Low efforts performed in Project 0007 will be transferred to PE 0604442F, Project 4598 in FY00 and 01.
0603800F, Joint Strike Fighter	Project 2025 will complete in FY01.

PROGRAM ELEMENT COMPARISON SUMMARY

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Program Element	Remarks
BUDGET ACTIVITY 4: DEMONSTRATION AND VALIDATION Continued	
0603854F, Wideband Milsatcom	Project 4870 is a FY01 new start.
0603856F, Air Force/NRO Partnership	Project 4782, the Air Force/National Program Cooperation (AFNPC) effort is a FY01 new start.
0603859F, Pollution Prevention	Project 4852, Pollution Prevention will be transferred from PE 0605854F, previously in Budget Activity 6 beginning in FY01.
BUDGET ACTIVITY 5: ENGINEERING AND MANUFACTURING DEVELOPMENT	
0207249F, Precision Attack Systems Procurement	Project 2693 is a FY01 new start.
0604012F, Joint Helmet Mounted Cueing System	Project 4789 the Joint Helmet Mounted Cueing Systems effort is a FY01 new start.
0604201F, Integrated Avionics Planning and Development	Project 2257 will complete in FY01.
0604270F, EW Development	Project 8462 is a FY01 new start.
0604602F, Armament Ordnance Development	Project 3133 will complete in FY01.
0604327F, Hardened Target Munitions	Project 4641 will complete in FY00.
0604617F, Agile Combat Support	Project 2895 will complete in FY01.
0604706F, Life Support System	Project 412A, the K-36/3.5A Ejection Seat effort is a FY01 new start.
0604754F, Joint Tacital Information Distribution System	Project 4749, the Air Defense System Integrator effort is a FY01 new start
0604851F, ICBM	Project 4210 completes in FY00.
BUDGET ACTIVITY 6: MANAGEMENT AND SUPPORT	
0604256F, Threat Simulator Development	Project 3321, Joint Modeling and Simulation System (JMASS) funding and responsibility transferred in FY00 to PE 0207601F.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
BUDGET ACTIVITY 6: MANAGEMENT AND SUPPORT Continued	
0604256F, Threat Simulator Development	Project 7500, Foreign Materiel Acquisition and Exploitation (FMA/E) established a funding line in FY00.
0605808F, Development Planning	PE terminated in FY00.
0604759F, Major T&E Investment	Project 4759, two I&M projects started in FY00: Modeling & Simulation T&E Resources (MASTER); and Seeker T&E.
0604759F, Major T&E Investment	Project 4759, the Advanced Range Telemetry Integration (ARTM) was developed by CTEIP (OSD PE 0604940D). The ARTM I&S (Integration and Support) funding in this PE begins in FY01. Integrates the OSD developed ARTM into the Edwards AFB range.
0605854F, Pollution Prevention	Program moved into Budget Activity 4, to PE 0603859F beginning in FY01.
BUDGET ACTIVITY 7: OPERATIONAL SYSTEM DEVELOPMENT	
0101120F, Advanced Cruise Missile	Project 4798, the AGM-129A Advanced Cruise Missile Service Life Extension Program effort is a FY01 new start.
0207133F, F-16 Squadrons	Project 2671, the Automated Ground Collision Avoidance system, Falcon Star, and Targeting Pod/HARM Targeting Systems efforts are FY01 new starts.
0207141F, F-117A Squadrons	Project 3956, the F-117 Enhanced GBU-27 effort is a FY01 new start.
0303140F, Information Systems Security Program	Project 4585, Cryptologic 2020, will be funded under PE 33401F, Comm Sec, Project 4861, Cryptologic 2020, beginning in FY01.
0303601F, Milsatcom Terminals	Project 2487, the Airborne Wideband Terminal and Ground Multiband Terminal effort are a FY01 new start.
0305205F, Endurance Unmanned Aerial Vehicles	Project 4883 is a FY01 new start. Project 4816 will merge into 4799 in FY00.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	**Remarks**
BUDGET ACTIVITY 7: OPERATIONAL SYSTEM DEVELOPMENT Continued	
0305206F, Airborne Reconnaissance System	Project 4882 is a FY01 new start.
0305207F, Manned Reconnaissance system	Project 4820 will be transferred to PE 0305202F beginning in FY01.
0305910F, Spacetrack	Project 4791, the Ground-Based Electro-Optical Deep Space Surveillance Sustainment effort is a FY00 new start.
0401115F, C-130 Airlift Squadrons	Project 4885 is a FY01 new start.
0401130F, C-17 Aircraft	Project 4886 is a FY01 new start.
0404011F, Special Operations Forces	Project 4860 is a FY01 new start.
0708612F, Computer Resources Support Improvement Program	FY01 funding was moved to this PE from PE 0708611F, Project 67309.
1001018F, NATO Joint Stars	Project 0002, the Project Definition of NATO Advanced Trans Atlantic Radar Project effort is a FY01 new start pending Congressional approval.

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

DATE: February 2000

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	197,507	213,822	206,149	204,094	202,046	199,897	197,822	Continuing	TBD
612301	Physics	21,401	25,690	22,038	21,952	21,964	22,126	22,700	Continuing	TBD
612302	Solid Mechanics and Structures	17,325	15,907	11,489	11,258	11,157	10,872	10,457	Continuing	TBD
612303	Chemistry	24,304	27,215	26,735	26,681	26,693	26,635	27,421	Continuing	TBD
612304	Mathematical and Computer Sciences	32,388	32,557	33,153	32,683	32,237	31,590	30,971	Continuing	TBD
612305	Electronics	22,021	24,144	24,246	24,082	23,710	23,247	22,728	Continuing	TBD
612306	Materials	11,407	13,102	14,082	14,200	14,246	14,378	14,920	Continuing	TBD
612307	Fluid Mechanics	6,766	9,858	9,712	9,769	9,886	10,103	10,616	Continuing	TBD
612308	Propulsion	13,766	20,027	18,648	18,486	18,390	18,413	18,540	Continuing	TBD
612310	Atmospheric Sciences	5,217	5,594	0	0	0	0	0	Continuing	TBD
612311	Space Sciences	6,404	8,524	14,894	14,786	14,768	14,866	15,054	Continuing	TBD
612312	Biological Sciences	12,256	13,326	13,556	13,671	13,632	13,540	13,481	Continuing	TBD
612313	Human Performance	11,790	13,057	13,211	12,708	12,307	11,929	10,934	Continuing	TBD
614113	External Research Programs Interface	12,462	4,821	4,385	3,818	3,056	2,198	0	Continuing	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences

Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, Project 612310, Atmospheric Sciences, is eliminated with space sciences efforts being moved into Project 612311, Space Sciences.

(U) **A. Mission Description**

This program, managed by the Air Force Office of Scientific Research (AFOSR), comprises extramural research activities in academia and industry and in-house investigations in Air Force laboratories. The program element funds fundamental broad-based scientific and engineering research in technologies critical to the Air Force mission. These technologies include physics, solid mechanics and structures, chemistry, mathematical and computer sciences, electronics, materials, fluid mechanics, propulsion, atmospheric sciences, space sciences, biological sciences, and human performance. All projects are coordinated through the Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds across the Department of Defense. All technology areas are subject to long-range research planning and technical review by tri-Service scientific planning groups. Note: Congress added $2.0 million for the Center for Adaptive Optics and $3.0 million for Coal-Derived Jet Fuel in FY 1999. Congress added $3.8 million for the Center for Adaptive Optics and $3.0 million for Coal-Derived Jet Fuel, and earmarked $0.6 million of appropriated funds in FY 2000.

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

This program is 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) **C. Program Change Summary ($ in Thousands)**

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	209,731	209,505	177,513	
(U)	Appropriated Value	210,395	216,305		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-664	-2		
	b. Small Business Innovative Research	-5,524			
	c. Omnibus or Other Above Threshold Reprogram		-1,124		
	d. Below Threshold Reprogram	-5,594			
	e. Rescissions	-1,106	-1,357		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			28,636	
(U)	Current Budget Submit/FY 2001 PBR	197,507	213,822	206,149	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences

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

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to a joint re-evaluation of priorities by the Air Force and the Office of the Secretary of Defense.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612301

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612301 Physics	21,401	25,690	22,038	21,952	21,964	22,126	22,700	Continuing	TBD

(U) **A. Mission Description**

Physics research provides the fundamental understanding to improve technologies critical to Air Force lasers, avionics, and microwaves. The research enables improvements in electromagnetic countermeasures, protection against nuclear weapons effects, communications, small satellites, and non-destructive, and non-intrusive testing and analysis. It also supports the development of new sensors. The primary areas of research investigated by this project are laser and optical physics; atomic, molecular, and imaging physics; and plasma physics.

(U) FY 1999 ($ in Thousands)

(U) $7,082 Performed research in laser and optical physics for aerospace applications, and optical devices for spoofing and damaging infrared seeking missiles, countermeasures, and directed energy weapons devices. Directed studies toward developing optimum lasers for high image quality telescopes for space surveillance. Examined the physics of lethal and non-lethal directed energy for speed-of-light target kill.

(U) $6,315 Studied atomic, molecular, and imaging physics to enhance space surveillance capabilities in the area of target detection and recognition. Developed advanced atomic molecular processes to produce ideal performance time standards.

(U) $5,867 Conducted plasma physics research for future directed energy weapons, affordable low-observables, and space communications and surveillance. Advanced state-of-the-art in explosive-driven power generators. Examined the feasibility of using collisional ionized gas volumes to protect friendly assets from directed energy weapon threats.

(U) $2,137 Performed research in adaptive optics for application in advanced ground-based telescopes.

(U) $21,401 Total

(U) FY 2000 ($ in Thousands)

(U) $9,801 Perform laser and optical physics research for new laser devices and controls to make possible spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and enable new directed energy weapons. Investigate the physics of semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Study a new high-power laser to replace oxygen-iodine for the next generation of the airborne laser. Examine pico-second and femto-second (extremely fast) lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Evaluate micro-electro-mechanical systems (MEMS) to enable specialized devices for micro-satellite applications.

(U) $7,533 Conduct research in plasma physics to investigate fundamental atomic and molecular interactions for future directed-energy weapons, affordable low-observables, and space communications and surveillance. Examine the controlled resistive, dielectric, and conducting behavior of plasmas

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
	PROJECT: 612301

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

(U) FY 2000 ($ in Thousands) Continued

and the effects of plasmas on transmission, reflection, and absorption of electromagnetic waves to enable novel stealth aircraft mechanisms.

(U) $4,556 Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information for use in improved explosives and fuels, enhanced space surveillance, superior communications, and precision navigation. Identify interactions of atoms in strong fields to discover novel lasers for Air Force applications. Examine isomeric, high density energy storage for flash radiation devices and to make long flight missions possible without refueling.

(U) $3,800 Continue research on adaptive optics to study phenomena and devices associated with guide star adaptive optical telescopes for laser beam projection into space, and deep space surveillance and identification.

(U) $25,690 Total

(U) FY 2001 ($ in Thousands)

(U) $10,002 Perform laser and optical physics research for new laser devices and controls to make possible spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and enable new directed energy weapons. Continue to investigate semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Investigate a new high-power laser to replace oxygen-iodine for the next generation of the airborne laser. Examine pico-second and femto-second (extremely fast) lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Expand studies of micro-electro-mechanical systems (MEMS) and laser photochemical processes to enable specialized devices for micro-satellite applications.

(U) $7,713 Conduct research in plasma physics to investigate fundamental atomic and molecular interactions for future directed-energy weapons, affordable low-observables, and space communications and surveillance. Explore physics issues relating to plasma processing of materials at atmospheric pressures to contribute to higher frequency, more efficient, high power microwave systems. Examine the controlled resistive, dielectric, and conducting behavior of plasmas, and the effects of plasmas on transmission, reflection, and absorption of electromagnetic waves to enable novel stealth aircraft mechanisms. Investigate the feasibility of using collisional ionized gas volumes to protect friendly assets from directed energy.

(U) $4,323 Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information for use in improved explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Investigate the trapping and cooling of atoms and ions to enrich high-resolution spectroscopy. Characterize interactions of atoms in strong fields to discover novel lasers for Air Force applications. Continue to examine isomeric, very high density energy storage for flash radiation devices and to make long flight missions possible without refueling.

(U) $22,038 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 612301

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Space Technology.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602605F, Directed Energy Technology.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences	PROJECT: 612302

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612302 Solid Mechanics and Structures	17,325	15,907	11,489	11,258	11,157	10,872	10,457	Continuing	TBD

(U) **A. Mission Description**

Solid Mechanics and Structures basic research aims to drastically improve the behavior of aerospace materials and structures by better describing how they wear and are damaged. It also expands fundamental knowledge of the aero-elastic and acoustic behavior of airframes and engine structures, and the dynamic behavior of launch vehicles and space structures. The goal is the cost-effective development, and safe, reliable operation of superior Air Force weapons and defensive systems. Research topics include: the design of advanced material structures on a micro scale; modeling and simulation of the dynamic behavior of aircraft, missiles, and large space structures; and technology integration for the performance and survivability enhancement of these systems. The primary areas of research investigated by this project are mechanics of composite materials, structural mechanics and dynamics, and shock physics.

(U) FY 1999 ($ in Thousands)

(U) $6,375 Studied thermomechanical behavior of advanced structural materials, including micromechanics of high-temperature composite materials for aerospace structural systems and coatings. Investigated the fracture behavior and thermomechanical behavior of high temperature alloys and composite materials for engine and hypersonic vehicle applications.

(U) $5,850 Modeled materials for aerospace structures, including dynamics and mechanics of materials at very small scales, as necessary for the development of micro-electromechanical systems. Developed fundamental understanding of the behavior of aeroelastic structures and conducted research into the behavior of actuator/structure interaction for control of shell-structures in vibro/acoustic environments.

(U) $5,100 Sought fundamental particulate mechanics knowledge, including quantitative relationships to describe the fundamental mechanics governing the behavior of geomaterial systems. Investigated the fundamental relationship of geomaterials undergoing high strain rate loadings with increased confining pressures as occurs when facilities are impacted by penetrating weapons.

(U) $17,325 Total

(U) FY 2000 ($ in Thousands)

(U) $3,339 Study mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles that will enable revolutionary improvements in design and capability of air and space weapon systems. Examine the fundamental behavior of dynamic systems to enable the development of efficient computational techniques and design methodologies for turbine engines, air vehicles, launch systems, and orbital weapon systems. Seek fundamental knowledge on potential air vehicle components, including metallic and inter-metallic alloys, and solid rocket propellants and liners to enhance air and space vehicle performance and longevity.

(U) $10,240 Expand structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 612302

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

(U) FY 2000 ($ in Thousands) Continued

multi-mission uninhabited air vehicles. Evaluate the behavior of distributed sensor and actuator systems to achieve major improvements in the design and performance prediction of aerospace weapon systems. Identify system techniques to analyze vehicle integrity and achieve major increases in structural longevity of Air Force weapon systems.

(U) $2,328 Perform dynamics and shock physics research to identify the fundamental damage mechanisms in structural materials in order to model and predict effects of weapon impacts and assess damage of penetrating munitions. Devise fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems.

(U) $15,907 Total

(U) FY 2001 ($ in Thousands)

(U) $2,410 Study mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles that will enable revolutionary improvements in capability and design of air and space weapon systems. Continue to explore the fundamental behavior of dynamic systems and develop efficient computational techniques and design methodologies for turbine engines, air vehicles, launch systems, and orbital weapon systems. Continue efforts to seek fundamental knowledge on air vehicle components, including metallic and inter-metallic alloys, advanced composite materials, and solid rocket propellants and liners to enhance air and space vehicle performance and longevity.

(U) $7,399 Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission uninhabited air vehicles. Evaluate the behavior of distributed sensor and actuator systems to improve the design and performance prediction of aerospace systems. Identify fundamental structural design characteristics underpinning the life cycle of airframe structures. Develop system techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapon systems.

(U) $1,680 Perform dynamics and shock physics research to identify the fundamental damage mechanisms in structural materials to model and predict effects of weapon impacts and assess damage of penetrating munitions. Devise fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems. Investigate the mechanical and dynamic behavior of micro-scale structures leading to exceptional capabilities in micro-electro-mechanical systems (MEMS).

(U) $11,489 Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 612302

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602269F, Hypersonic Technology Program.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 612303

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612303 Chemistry	24,304	27,215	26,735	26,681	26,693	26,635	27,421	Continuing	TBD

(U) **A. Mission Description**

Chemistry research seeks bold innovation in understanding and controlling chemical reactions to develop new materials, improve synthesis of existing materials, control energy flow and storage, and control the interaction between materials and their environments. Studies address chemical dynamics and energy transfer processes that foster advances in laser weaponry, allow predicting infrared, optical and radar signatures, and enable the synthesis of new chemical propellants. Critical research topics include novel synthesis and characterization of lower cost and higher performance functional and structural materials, electronic and photonic materials, nano-structures, electromagnetic and conventional weaponry, and propellants. 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. The primary areas of research are molecular dynamics and theoretical chemistry, polymer chemistry, and surface science.

(U) FY 1999 ($ in Thousands)

(U) $10,254 Investigated impact of emissions from solid rocket motor exhaust on the atmosphere. Studied rates of reactions of ions with fuel constituents to enable ways to improve high-speed propulsion. Developed and synthesized novel energetic compounds for application as high energy density rocket propellants. Investigated new approaches for generating novel chemical laser systems.

(U) $7,262 Achieved large electro-optical coefficient polymers for highly efficient radio frequency (RF) link applications. Investigated charge-trapping mechanism in photorefractive polymers to improve their response speed. Investigated nanostructures for photonic bandgap applications. Improved impact toughness of polymers based on nanophase separation control.

(U) $6,788 Developed an atomistic model for aircraft aluminum corrosion. Synthesized and evaluated an advanced vapor lubricant for operations in the extreme temperature environments of high performance turbine engines. Developed a new nanolithographic method for generation of novel surface nanostructures. Conducted research on unique energy-dense materials for compact power systems.

(U) $24,304 Total

(U) FY 2000 ($ in Thousands)

(U) $12,037 Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow and to develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Devise methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Seek fundamental knowledge to formulate new high energy density materials for rocket propellants.

(U) $9,144 Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions to develop

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 612303

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

(U) FY 2000 ($ in Thousands) Continued

advanced polymeric materials that significantly improve aircraft and spacecraft performance and life-spans. Evaluate spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigate polymer coatings to enable advanced sensors applications. Develop fundamental knowledge to formulate materials that have suitable optical transitions for highly efficient optical limiting properties to enable flexible communications in space operations. Evaluate high temperature nanocomposite polymers for superior space propulsion.

(U) $6,034 Study surface science to investigate the chemistry of surface processes for accurate detection and prevention of corrosion and degradation of air and space systems, and formulation of novel lubricants. Investigate surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Explore the reactions and mechanisms for protection of aluminum aircraft from corrosion. Investigate novel three-dimensional surface nano-structures for sensor, optical, and power applications.

(U) $27,215 Total

(U) FY 2001 ($ in Thousands)

(U) $11,825 Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and to develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Evaluate methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Examine the use of molecular nano-clusters for use as catalysts and sensors. Develop new high energy density materials for rocket propellants and novel chemical laser systems.

(U) $8,982 Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions to develop advanced polymeric materials for significantly improved aircraft and spacecraft performance and life-spans. Improve spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigate polymer coatings to enable smart skins and advanced sensors for air and space weapon systems. Evaluate the stability of functional polymers in space environments to enhance survivability of vehicles exposed to space radiation. Continue to seek fundamental knowledge to formulate materials that have suitable optical transitions for highly efficient optical limiting properties.

(U) $5,928 Study surface science to investigate the chemistry of surface processes for accurate detection and prevention of corrosion and degradation of air and space systems, and formulation of novel lubricants. Continue investigation of surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Develop predictive and experimental models for molecular lubrication in high-temperature, high-wear environments. Explore the reactions and mechanisms for protection of aluminum aircraft from corrosion. Examine surface structures with enhanced energy-densities for significantly improved weapon system energy storage and delivery.

(U) $26,735 Total

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
01 - Basic Research	0601102F Defense Research Sciences	612303

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602601F, Space Technology.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 612304

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612304 Mathematical and Computer Sciences	32,388	32,557	33,153	32,683	32,237	31,590	30,971	Continuing	TBD

(U) **A. Mission Description**

Mathematics research expands techniques for mathematical modeling, simulation, and control of complex systems, and develops innovative analytical and computational methods for aerospace systems. Research provides improved performance and control of aerospace systems 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, computational mathematics, optimization and discrete mathematics, signals communication and surveillance, systems and software, and external aerodynamics and hypersonics.

(U) FY 1999 ($ in Thousands)

(U) $11,661 Performed research on computer software and systems for battlespace information management. Expanded research in transportable agent technology to support defensive information warfare applications and real-time problem solving strategies to support dynamic planning and execution.

(U) $11,010 Studied physical mathematics, control and signal processing, and modeled advanced materials including composites and smart skins in support of the Air Force's New World Vistas (NWV) programs. Developed modeling, identification, control, and signal processing capabilities necessary for the integrated control of jet engines, aerodynamics, and combustor instabilities. Created modeling and control algorithms for adaptive optics to handle extreme atmospheric turbulence encountered in target acquisition on systems such as the Airborne Laser.

(U) $9,717 Investigated computational science for improved design and simulation of advanced aerospace systems. Integrated new multidisciplinary optimization design strategies with higher order, time accurate flow solvers for improved design of jet engines, aircraft wings, and other aerospace components. Developed algorithms incorporating active control procedures.

(U) $32,388 Total

(U) FY 2000 ($ in Thousands)

(U) $6,707 Perform dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Develop modeling, identification, and control capabilities necessary for the integrated control of vehicle aerodynamics and jet engine performance. Create control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition on deployable laser platforms. Formulate algorithms incorporating active control procedures to provide more efficient flow through jet engines.

(U) $6,679 Conduct computational systems, software, artificial intelligence, and software reliability research to investigate unique computer technologies to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 612304

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

(U) FY 2000 ($ in Thousands) Continued

devise critical software and computational systems for battlespace information management. Expand automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Formulate distributed, automatic resource management approaches for new methods of mobile agent resource allocation and protection.

(U) $6,562 Conduct physical mathematics and applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Predict nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Model detonation shock dynamics to support reconfigurable conventional warhead design. Identify optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Refine physical mathematics, control and signal processing techniques, and model advanced electromagnetic materials, composites, and smart skins for air and space weapons.

(U) $4,748 Study optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expand transportable agent technology to support defensive information warfare applications. Integrate new multidisciplinary optimization design strategies with higher order, time accurate flow solvers for improved design of jet engines, aircraft wings, and other aerospace components.

(U) $3,548 Perform computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Integrate new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Invent methods to reduce computation time for chemical laser simulations. Identify failure modes of bonded composite materials by inserting novel computational methods into mission-support software tools.

(U) $2,649 Study signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, wireless, and networked communications systems, and strengthens performance of surveillance and targeting functions through autonomous and human-assisted sensing/response platforms. Analyze irreducible expansions of signals, soft threshholding, and efficient source-channel coding in wireless communication to improve cost versus performance trade offs.

(U) $1,664 Perform external aerodynamics and hypersonics research to develop fundamental knowledge of basic fluid dynamics and plasma-aerodynamics to predict and control supersonic and hypersonic flows over combat maneuvering flight vehicle systems. Devise accurate flow solvers for optimal design of aircraft wings and novel aerospace components.

(U) $32,557 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612304

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

(U) FY 2001 ($ in Thousands)

(U)	$6,828	Perform dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Develop modeling, identification, and control capabilities necessary for the integrated control of vehicle aerodynamics and engine performance. Continue creating control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition on deployable laser platforms. Expand active and adaptive control algorithms to enable autonomous air, space, and ground operations.
(U)	$6,800	Conduct computational systems, software, artificial intelligence, and software reliability research to investigate unique computer technologies to devise critical software and computational systems for battlespace information management. Continue automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Refine distributed, automatic resource management approaches for advanced methods of mobile agent resource allocation and protection.
(U)	$6,682	Conduct physical mathematics and applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Investigate the feasibility of coherently propagating short laser pulses through the air for superior accuracy in laser guided munitions. Predict nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluate methods to penetrate tree cover and recognize targets.
(U)	$4,834	Study optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expand transportable agent technology to support defensive information warfare applications and formulate real-time problem solving strategies to support dynamic planning and execution.
(U)	$3,612	Perform computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Continue integrating new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Devise methods to reduce computation time for chemical laser simulations from months to days. Investigate failure modes of bonded composite materials by inserting novel computational methods into mission support software tools.
(U)	$2,698	Study signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, wireless, and networked communications systems, and strengthens performance of surveillance and targeting functions through autonomous and human-assisted sensing/response platforms. Investigate irreducible expansions of signals, soft threshholding, and efficient source-channel coding in wireless communication to achieve major improvements in cost versus performance trade offs. Expand probabilistic process theory, functional analysis techniques, and information theory to eliminate current limits of sensing and communication system performance.
(U)	$1,699	Perform external aerodynamics and hypersonics research to develop fundamental knowledge of basic fluid dynamics and plasma-aerodynamics to predict and control supersonic and hypersonic flows over combat maneuvering flight vehicle systems. Devise accurate flow solvers for

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612304

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

(U) FY 2001 ($ in Thousands) Continued

optimal design of aircraft wings and novel aerospace components. Refine plasma-aerodynamic optimization techniques to enable design of superior scramjet engines.

(U) $33,153 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602201F, Aerospace Flight Dynamics.

(U) PE 0602702F, Command, Control, and Communications

(U) PE 0603789F, C3I Advanced Development.

(U) PE 0602269F, Hypersonic Technology Program.

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences	PROJECT: 612305

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612305 Electronics	22,021	24,144	24,246	24,082	23,710	23,247	22,728	Continuing	TBD

(U) **A. Mission Description**

Electronics research builds a 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. The focus is on developing electronic processes to model and predict 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 of Air Force systems, and improve the security and reliability of electronic information. The primary areas of research investigated by this project are space electronics, optoelectronic materials, optoelectronic information processing, and quantum electronic solids.

(U) FY 1999 ($ in Thousands)

(U) $11,867 Studied semiconductor electronic materials, advanced devices, interface control, and stability for improved laser and detector applications. Investigated methods to electronically tailor compound semiconductors and examined high-temperature electronics for use in hostile environments.

(U) $6,340 Sought fundamental understanding of optoelectronic information processing and storage. Investigated advanced communications, signal processing, and computing; and examined novel micro-lasers and ultra-high density information storage and retrieval.

(U) $3,814 Investigated superconducting and nanoscopic materials, devices, and applications for advanced communications and higher speed signal processing and denser memory. Created high current, high temperature, superconducting materials for power generation and storage on space platforms.

(U) $22,021 Total

(U) FY 2000 ($ in Thousands)

(U) $7,886 Perform space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Characterize surface and interface states to prevent electronic device degradation in Air Force systems. Explore wide bandgap semiconductor materials ideal for radio frequency power sources and high-temperature operations for air and space weapon systems.

(U) $7,798 Conduct optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Invent unique materials to protect critical optical systems from enemy attack. Devise laser materials to detect, degrade, or blind an adversary's detection capabilities. Create models of new detectors for characterization of the battlespace and surveillance.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612305

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$4,590	Study optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Formulate high bandwidth, multi-wavelength modulators and detectors for Air Force imaging and communication systems. Create optical materials for high-bandwidth communication and parallel signal processing for enabling the increased data transfer speeds required for military operations.
(U)	$3,870	Perform quantum electronic solids research to investigate superconducting, magnetic and nanoscopic materials and devices for advanced sensing communications and signal processing, and superior data storage capabilities. Create high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms. Investigate measurement of corrosion in aircraft structures to extend performance life span.
(U)	$24,144	Total

(U) FY 2001 ($ in Thousands)

(U)	$7,920	Perform space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Continue characterizing surface and interface states to prevent electronic device degradation. Explore wide bandgap semiconductor materials ideal for radio frequency power sources and high-temperature operations. Identify fundamental radiation effects on electronic and semiconductor materials and devise methods to prevent space system degradation or destruction.
(U)	$7,831	Conduct optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Invent unique materials to protect critical optical systems from enemy attack. Devise laser materials to detect, degrade, or blind an adversary's detection capabilities. Create new detectors for characterization of the battlespace, surveillance, and to obtain target signatures in spectral ranges appropriate for quick target recognition.
(U)	$4,609	Study optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigate high bandwidth, multi-wavelength modulators and detectors to refine complex semiconductor structures for imaging and communication systems. Create optical materials for maximum high-bandwidth communication and parallel signal processing for enabling secure satellite communications and the increased data transfer speeds required for military operations.
(U)	$3,886	Perform quantum electronic solids research to investigate superconducting, magnetic and nanoscopic materials and devices for advanced sensing communications and signal processing, and superior data storage capabilities. Create high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms and directed energy weapons. Formulate innovative approaches to measure active corrosion in aircraft structures to extend performance lifespan.
(U)	$24,246	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 612305

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602702F, Command, Control, and Communications.
(U) PE 0603789F, C3I Advanced Development.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 612306

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612306 Materials	11,407	13,102	14,082	14,200	14,246	14,378	14,920	Continuing	TBD

(U) **A. Mission Description**

Materials research enhances the performance, cost, and reliability of structural materials to eliminate material reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. Examination of material strength, toughness, fatigue resistance, and corrosion resistance will enable novel materials for airframe, turbine engine, and spacecraft structures. Emphasis is on refractory alloys, inter-metallics, polymer composites, metal and ceramic matrix composites, and advanced ceramics, such as alumina, silicon carbide, silicon nitride, and carbon/carbon. Research seeks to develop improved aerospace vehicle structural materials, increase the operating temperature of engine materials which will further increase thrust-to-weight ratio of engines. Research in new processing methods complements research on materials properties. The primary areas investigated by this project are ceramic and non-metallic materials, metallic materials, and organic matrix composites.

(U) FY 1999 ($ in Thousands)

(U) $6,165 Performed fundamental studies of very-high temperature, non-metallic materials for airbreathing engine, space vehicle, and rocket propulsion applications. Investigated coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for engine blade applications, and ultra-high temperature materials systems based on carbides for rocket propulsion applications.

(U) $4,107 Performed research on metallic systems for engines and airframe applications. Studied thermal and mechanical stability of refractory metal systems for very-high temperature applications, and investigated functionally gradient structures for thermal barrier coatings.

(U) $1,135 Studied life and reliability of polymeric composites by researching non-destructive evaluation techniques on adhesive-bonded structures. Investigated free-volume effects in controlling moisture absorption mechanisms and rates in polymer matrix composites.

(U) $11,407 Total

(U) FY 2000 ($ in Thousands)

(U) $4,261 Perform ceramic and non-metallic materials research to examine the fundamentals of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Investigate coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for jet engine blade applications.

(U) $6,936 Conduct metallic materials research to evaluate novel metallic systems for engines and airframe applications. Expand investigations of thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Identify functionally gradient structures for superior thermal barrier coatings.

(U) $1,905 Study organic matrix composites to expand knowledge of polymer matrix composites for increasing the strength and life-span of air and space

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 612306

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

(U) FY 2000 ($ in Thousands) Continued

vehicle structures. Explore novel ring-opening chemistry to develop resins with controlled volume shrinkage to improve mechanical properties of high performance adhesives and matrix resins. Investigate moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $13,102 Total

(U) FY 2001 ($ in Thousands)

(U) $4,579 Perform ceramic and non-metallic materials research to examine the fundamentals of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Investigate coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for jet engine blade applications. Seek fundamental knowledge to formulate ultra-high temperature materials systems based on carbides for rocket propulsion applications.

(U) $7,454 Conduct metallic materials research evaluates novel metallic systems for engines and airframe applications. Explore thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Evaluate functionally gradient structures for superior thermal barrier coatings.

(U) $2,049 Study organic matrix composites to expand knowledge of polymer matrix composites to increase the strength and life-span of air and space vehicle structures. Explore thermal cycling effects of polymer matrix composites down to cryogenic temperature range to better understand durability issues in liquid fuel tank environments. Investigate innovative fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $14,082 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials
(U) PE 0603211F, Aerospace Structures.
(U) PE 0708011F, Industrial Preparedness.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602269F, Hypersonic Technology Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612306

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

(U) PE 0602601F, Space Technology.

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 612307

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612307 Fluid Mechanics	6,766	9,858	9,712	9,769	9,886	10,103	10,616	Continuing	TBD

(U) **A. Mission Description**

Fluid Mechanics research advances fundamental knowledge, tools, data, concepts, and methods for improving the efficiency, effectiveness, and reliability of aerospace vehicles. Understanding of key fluid flow (primarily high-speed air) phenomena is directed to improve theoretical models for aerodynamic prediction and design, and to originate flow control concepts and predictive methods to expand current flight performance boundaries. The emphasis is on turbulence prediction and control, unsteady and separated flows, hypersonics, and internal fluid dynamics. The primary approach is to formulate advanced computational methods to: simulate and study complex flows; predict real gas effects in high-speed flight; and control and predict turbulence in flight vehicles and propulsion systems. The primary areas of research investigated by this project are unsteady aerodynamics, hypersonic aerodynamics, turbulence and flow control, and rotating flows.

(U) FY 1999 ($ in Thousands)

(U) $1,556 Conducted external aerodynamics and hypersonics basic research for improved flight performance and control of Air Force air vehicle systems. Developed fluid/structural interaction models based on flow field interaction research. Investigated novel concepts for hypersonic flow control to reduce the size and weight of new hypersonic air vehicles.

(U) $3,231 Performed turbulence and flow control research to enhance air vehicle stability, performance, and control. Developed micro-electromechanical systems (MEMS) actuators and sensors for micro-air vehicle systems, and investigated the use of MEMS devices on swept wing air vehicles.

(U) $1,979 Conducted internal flow research to improve the performance and reliability/maintainability of airbreathing propulsion systems. Developed MEMS devices for turbine engine control and Large Eddy Simulation (LES) methodology for turbomachinery flows.

(U) $6,766 Total

(U) FY 2000 ($ in Thousands)

(U) $2,957 Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flow to optimize current Air Force air vehicle designs, and enable revolutionary future weapon systems. Investigate unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Devise flow control design tools used to minimize flow separation and air vehicle drag. Develop fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $2,465 Conduct hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Formulate concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques to enable new high-speed weapon systems. Develop high-speed flow prediction codes to quantify thermal stresses in high performance air and space weapon systems.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 612307	

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,464	Seek fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in high performance air vehicles. Create novel micro-electromechanical systems (MEMS) actuators, and investigate actuation coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements. Evaluate the use of MEMS devices for flow control on swept wing air vehicles to substantially reduce drag.
(U)	$1,972	Study rotating flows to evaluate internal flow characteristics for enabling significant enhancement of performance and reliability/ maintainability of airbreathing propulsion systems. Invent promising MEMS devices for turbine engine control and Large Eddy Simulation methodology for affordable, high fidelity predictions of gas turbine engine flow fields.
(U)	$9,858	Total

(U) FY 2001 ($ in Thousands)

(U)	$2,428	Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize current Air Force air vehicle designs, and enable revolutionary future weapon systems. Investigate unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Continue to devise design tools for flow control to minimize flow separation and air vehicle drag. Continue to develop fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.
(U)	$2,913	Conduct hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Advance concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses.
(U)	$2,429	Seek fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in air vehicles. Evaluate novel MEMS actuators, and investigate actuation coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements. Evaluate the use of MEMS devices for flow control on swept wing air vehicles with a goal of substantial drag reduction.
(U)	$1,942	Study rotating flows to evaluate internal flow characteristics for enhancing the performance and reliability/maintainability of air-breathing propulsion systems. Evaluate promising MEMS devices for turbine engine control and Large Eddy Simulation methodology for affordable high fidelity predictions of gas turbine engine flow fields and heat transfer effects.
(U)	$9,712	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 612307	

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0602269F, Hypersonic Technology Program.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 612308

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612308 Propulsion	13,766	20,027	18,648	18,486	18,390	18,413	18,540	Continuing	TBD

(U) **A. Mission Description**

Propulsion research seeks the efficient utilization of energy in airbreathing engines, chemical and non-chemical rockets, and combined cycle propulsion systems for access to space. Research thrusts include airbreathing propulsion, space power and propulsion, high altitude signature characterization and contamination, propulsion diagnostics, and thermal management of space-based power and propulsion systems. Chemically reacting flow and non-chemical energetics are investigated. Study of chemically 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 energetic systems include plasma and beamed energy propulsion for orbit raising space missions, and efficient ultra-high energy techniques for space-based energy utilization. The primary areas of research investigated by this project are space power and propulsion, combustion, and diagnostics.

(U) FY 1999 ($ in Thousands)

(U) $5,434 Performed research on space and rocket propulsion and power through the development of supercritical combustion models for rocket propulsion. Modeled predictions of mini-satellite propulsion and performance for high precision clusters of cooperating autonomous microsatellite operations. Performed experimental and numerical studies of high altitude ultraviolet (UV) and infrared (IR) signatures to protect space assets.

(U) $4,592 Studied airbreathing combustion for propulsion systems for hypersonic flight capability by examining combustion product formation in gas turbine engines, and explored very high temperature and pressure (supercritical) fuel behavior under high temperatures and pressure conditions. Studied the coupling mechanisms between turbulence and liquid hydrocarbon fuel injection in gas turbine and scramjet engines.

(U) $740 Investigated propulsion diagnostics of new propulsion system concepts through data reduction and interpretation approaches. Extended diode-laser spectroscopic technique for on-board control of propulsion system operation and performance.

(U) $3,000 Developed coal-derived jet fuels by investigating refinery processing techniques for coal processing with petroleum, additives to suppress fuel system fouling, combustion characteristics of candidate fuels, and fuel-material interactions.

(U) $13,766 Total

(U) FY 2000 ($ in Thousands)

(U) $6,657 Perform research on space power and propulsion to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Model satellite propulsion characteristics for high-precision clusters of cooperating autonomous micro-satellites. Examine self-consuming satellites to increase payload and thrust capabilities. Create new concepts, such as pulsed detonation rocket and hybrid rocket engines, for optimal rocket propulsion. Identify experimental and numerical characteristics of high-altitude UV and IR and satellite

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 612308

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

(U) FY 2000 ($ in Thousands) Continued

contamination to develop techniques to protect space assets.

(U) $6,222 Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Develop computer models to increase weapon system efficiency by predicting unsteady behavior such as combustion instability. Examine the coupling mechanisms between turbulence and liquid hydrocarbon fuel injection in gas turbine and scramjet engines to increase thrust output and enable significantly advanced weapon systems.

(U) $4,148 Investigate advanced diagnostic systems for data reduction and interpretation to create concepts for novel propulsion system applications. Extend diode-laser spectroscopic technique for on-board control of propulsion system operation and performance.

(U) $3,000 Continue coal-derived jet fuels research to investigate refinery processing techniques for coal processing with petroleum, additives to suppress fuel system fouling, combustion characteristics of candidate fuels, and fuel-material interactions.

(U) $20,027 Total

(U) FY 2001 ($ in Thousands)

(U) $7,299 Perform space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Increase thrust and control of micro-satellite and nano-satellite propulsion systems to enable high-precision clusters of cooperating autonomous micro-satellites. Examine self-consuming satellites and mechanical-electric energy conversion to increase payload and thrust capabilities. Continue to develop new concepts, such as pulsed detonation, hybrid rockets and combined cycle engines, to enable very high temperature and pressure (supercritical) combustion for optimal rocket propulsion. Study experimental and numerical characteristics of high-altitude ultraviolet and infrared signatures and satellite contamination to develop techniques to protect space assets.

(U) $6,810 Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Enhance computer models to increase efficiency by predicting unsteady behavior such as combustion instability. Examine primary and secondary atomization and mixing of fuels to optimize fuel injection to increase thrust output.

(U) $4,539 Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Obtain essential data through multiplexed diode-laser spectroscopy, enabling simultaneous detection of temperature and pressure within chemical propulsion systems to increase their thrust and efficiency.

(U) $18,648 Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 612308	

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Space Technology.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0602269F, Hypersonic Technology Program.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612310

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612310 Atmospheric Sciences	5,217	5,594	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

Upper Atmospheric research characterizes the Earth's upper atmosphere to predict and control its effects on Air Force tactical and strategic operations. The goal is to accurately model ionospheric irregularities and thermospheric dynamics to provide reliable, continuous communications, command, and control. Innovative techniques enable evaluation of the structure and chemistry of the mesosphere and thermosphere, and modeling of the physics and dynamics of the ionosphere to enhance global surveillance, geolocation, and communication capabilities. Focused investigations include observation and modeling of atmospheric tides and gravity waves, geomagnetic disturbances, auroral and airglow emissions, and plasma turbulence and dynamics. The primary areas of research investigated by this project are space weather, optical and auroral emission, and ionospheric scintillation and turbulence.

(U) FY 1999 ($ in Thousands)

(U) $1,603 Improved space weather specification and forecast models, and studied the coupling between the solar wind, the interplanetary magnetic field (IMF), and the earth's magnetosphere by using satellites to analyze the IMF and solar wind ions. Developed a Coordinated Community Modeling Center to bring researchers directly in touch with the DoD user community.

(U) $1,094 Analyzed atmospheric physics to understand and exploit the aerospace environment and improved atmospheric radiative transfer models to estimate the impacts of weather limitations on the employment of directed energy weapons. Investigated gravity wave interactions with ambient atmospheric vorticity fields that affect optical atmospheric emissions observed from orbit.

(U) $2,520 Studied ionospheric physics to enhance global surveillance capability and investigated ionosphere phenomena. Examined signatures of solar activity which disrupt global radio communications and space surveillance.

(U) $5,217 Total

(U) FY 2000 ($ in Thousands)

(U) $2,237 Perform space weather research to refine space phenomena prediction models to enable optimal design and protection of Air Force space assets. Develop satellite-based analysis techniques to examine the coupling between the solar wind, the interplanetary magnetic field, and the Earth's magnetosphere, and its effect on space operations. Support the space weather Coordinated Community Modeling Center, to transition information directly to the Air Force Space Forecast Center.

(U) $1,398 Conduct optical and auroral emission research to characterize the chemical and physical dynamics of the mesosphere, thermosphere, and ionosphere to develop a comprehensive map of regions that cause mission failure in space assets. Investigate atmospheric gravity wave interactions from high-latitude observation sites, using powerful new Light Detection and Ranging (LIDAR) techniques, to enable accurate

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BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 612310

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

(U) FY 2000 ($ in Thousands) Continued

interpretation of optical emissions and refined modeling of the operational space environment.

(U) $1,959 Study ionospheric scintillation and turbulence to formulate prediction models to enhance global surveillance, geolocation, and communication capability. Investigate ionosphere plasma phenomena created by man-made radio waves, to enable active control of the operational space environment. Analyze and interpret signatures of solar activity to provide fundamantal knowledge to design techniques to prevent disruption of global radio communications, geolocation, and space surveillance.

(U) $5,594 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 612311.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0305160F, Defense Meteorological Satellite Program.

(U) PE 0602601F, Space Technology.

(U) PE 0603220C, Surveillance, Acquisition, Tracking, and Kill.

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences	PROJECT: 612311

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612311 Space Sciences	6,404	8,524	14,894	14,786	14,768	14,866	15,054	Continuing	TBD

(U) **A. Mission Description**

Space Sciences research provides fundamental understanding of the space environment for optimum design of Air Force systems operating in near-Earth orbit and geosynchronous space. The goal is to enable protection of space assets from space debris, solar wind, solar flares, 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, to enhance the effectiveness of Air Force satellite operations. The primary areas of research investigated by this project are solar phenomena, solar wind transport, and energization processes.

(U) FY 1999 ($ in Thousands)

(U) $1,887 Analyzed physics of solar magnetic fields, flares, and coronal mass ejections to provide a physical basis for predictive models of the effects of solar disturbances on near-Earth space to predict the state of the interplanetary medium using solar magnetic field and coronal data that can be related to disturbances.

(U) $2,580 Studied the particle and interplanetary magnetic field properties of the solar wind which transports solar disturbances to the Earth's magnetosphere, and evaluated techniques to study solar source regions and infer the magnetic structures of interplanetary disturbances. Tested solar wind shock detection algorithms.

(U) $1,937 Studied magnetospheric and radiation belt processes to eliminate operational deficiencies, and fluid and particle dynamics to determine criteria for substorm onset and model rapid variations in the interaction between the solar wind and magnetosphere using diffusion coefficients estimated from electric propagation studies.

(U) $6,404 Total

(U) FY 2000 ($ in Thousands)

(U) $3,410 Analyze solar phenomena to characterize and model solar phenomena for much better prediction of large-scale disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Investigate sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar eruptions.

(U) $2,130 Study solar wind transport to evaluate the magnetic transport of solar eruptions to formulate accurate maps of environmental vulnerability, and to identify orbits that ensure continued, reliable performance of Air Force satellites. Evaluate effects of the solar wind, the interplanetary magnetic field, and the Earth's magnetosphere to enhance space weather specification and forecast models.

(U) $2,984 Study energization processes to examine the transient and long-term effects of the Earth's magnetospheric and radiation belt energization

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 612311

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

(U) FY 2000 ($ in Thousands) Continued

processes to predict performance degradation levels in Air Force space systems. Examine charged particle dynamics for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth's satellite environment. Investigate turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $8,524 Total

(U) FY 2001 ($ in Thousands)

(U) $5,957 Analyze solar phenomena to characterize and model solar phenomena for much better prediction of large-scale disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Discover the physics of solar plasma arcades, solar flares, and coronal mass ejections to establish the physical basis for solar disturbance models. Continue investigating sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar eruptions, and predict risk to critical Air Force space operations.

(U) $4,467 Study solar wind transport to evaluate the magnetic transport of solar eruptions to formulate accurate maps of environmental vulnerability, and to identify orbits that ensure continued, reliable performance of Air Force satellites. Integrate solar magnetic field and coronal data to discover the science underpinning solar ejection paths and devise accurate modeling techniques. Evaluate effects of the solar wind, the interplanetary magnetic field, and the Earth's magnetosphere to enhance space weather specification and forecast models.

(U) $4,470 Study energization processes to examine the transient and long-term effects of the Earth's magnetospheric and radiation belt energization processes to predict performance degradation levels in Air Force space systems. Examine charged particle dynamics and magnetohydrodynamic fluid flow for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth's satellite environment. Relate fundamentals of turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $14,894 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602601F, Space Technology.

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

(U) PE 0603410F, Space System Environmental Interactions Technology.

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(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 612312

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612312 Biological Sciences	12,256	13,326	13,556	13,671	13,632	13,540	13,481	Continuing	TBD

(U) **A. Mission Description**

Biological Science research explores the interaction of Air Force chemicals and physical agents (lasers and microwaves) with human tissues and their production of toxic effects to enable safety assessment strategies and to ensure the hazard-free development and use of future aerospace materials and directed energy systems. Research in biomimetic sensors strives to understand the biological detection systems of organisms at the molecular level and apply this understanding to the development of novel man-made sensors. Biocatalysis research aims to discover and characterize cellular enzymes that will catalyze the synthesis of chemical feedstocks used in the safe production of space and aerospace materials. Research in neuroscience and chronobiology will result in new strategies to prevent impaired performance due to jet lag and shift-work, night operations, and the loss of life and/or aircraft due to stress, inattention, or lack of vigilance. The primary areas of research investigated by this project are bioenvironmental sciences, biocatalysis, chronobiology and neural adaptation, and biomimetic sensors.

(U) FY 1999 ($ in Thousands)

(U) $4,972 Studied the effects of JP-8 jet fuel and its individual components on the lungs, brain, immune system, and skin of animals. Investigated computational and in vitro models for predicting chemical toxicity. Used molecular techniques to characterize changes in proteins and DNA derived from microwave-exposed animals. Developed the rationale for proposed new national safety standards for short-term retinal exposure to ultrashort laser pulses.

(U) $994 Researched mechanisms of infrared sensing systems in snakes and studied the sensory applications of novel microbial chromophores/ photophores for insights to military applications including space sensors.

(U) $299 Performed research to identify and characterize enzymes that catalyze intermediate products in polymer synthesis.

(U) $5,991 Investigated biological mechanisms responsible for circadian rhythmicity by examining individual differences in periodic responses to predict effects of night operations and jet lag on military personnel.

(U) $12,256 Total

(U) FY 2000 ($ in Thousands)

(U) $7,729 Study bioenvironmental sciences to investigate and predict biological effects of novel aerospace chemicals and directed energy systems to assure the safety, health, and high-performance of military personnel during and after mission-directed activities. Evaluate underlying biochemical alterations related to the adverse effects of JP-8 jet fuel. Explore in vitro biodynamic alterations that together with biokinetic parameters can aid in predicting toxicity and be integrated into the early computational design of new, safer, aerospace materials. Examine the effects of novel forms of directed energy (microwaves and lasers) on gene expression as an approach to identifying the specific sub-cellular targets of directed

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 612312

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

(U) FY 2000 ($ in Thousands) Continued

energy.

(U)	$1,333	Research biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety in the process of synthesizing chemical feedstocks used in the manufacture of aerospace materials. Identify and isolate bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of the synthesis of aerospace materials.
(U)	$2,665	Perform chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the environment, and individual performance capabilities to improve skilled human performance. Devise and test new preventative countermeasures for human errors induced by fatigue and jet lag, and perform fundamental research on the biophysical basis of alert cognitive performance.
(U)	$1,599	Investigate biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identify methods to enhance them. Investigate, predict, and model biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Devise techniques to model alternate mechanisms of near ambient infrared sensing systems in snakes and beetles to enable room-temperature, compact infrared sensors.
(U)	$13,326	Total

(U) FY 2001 ($ in Thousands)

(U)	$6,642	Study bioenvironmental sciences to investigate and predict biological effects of novel aerospace chemicals and directed energy systems to assure the safety, health, and high-performance of military personnel during and after mission-directed activities. Evaluate underlying biochemical alterations related to the adverse effects of JP-8 jet fuel and begin to identify specific protein targets responsible for triggering the toxic responses. Explore in vitro biodynamic alterations that together with biokinetic parameters can aid in predicting toxicity and be integrated into the early computational design of new, safer, aerospace materials. Examine the effects of novel forms of directed energy (microwaves and lasers) on gene expression and to identify the specific sub-cellular targets of directed energy.
(U)	$3,389	Research biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety in the process of synthesizing chemical feedstocks used in the manufacture of aerospace materials. Various bacterial enzymes will be sub-cloned to enhance the level of gene expression so that the enzymes can be produced in sufficient yields for additional research and biotechnology development. Identify and isolate bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of the synthesis of aerospace materials.
(U)	$1,899	Perform chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the environment, and individual performance capabilities to improve skilled human performance. Interpret the mechanism by which serotonin regulates the circadian clock, determine if modafinil can prevent adverse effects on performance without disrupting sleep, and investigate the

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BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 612312	

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

(U) FY 2001 ($ in Thousands) Continued

combination of countermeasures such as optimally-timed rest periods and wake promoting compounds.

(U) $1,626 Investigate biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identify methods to enhance them. Analyze, predict, and model biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Isolate and begin to model alternate mechanisms of near ambient infrared sensing systems in snakes and beetles to enable room-temperature, compact infrared sensors. Investigate and adapt chromophores and photoluminescent characteristics in microbial and protein-based biological systems for insights to military sensor applications.

(U) $13,556 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602202F, Human Effectiveness Applied Research.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 612313

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
612313 Human Performance	11,790	13,057	13,211	12,708	12,307	11,929	10,934	Continuing	TBD

(U) **A. Mission Description**

Human Performance research examines all aspects of human information processing critical to Air Force operations. The overall objective is to develop useful, quantitative models of the way people: perceive, navigate, and manipulate their environment; make decisions in complex tasks under stress or uncertainty; and adapt to extreme sensory, biophysical, or cognitive workloads. The sensory component emphasizes visual, auditory, vestibular, and kinesthetic systems and their optimal integration. Focused investigations seek the scientific foundation for several developing Air Force technologies including the design of interactive displays, virtual reality simulators, intelligent control systems, sensors and fused-image displays, and adaptive systems for personnel training and selection. The primary areas of research investigated by this project are sensory and perceptual systems, cognition, and cognitive workload.

(U) FY 1999 ($ in Thousands)

(U) $3,145 Performed sensory and perceptual system analysis for human-machine interface and image exploitation by developing image representation theory and investigating algorithms for visual attention to improve performance in command and control environments; also supported model-based predictions of limits in speech communication.

(U) $4,528 Conducted cognitive workload analysis for crew training and performance enhancement by examining cognitive performance models, developing a theory of cognitive workload, and extending the cognitive models to include characterization of on-line job aiding systems used in command and control environments.

(U) $4,117 Studied synthetic task environments for baseline performance measurement, and conducted experiments leading to a more general theory of utility for performance enhancement techniques. Extended experimental techniques for command and control team performance and developed multi-ship modeling for uninhabited aerial vehicles (UAV) surveillance and targeting.

(U) $11,790 Total

(U) FY 2000 ($ in Thousands)

(U) $3,525 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Expand theories of visual search and scene analysis and control of attention for optimal cockpit performance. Investigate the perceptual and cognitive requirements for accurate simulation of virtual environments.

(U) $4,962 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Formulate models of intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations.

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BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences
PROJECT: 612313	

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$4,570	Study cognitive workload research to formulate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss to enable cognitive performance modeling and prediction. Devise innovative approaches to understanding individual skill differences, and identify new training and selection system models relevant to modern, technology-dependent environments.
(U)	$13,057	Total

(U) FY 2001 ($ in Thousands)

(U)	$3,567	Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Refine theories of visual search and scene analysis, control of attention, perception of orientation, and localization of sound for optimal cockpit performance. Analyze the perceptual and cognitive requirements for accurate simulation of virtual environments and for effective design of informative displays. Understand human multisensory integration to enable the design of automated sensing devices.
(U)	$5,021	Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Enhance human performance via intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations. Develop and test training protocols to maximize team effectiveness under stress and sustained operation.
(U)	$4,623	Study cognitive workload to formulate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss to enable cognitive performance modeling and prediction. Invent innovative approaches to understanding individual skill differences, and create new training and selection systems relevant to modern, technology-dependent environments. Study behavioral and physiological measures to avert human error in conditions of information overload and fatigue.
(U)	$13,211	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602202F, Human Effectiveness Applied Research.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 612313

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

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences		PROJECT: 614113

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
614113 External Research Programs Interface	12,462	4,821	4,385	3,818	3,056	2,198	0	Continuing	TBD

(U) **A. Mission Description**

International and domestic interchange research programs optimize the interaction between the international research community and Air Force researchers, and stimulate scientific and engineering education beneficial to the Air Force. The programs increase the awareness of Air Force basic research priorities and attracts talented scientists and engineers to address its needs. The primary elements of this effort are international strategy, international technology liaison, and scientist and engineer education research interchange.

(U) FY 1999 ($ in Thousands)

(U) $4,112 Funded international science and personnel exchange programs.

(U) $4,890 Supported technology liaison missions in Europe and Asia to support scientists and engineers performing research in international laboratories.

(U) $3,460 Provided Air Force share of funding for North Atlantic Treaty Organization (NATO) affiliated research institutes.

(U) $12,462 Total

(U) FY 2000 ($ in Thousands)

(U) $1,590 Support the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, international science programs to the benefit of the Air Force. Provide primary interface with the Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.

(U) $1,891 Support international technology liaison missions to identify unique international research capabilities, and make them available to the U.S. Air Force. Use the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations, and support international visits of high level Department of Defense delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,340 Support scientist and engineer research interchange to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging associateships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.

(U) $4,821 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 01 - Basic Research	PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 614113

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

(U) FY 2001 ($ in Thousands)

(U)	$1,447	Support the Air Force Research Laboratory international strategy mission to provide centralized international expertise to assist formulation of optimal cooperation with, and leveraging of, foreign science programs to the benefit of the Air Force. Provide the primary interface with Office of the Secretary of Defense, the Office of the Secretary of the Air Force, and Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations.
(U)	$1,720	Support international technology liaison missions to identify unique international research capabilities, and makes them available to the U.S. Air Force. Use the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development to provide on-site coordination with international research organizations, and support international visits of high level Department of Defense delegations. Sustain and fund Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.
(U)	$1,218	Support scientist and engineer education to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging associateships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.
(U)	$4,385	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0601103D, University Research Initiative.
(U) PE 0602102F, Materials.
(U) PE 0602202F, 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 0602601F, Space Technology (formerly Phillips Lab).
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702F, Command, Control and Communication.

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences
	PROJECT 614113

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	70,495	78,103	72,815	70,719	74,667	76,220	76,899	Continuing	TBD
624347	Materials for Structures, Propulsion, and Subsystems	41,812	52,526	44,127	43,178	46,313	47,599	48,058	Continuing	TBD
624348	Materials for Electronics, Optics, and Survivability	13,251	4,761	9,023	7,788	8,015	7,858	7,770	Continuing	TBD
624349	Materials Technology for Sustainment	15,432	20,816	19,665	19,753	20,339	20,763	21,071	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program is the primary source of advanced materials and processing technology to reduce life cycle costs and improve performance, affordability, supportability, reliability, and survivability of current and future Air Force systems. Structural, propulsion, and sub-systems materials and processes are being developed for aircraft, missile, space, satellite, and launch systems applications. Electronic, optical, advanced electromagnetic, and laser protection materials and processes are being developed for application in Air Force aircraft, missile, space, and personnel protection systems. Advanced nondestructive materials evaluation methods, materials design data, materials failure analysis, and materials repair methods are being developed to improve the sustainment of Air Force systems for the current and future warfighters. Note: In FY 2000 Congress added $1.8 million for titanium metal matrix composite airframe structures; $1.0 million for titanium metal matrix composite high temperature ceramic fibers; $2.0 million for friction stir welding; $5.0 million for a metals affordability initiative; $0.5 million for high temperature materials; $1.0 million for turbine engine transfer molding high temperature resins; $2.5 million for space structures thermal management; $0.75 million for carbon foams; $0.8 million for metal cleaning, corrosion control, and coatings; $0.5 million for the National Composite Center; $1.0 million for structural monitoring of aging aircraft, and $2.4 million for a nondestructive evaluation electromagnetic fatigue sensor which explains the perceived decrease in FY 2001.

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

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602102F Materials

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	73,855	63,334	69,521	
(U)	Appropriated Value	75,278	78,811		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1,423	-45		
	b. Small Business Innovative Research	-1,288			
	c. Omnibus or Other Above Threshold Reprogram		-352		
	d. Below Threshold Reprogram	-1,679			
	e. Rescissions	-393	-311		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			3,294	
(U)	Current Budget Submit/FY 2001 PBR	70,495	78,103	72,815	TBD

(U) Significant Program Changes:

Changes to this program element since the previous President's Budget refelect increased emphasis on turbine engine materials.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT: 624347

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624347	Materials for Structures, Propulsion, and Subsystems	41,812	52,526	44,127	43,178	46,313	47,599	48,058	Continuing	TBD

(U) **A. Mission Description**

Develops materials and processing technology base for aircraft, spacecraft, and missiles to improve affordability, maintainability and performance of current and future Air Force systems. The performance, affordability, and sustainability of current and planned Air Force systems are constrained by the characteristics of available materials for structures, propulsion, and subsystems. A family of affordable lightweight materials are being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites to provide upgraded capability for existing aircraft, spacecraft, missile, and propulsion systems to meet the future system requirements. Included are high temperature turbine engine materials that will enable engine designs to double the thrust to weight using 1986 engine performance as a baseline. Spacecraft material technologies are being developed that are lightweight, thermally conductive, dimensionally stable, noncontaminating, and resistant to the space environment. Fluids, lubricants, paints, coatings, and other nonstructural material technologies are being developed for the subsystems on aircraft, spacecraft, and missile systems as well as their propulsion systems. Pervasive across the classes of material is the development of advanced processing methods to enable 'adaptive' processing of materials and virtual materials research.

(U) FY 1999 ($ in Thousands)

(U)	$8,084	Developed carbon-carbon (C-C) and thermal protection material (TPM) technologies to improve performance, affordability, and operational capability of strategic and tactical systems.
(U)	$6,973	Developed nonstructural materials (such as fluids, lubricants, seals, greases, and coatings) for improved system performance and reduced life cycle costs.
(U)	$9,270	Developed advanced nonmetallic composite structural materials that are affordable for aircraft applications including lightweight airframes, control surfaces, smart skins, and engine compressor frames and ducts, and for spacecraft applications including lightweight trusses, struts, solar arrays, antenna supports, and space vehicle bus structures.
(U)	$9,367	Developed and transitioned affordable lightweight metals and metal matrix composites, higher-temperature intermetallic alloys, and materials processing technology to enable enhanced performance, lower acquisition costs, and improved reliability of Air Force weapon systems.
(U)	$8,118	Developed ceramic matrix composites to develop an understanding of material response to service life environments and to characterize materials to enable revolutionary performance improvements in advanced propulsion systems and high temperature airframe structures.
(U)	$41,812	Total

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602102F Materials
PROJECT: 624347	

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

(U) FY 2000 ($ in Thousands)

(U) $9,400 Develop enabling polymeric and carbon-carbon materials technologies for diverse, high-payoff Air Force system needs including structural and thermal applications. Evaluate carbon matrix composites degradation mechanisms to enhance life prediction of advanced aircraft environmental control systems and hot, exhaust-washed structures and engine components. Identify suitable polymers and conductive elastomers as base materials for low-observable gap sealants, thin wires, and electrostatic discharge coatings. Identify and evaluate toughened and nanostructured polymers for thin films to enable inflatable membrane structures such as deployable mirrors for surveillance and space counterforce applications.

(U) $7,559 Develop nonstructural materials technology base for fluids, lubricants, aircraft topcoat, and corrosion resistant coatings and specialty treatments to improve system performance and reduce life cycle costs. Evaluate advanced lubricants for high-speed bearing and rotating components in spacecraft and developed optically tailorable thermal control coatings with controlled emissivity for spacecraft thermal control. Demonstrate the feasibility of electrically conductive elastomers for use in low-observable gap treatments and establish baseline analytical capability to predict the optical properties of specialty coatings. Evaluate permanent corrosion resistant primer resins and environmentally safe corrosion protection with a 30-year life.

(U) $9,314 Develop advanced, affordable nonmetallic composite structural materials and process technologies for Air Force systems applications including lightweight structures (airframes, control surfaces, trusses, struts, engine components, substructures), space vehicle tanks, and space vehicle bus structures. Develop processing and/or mechanics models which predict component dimensions and decrease the amount of shimming, rework, and fit up of large integrated structures for future Air Force air platforms. Develop non-autoclave processes for large structural, cryogenics tanks, and substructures for future Air Force space platforms. Identify materials and processes for low-cost, multifunction composites to enable small, highly tailorable space platforms. Identify and develop novel product forms (foams, nanomaterials) for lightweight, tough, and affordable structural materials.

(U) $21,329 Develop and transition affordable lightweight metallic materials, behavior and life prediction technology, higher temperature intermetallic alloys, and metals processing technology to enable enhanced performance, lower acquisition cost, increased durability, and improved reliability for Air Force weapon systems. Optimize wrought gamma titanium aluminides with a 200°F higher temperature capability for advanced gas turbine engine critical components and characterize advanced intermetallic alloys with the potential of achieving a 300°F temperature increase over current nickel-based superalloy turbine blade materials. Develop life prediction and design methods to better predict theimpact of high cycle fatigue (HCF) on critical engine components and identify critical components and inspection requirements for turbine engine rotor life extension, retirement for cause criteria and enable repair processes. Develop and optimize process technologies, such as spray forming, permanent mold casting and advanced metalworking processes to enable the production of affordable and high quality aluminum, titanium, nickel, and beryllium alloys. Develop process technology for lower tier materials suppliers to improve quality and affordability of components for weapon systems. Develop metallic materials, such as discontinuously reinforced aluminum, nanocrystalline aluminum and high temperature metallic sheets for

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT 624347

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

(U) FY 2000 ($ in Thousands) Continued

lighter weight and higher strength components for space systems and thermal protection for space vehicles.

(U) $4,924 Develop ceramics and ceramic matrix composites technology base for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures, and determine the durability of ceramics under service life conditions to guide further materials development and to assess useable life. Conduct rocket engine rig tests of vanes, thrusters, and nozzle ramp subelements, develop integrally woven ceramic composite structures for actively cooled space vehicle applications, and develop thermal protection materials for emerging reusable space vehicles. Identify optimum constituents for 2400°F capable ceramic matrix composite for turbine engine combustors and airfoils, perform subscale dynamometer testing of multiple ceramic composites for next generation aircraft brake friction materials, and initiate extended durability testing of ceramic composites for exhaust components. Develop repair techniques for radar absorbing material (RAM) coatings and engine test a repaired ceramic matrix composite exhaust nozzle seal. Develop advanced constituents such as oxidation resistant interface coatings for longest life, highest performance ceramic composites.

(U) $52,526 Total

(U) FY 2001 ($ in Thousands)

(U) $5,049 Develop enabling polymeric materials technologies for diverse, high-payoff Air Force system needs including structural applications. Evaluate suitable polymers and conductive elastomers as base materials for low-observable gap sealants, thin wires, and electrostatic discharge coatings. Evaluate toughened and nanostructured polymers for thin films to enable inflatable membrane structures such as deployable mirrors for surveillance and space counterforce applications. Develop new methods for rapid fabrication of nanometer to micron three-dimensional structures and rapid composite repair.

(U) $8,116 Develop and transition nonstructural materials technology base for fluids, lubricants, aircraft topcoat and corrosion resistant coatings and specialty treatments to improve system performance and reduced life cycle costs. Develop advanced lubricant materials for high-speed bearing and rotating components (gyroscopes) in spacecraft and fabricate optically tailorable thermal control coatings with controlled emissivity for spacecraft thermal control. Validate feasibility of electrically conductive elastomers for use in low-observable gap treatments and develop analytical techniques to predict the optical properties of specialty coatings. Develop permanent corrosion resistant primer resins and environmentally safe corrosion protection with a 30-year life.

(U) $10,917 Develop affordable, advanced organic matrix composite structural materials and technologies for Air Force systems applications including lightweight structures (airframes, control surfaces, trusses, struts, engine components, substructures), space vehicles tanks, space vehicle bus structures, radiators, and other structures requiring thermal and/or structural management for environmental control. Validate processing and/or mechanics models which predict component dimensions and decrease the amount of shimming, rework, and fit up for large integrated structures for future Air Force air platforms. Develop composite material degradation mechanisms to improve life prediction for aircraft environmental

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

(U) FY 2001 ($ in Thousands) Continued

control systems and hot, exhaust-washed structures and engine components. Validate non-autoclave processes for large structural, cryogenics tanks, and substructures for future Air Force space platforms and develop materials and process for low-cost, multifunction composites enabling small, highly tailorable space platforms. Evaluate novel product forms (foams, nanomaterials) for lightweight, tough, and affordable structural materials.

(U) $16,056 Develop and transition affordable lightweight metallic materials, behavior and life prediction technology, higher temperature intermetallic alloys, and metals processing technology to enable enhanced performance, lower acquisition cost, increased durability, and improved reliability of Air Force weapon systems. Transition wrought gamma titanium aluminides with a 200°F higher temperature capability for demonstration as advanced gas turbine engine critical components. Develop specific molybdenum-based and niobium-based intermetallic alloys with the potential of achieving a 300°F temperature capability increase over current nickel-based superalloy turbine blade materials. Develop life prediction and design methods to better predictthe impact of high cycle fatigue damage on critical engine components. Develop life prediction methodologies and inspection technologies to extend turbine engine rotor life, establish retirement for cause criteria, and enable repair processes for critical components. Optimize and transition process technologies, such as permanent mold casting, laser forming, and roll forming to enable the production of affordable and high quality metallic components. Optimize metallic materials, such as discontinuously reinforced aluminum, nanocrystalline aluminum, and high temperature metallic sheets to produce lightweight, high strength components for space systems and thermal protection for space vehicles.

(U) $3,989 Develop ceramics and ceramic matrix composites technologies for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures. Determine the durability of ceramics under service life conditions to guide further materials development and to assess useable life. Test integrally woven ceramic composite structures for actively cooled space vehicle applications, develop thermal protection materials with improved durability for emerging reusable space vehicles, and evaluate ceramic composites for space mirror applications. Validate 2400°F material capability for turbine engine combustors and airfoils through extensive coupon and subelement testing, optimize ceramic composites for aircraft brake friction materials, and test durability of reduced cost ceramic composite for exhaust components. Validate repair techniques for radar absorbing material (RAM) coatings and quantifying the shelf life of the repair constituents. Validate advanced constituent, oxidation resistant, interface coatings through fiber and composite testing.

(U) $44,127 Total

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

Not Applicable.

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	PROJECT: 624347

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

(U) Related Activities:

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

(U) PE 0603211F, Aerospace Systems

(U) PE 0603202F, Aeropropulsion Subsystem Integration.

(U) PE 0603216F, Aeropropulsion 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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602102F Materials		PROJECT: 624348

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624348 Materials for Electronics, Optics, and Survivability	13,251	4,761	9,023	7,788	8,015	7,858	7,770	Continuing	TBD

(U) **A. Mission Description**

Develops enabling materials for protection of aircrews, sensors, aircraft, and space systems from laser and high power microwave (HPM) threats and infrared (IR) seeker materials. Also develops materials technologies for surveillance and situational awareness systems and subsystems for aircraft, missile, and space applications. The protection of aircrews, sensors, aircraft, and space systems from lasers and HPM is dependent upon the power level and wavelength emanating from the threat device and the susceptibility of the target being irradiated. Additionally, protection schemes are dependent on other characteristics of the directed energy threat such as variability (agility) of the wavelength and mode of operation (continuous wave or pulsed). Current materials are being optimized to counter the most prominent threat wavelengths. New materials are being developed to respond to emerging threat wavelengths and ultimately to reject the directed energy independent of threat wavelengths. Sensor modules, microwave devices, IR detectors, and infrared countermeasures (IRCM) devices are used in target detection, weapons targeting, electronic warfare, and active aircraft protection. The performance of these systems for surveillance and situational awareness is constrained by the quality and physical characteristics of available electronic and optical materials. Electronic and optical materials are being developed to enable surveillance and situational awareness with higher operating speeds, greater tunability, higher output power, improved thermal management, greater sensitivity, and extended dynamic range. The improved materials will also increase production quality, increase yields, and reduce costs for these systems.

(U) FY 1999 ($ in Thousands)

(U) $6,651 Developed new materials and processes to provide improved performance, affordability, and operational capability for Air Force radar and space sensor systems.

(U) $4,980 Developed materials to enhance the safety and survivability of aircrews against laser threats and heat seeking IR missiles.

(U) $1,620 Developed materials to enhance the survivability and mission effectiveness of air and space sensor systems against laser threats.

(U) $13,251 Total

(U) FY 2000 ($ in Thousands)

(U) $100 Develop and transition materials technology base to enhance the safety and survivability of aircrews against heat seeking IR missile threats. Determine viability of new ferroelectric nonlinear-optical (NLO) materials that can be periodically poled for far-infrared laser generation with high energy to replace state-of-the-art lithium niobate for infrared IRCM devices.

(U) $3,780 Develop and transition materials technology base to enhance the safety and survivability of aircrews against laser threats. Develop second generation, nonlinear absorbers as infrared materials. Validate stepped limiter device. Demonstrate damage tolerant, biological limiter host materials for protection of personnel eyes, viewing systems, and night vision goggles.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT 624348

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

(U) FY 2000 ($ in Thousands) Continued

(U) $881 Develop and transition enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensor systems against laser threats. Identify liquid crystal materials for autonomous tunable filters to block unknown wavelengths in evaluating switchable (hologram) narrow notch filters to provide day and night sensor agile jamming protection and in demonstrating switchable filters.

(U) $4,761 Total

(U) FY 2001 ($ in Thousands)

(U) $2,625 Develop materials and process technologies for power control and microwave devices to provide improved performance, affordability, and operational capability of Air Force surveillance and situational awareness systems. Develop materials and materials processes to provide increased reliability and temperature capability while reducing power consumption, weight, cost, cooling, complexity, and size. Develop bulk and epitaxial semiconductor materials with improved performance at and above the X-band wavelength region to enable improved power control devices. Evaluate and optimize defect density, doping, and stoichiometry through advanced process control techniques.

(U) $2,791 Develop enabling infrared (IR) detector materials and process technologies to enable improved performance, affordability, and operational capability of surveillance and situational awareness systems. Evaluate alternative materials to fabricate IR detector focal plane arrays at very long wavelengths. Demonstrate multi-layered and hyperspectral/multi-spectral IR detector materials that respond to combinations of wavelengths within spectral bands and between spectral bands. Develop new processing techniques to improve yield in small lot manufacturing.

(U) $2,890 Develop materials technology to enhance the safety and survivability of aircrews against heat seeking IR missile and laser threats. Develop new nonlinear-optical (NLO) materials to replace state-of-the-art lithium niobate for infrared countermeasure (IRCM) devices. Demonstrate second generation, nonlinear absorbers as IR materials; design a gradient limiter device, transition damage tolerant, biological limiter host materials for protection of personnel eyes, viewing systems, and night vision goggles; and establish a hardened night vision goggle testbed.

(U) $717 Develop and transition enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensor systems against laser threats. Evaluate liquid crystal materials for autonomous tunable filters to block unknown wavelengths. Evaluate switchable (hologram) narrow notch filters to provide day and night sensor agile jamming protection. Demonstrate dual wavelength, high optical density switchable filter stacks.

(U) $9,023 Total

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

Not Applicable

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602102F Materials
PROJECT: 624348	

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0603112F, Advanced Materials for Weapon Systems
(U) PE 0602202F, Human Effectiveness Applied Research
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) PE 0603211F, Aerospace Structures.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602102F Materials		PROJECT: 624349

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624349 Materials Technology for Sustainment	15,432	20,816	19,665	19,753	20,339	20,763	21,071	Continuing	TBD

(U) **A. Mission Description**

Develops and transitions materials and materials processing technologies to support operational Air Force mission areas by providing technologies to inspect the quality of delivered systems, transitioning more reliable and maintainable materials, establishing capability to detect and characterize performance threatening defects, characterizing materials processes and property necessary for materials transition, and providing quick reaction support and failure analysis to the operational commands and repair centers. Also develops repair techniques and nondestructive inspection/evaluation (NDI/E) methods. Repair techniques are needed for metallic and non-metallic structures, coatings, corrosion control processes, and to support integration of composite structures for space and aircraft systems. NDI/E methods are essential to ensure optimum quality in the design and production of aircraft, spacecraft, propulsion, and missile systems. 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) FY 1999 ($ in Thousands)

(U) $5,449 Developed NDI/E technologies to evaluate and characterize damage in complex, low-observable materials and structures, and to inspect and maintain integrity of aging aerospace structures and propulsion systems.

(U) $7,865 Developed support capabilities, information, and processes to resolve problems in the use of materials, in conducting failure analysis of components, in materials repair of aircraft structures, and in reducing corrosion in aircraft structures.

(U) $2,118 Developed alternative materials, processes, and environmentally friendly technologies which will eliminate dependency on hazardous and toxic substances in the acquisition, maintenance, and repair of aerospace systems.

(U) $15,432 Total

(U) FY 2000 ($ in Thousands)

(U) $7,187 Develop and transition NDI/E technology base to evaluate and characterize damage in complex, low-observable materials and structures, and to inspect and maintain integrity of aging aerospace structures and propulsion systems. Demonstrate enhanced laser generated ultrasound capabilities to detect the onset of hidden corrosion between metallic structural elements for aging aircraft structures. Establish design and laboratory scale baseline feasibility capability to evaluate remote inspection capabilities for crack detection within complex structures. Identify methods to nondestructively measure near surface (100 micron) residual stress depth gradients which will allow depots to safely extend the service life of turbine engine rotors.

(U) $2,500 Develop alternative materials, processes, and environmentally friendly technologies which will eliminate dependency on hazardous and toxic substances in the acquisition, maintenance, and repair of low-observable aerospace systems. Identify NDI/E point inspection device

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602102F Materials	PROJECT 624349

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

(U) FY 2000 ($ in Thousands) Continued

requirements to verify repair quality. Establish the baseline criteria for an integrated low-observable repair kit. Fabricate high temperature and/or ultraviolet (UV) gap sealants and conductive elastomers. Evaluate ultrasonically applied and/or removed thermoplastic Radar Absorbing Material (RAM) repairs, high temperature RAM coating repairs, and Radar Absorbing Structures (RAS) field level repairs.

(U) $11,129 Develop and transition support capabilities, information, and processes to resolve problems in the use of materials, to perform electronic and structural failure analysis of components, in the repair of aircraft structures, and to reduce aircraft corrosion. Provide failure analysis and materials investigations for field, acquisition, and depot organizations. Develop alternative wiring and connector technologies and investigate new techniques for analyzing structural failures of replacement materials for aging Air Force systems. Measure and characterize high cycle fatigue (HCF) foreign object damage (FOD) propagation values for turbine engine blade materials and transition funding to industry of military handbook 5 (MIL-HDBK 5), the primary source of static design allowables for metallic materials and structural elements (fasteners). Develop standard test procedures to assess application of low-observable gap-filler materials and evaluate on-aircraft processed adhesive and patch repair of high-temperature composite aircraft structures. Test capabilities for evaluation of corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems and develop technical understanding of corrosion to model and reduce corrosion in aircraft structures.

(U) $20,816 Total

(U) FY 2001 ($ in Thousands)

(U) $4,432 Develop and transition non-destructive inspection/evaluation (NDI/E) technology to identify and characterize damage in complex, low-observable materials and structures, and to inspect and maintain integrity of aging aerospace structures and propulsion systems. Transition enhanced laser generated ultrasound capabilities to detect the onset of hidden corrosion between metallic structural elements. Initiate development of an NDI/E response computer simulation model for integrated product design. Develop and design laboratory scale capability to evaluate remote inspection capabilities for crack detection within complex structures. Evaluate methods to nondestructively measure near surface (100 micron) residual stress depth gradients to allow depots to safely extend the service life of turbine engine rotors.

(U) $3,000 Develop and transition enabling technologies to reduce the Air Force maintenance burden due to low-observable requirements. Establish baseline capability for NDI/E point inspection devices to verify repair quality. Assemble an integrated low-observable repair kit. Demonstrate high temperature and/or ultraviolet (UV) gap sealants and conductive elastomers. Develop ultrasonically applied and/or removed thermoplastic RAM repairs, high temperature RAM coating repairs, and RAS field level repairs.

(U) $4,760 Develop and transition support capabilities, information, and processes to resolve problems in the use of materials and provide electronic and structural failure analysis of components. Perform failure analysis and materials investigations for field, acquisition, and depot organizations. Transition electrostatic discharge (ESD) protection materials technologies for space and low-observable applications. Experimentally evaluate

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

(U) FY 2001 ($ in Thousands) Continued

testing techniques needed for analyzing structural failures of replacement materials for aging Air Force systems.

(U) $7,473 Develop and transition support capabilities, information, and processes to resolve problems in the use of materials, in the repair of aircraft structures and to reduce aircraft corrosion. Establish residual stresses baseline criteria of high cycle fatigue (HCF) and foreign object damage (FOD) in turbine engine blade materials. Evaluate advanced composite materials compatibility with laser effluents as an alternative to metallic materials for high energy chemical oxygen-iodine laser devices. Develop improved gap-filler materials for low-observable platforms and test on-aircraft processed adhesive and patch repair of high-temperature composite aircraft structures. Develop capabilities to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Validate technical understanding of corrosion.

(U) $19,665 Total

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

Not Applicable.

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

(U) Related Activities:

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

(U) PE 0603211F, Aerospace Structures

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	60,746	45,594	48,775	55,436	62,802	66,285	66,056	Continuing	TBD
622401	Structures	16,730	19,398	47,489	54,751	60,606	64,159	63,665	Continuing	TBD
622402	Vehicle Equipment	10,957	3,739	0	0	0	0	0	Continuing	TBD
622403	Flight Controls and Pilot-Vehicle Interface	16,733	12,194	0	0	0	0	0	Continuing	TBD
622404	Aeromechanics and Integration	15,034	8,824	0	0	0	0	0	Continuing	TBD
624397	Air Base Technology	1,292	1,439	1,286	685	2,196	2,126	2,391	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: Beginning in FY 2001, Projects 622402, 622403, and 622404 are combined into Project 622401.

(U) **A. Mission Description**

This program determines the technical feasibility of aerospace vehicle technologies in aeromechanics, structures, flight control, air vehicle pilot interface, and air base technologies to reduce life cycle costs, improve the performance, and extend the life of legacy and future manned and unmanned aerospace vehicles, and increase the maintenance and survivability of air bases. The payoffs from these technology programs include decreased vulnerability, increased affordability, reliability, maintainability, and supportability of aerospace vehicles, and improved air base operations. Note: In FY 2000, Congress added $1.680 million for autonomous control technology, $1.680 million for virtual development and demonstration environment, and $0.960 million for extreme environment structures.

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

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

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	64,063	43,898	47,142	
(U)	Appropriated Value	64,932	45,718		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-869			
	b. Small Business Innovative Research	-696			
	c. Omnibus or Other Above Threshold Reprogram		-95		
	d. Below Threshold Reprogram	-2,281			
	e. Rescissions	-340	-29		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			1,633	
(U)	Current Budget Submit/FY 2001 PBR	60,746	45,594	48,775	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to increased funding for the unmanned air vehicle (UAV) program.

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics		PROJECT: 622401

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622401 Structures	16,730	19,398	47,489	54,751	60,606	64,159	63,665	Continuing	TBD

(U) **A. Mission Description**

This project develops aerospace vehicle technologies in aeromechanics, structures, flight control, air vehicle pilot interface, and design integration and analysis tools to reduce life cycle costs, improve the performance, and extend the life of legacy and future manned and unmanned aerospace vehicles. The payoffs from these technology programs include decreased vulnerability and increased affordability, reliability, maintainability, and supportability of aerospace vehicles.

(U) FY 1999 ($ in Thousands)

(U)	$883	Continued design, development, and test of advanced structures that incorporate distributed vibration suppression technologies for life extension and exploit wing warping, camber shaping, and adaptive structures technologies that enhance air vehicle performance. Technologies under development included distributed vibration suppression techniques, and evaluation and assessment of wing twisting and control surface warping.
(U)	$1,533	Developed composite structures that enhance affordability and survivability of future aircraft. Developed fail safe design criteria for translaminar reinforced composite structures to reduce inspection and repair costs. Integrated aerodynamics, flight control, and electromagnetics (radar/infrared) analyses into multi-disciplinary structural design methods to reduce design costs and improve accuracy.
(U)	$1,647	Developed multifunctional adaptive structures that sense aeromechanical loads, control structural response, and integrated subsystem functionality to reduce system level manufacturing costs and increase tactical performance of aerospace vehicles.
(U)	$11,392	Extended usable structural lives and/or reduced costs of aging aircraft with technologies that account for life, risk, repairs, and dynamic loads. Structural lives were extended by development of bonded composite repairs of metallic structures and evaluation of techniques to assess risk of failure of structural components due to corrosion and widespread fatigue damage.
(U)	$1,275	Improved durability for existing and future aerospace vehicle structures by developing technologies that incorporated advanced materials as well as passive and active cooling to withstand the extreme environments of high temperatures, vibrations, and acoustic noise to reduce cost and increase life of aerospace vehicle structures. Durability technologies included advanced thermal protection systems and an integrated thermal energy management/structure design.
(U)	$16,730	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics — PROJECT: 622401

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

(U) FY 2000 ($ in Thousands)

(U)	$1,566	Continue design, development, and test of advanced structures that incorporate distributed vibration suppression technologies for life extension and exploit wing warping, camber shaping, and adaptive structures technologies that enhance aerospace vehicle performance. Continue development of distributed vibration suppression techniques, and the evaluation and assessment of wing twisting and control surface warping of manned and unmanned aerospace vehicles.
(U)	$1,411	Develop unitized composite and metallic concepts that reduce manufacturing costs of future aerospace vehicles. Verify design criteria for translaminar reinforced composites to reduce inspection and repair costs. Develop integrated multidisciplinary design methods to reduce design time.
(U)	$1,579	Continue development of multifunctional structures that tailor structural response, and integrate subsystem functionality to reduce system level manufacturing costs and increase tactical performance of future aerospace vehicles. Test advanced airframe structural integration concepts to detect widespread fatigue and corrosion.
(U)	$2,713	Continue durability improvements for existing and future aerospace structures by developing concepts that incorporate advanced materials as well as passive and active cooling to withstand the extreme environments of high temperatures, cryogenic temperatures, vibrations, and acoustic noise to reduce cost and increase life of aerospace vehicle structures. Durability technologies include advanced thermal protection systems, high temperature composite structures, and integrated thermal subsystems/structures. Develops turbine engine nozzles that are structurally integrated with the airframe for future aerospace operating vehicles.
(U)	$10,425	Extend usable structural lives and/or reduce costs of aging aircraft and unmanned aerospace vehicles with technologies that account for life, risk, repairs, and dynamic loads. Structural lives can be extended by development of bonded composite repairs of metallic structures and evaluation of techniques to assess risk of failure of structural components. Dynamic loads can be reduced through active suppression techniques.
(U)	$1,704	Develops an advanced technology assessment capability which serves Air Force with leadership in identifying, prioritizing, developing, and demonstrating next-generation aerospace vehicle concepts. Facilitates web-based design environment process by bringing the best ideas to a design without the constraint of time and space.
(U)	$19,398	Total

(U) FY 2001 ($ in Thousands)

(U)	$3,850	Develop methods to predict and to suppress structural damage due to high cycle fatigue that reduce operations and support costs and provide higher aircraft availability. Continue development of durability patches for structures experiencing premature failure due to high cycle fatigue. Continue technology improvements of airframe structual vibration suppression techniques which delay the onset of high cycle fatigue failures.
(U)	$5,448	Develop and demonstrate new control techniques to enable safe, highly autonomous mixed-fleet and multi-unmanned air vehicle operations for increased combat effectiveness. Continue unmanned aerospace vehicle development to ensure safe operation and allow precision close

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics	PROJECT 622401

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

(U) FY 2001 ($ in Thousands) Continued

operations of mixed manned and unmanned air vehicles. Develop adaptive flight control algorithms for autonomous vehicle operations. Initiate development of advanced system for automatic Unmanned Air Vehcile (UAV) in-flight refueling.

(U) $1,828 Continue development of composite and metallic concepts that reduce manufacturing costs of future air vehicles. Initiate development of Analytical Certification Methodologies for unitized structures to ensure transition of advanced concepts and manufacturing processes to future airframe designs. Continue development of integrated multidisciplinary design methodologies that enhance affordability and decrease vulnerability of future aerospace vehicles.

(U) $3,163 Develop new flight control design methods and criteria that provide air combat advantage by increasing performance and decreasing vulnerability and cost. Initiate development of new intelligent/learning reconfigurable controller to enable continued air vehicle operation in event of damage or failure, and develop a new air vehicle flight control learning concept.

(U) $3,343 Develop advanced flight control technology to enable aircraft-like operations for affordable on-demand military access to space. Develop technology concepts for integration of vehicle management system with vehicle health management/prognostics. Complete aerospace vehicle requirements definition study and conceptual design.

(U) $2,879 Continue development of a signature-compatible, integrated high lift device that will improve aerodynamic performance and survivability with lower cost of ownership than conventional flight control devices. Perform analytical design of subscale aerospace vehicle model for future powered testing and analysis.

(U) $3,786 Develop computational tools and techniques for predicting and optimizing aerodynamic and structural performance of advanced manned and unmanned aerospace vehicles. Continue development of next generation, multi-disciplinary optimization computer design code integrating aerodynamics, structures, thermal mangement, signatures, and flight controls. Complete development of fully associative object-oriented multi-disciplinary design architecture and demonstrate capability to employ high fidelity analyses earlier in aircraft design to rapidly synthesize and evaluate cost of advanced configurations for UAVs.

(U) $5,107 Develop and demonstrate affordable aerospace vehicle aerodynamic technologies that increase aerospace vehicle peformance. Initiate investigation into techniques to generate and control plasma flow field over hypersonic vehicles. This will improve hypersonic maneuverability of transatmospheric vehicles and save weight over traditional reaction control and aerodynamic control surface approaches.

(U) $2,698 Evaluate the integration of multifunctional structures that tailor structural response and integrate subsystem functionality to reduce system level manufacturing costs and increase tactical performance of future aerospace vehicles. Initiate development of full wing span structurally integrated with a low frequency multifunctional antenna to increase radio frequency performance and reduce weight.

(U) $3,155 Improve durability of existing and future aerospace vehicle structures by developing technologies that incorporate advanced materials as well as passive and active cooling to withstand the extreme environments of high temperatures, vibrations, and acoustic noise to reduce cost and increase

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics
	PROJECT 622401

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

(U) FY 2001 ($ in Thousands) Continued

life of aerospace vehicle structures. Concepts under development consist of design, fabrication, and assessment of high temperature composite and metallic aerospace vehicle structures.

(U) $9,236 Investigate modification and repair techniques to retrofit fail-safety into aging aircraft to increase availability and reduce operations and support costs. Develop composite and metallic bonded repair techniques which provide for damage tolerance where none now exists. Investigate low-cost structrual modifications to aging systems which provide fail-safety in critical areas of the aircraft.

(U) $2,996 Develop advanced analytical methods for analysis of unitized structures and certification of structural components which reduce development time and cost of aircraft. Initiate exploration of damage initiation and propagation models for unitized metallic structure. Develop analytical methods for certification of aging aircraft repairs and structural modifications.

(U) $47,489 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials

(U) PE 0602269F, Hypersonic Technology Development.

(U) PE 0603211F, Aerospace Structures

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics — PROJECT: 622402

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622402 Vehicle Equipment	10,957	3,739	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops technologies to reduce subsystem and component life cycle costs in operational environments and improves subsystem performance for current and future manned and unmanned aerospace vehicles.

(U) FY 1999 ($ in Thousands)

(U) $2,590 Developed and assessed component combat damage repair technologies, deflagration suppression techniques, and hydrodynamic ram tolerance techniques that decrease aerospace vehicle vulnerability. Techniques developed include analytical tools to define and reduce vulnerability to missile and ballistic threats on critical components. Developed and validated new criteria for selecting deflagration suppression techniques in internal munitions bays and engine nacelles.

(U) $1,788 Developed and evaluated affordable subsystem technologies that enhance aerospace vehicle safety and reliability, and reduce cost. Completed a study to assess the feasibility of applying electric actuation to utility subsystems to reduce aircraft maintenance costs. Initiated a program to develop technologies required to apply electric actuation to manned and unmanned aerospace vehicles.

(U) $4,502 Developed and evaluated designs for affordable structural life for an increase in maintenance/durability of existing and future aerospace vehicles. Designs included noise suppression techniques as well as development of composite repair process for damaged or cracked components.

(U) $2,077 Developed and assessed technologies for aerospace vehicle internal energy management systems to reduce cost and weight. Completed development of a full-scale advanced composite material heat exchanger to demonstrate a 50% reduction in heat exchanger weight.

(U) $10,957 Total

(U) FY 2000 ($ in Thousands)

(U) $1,035 Develop and assess component combat damage repair technologies, deflagration suppression techniques, and hydrodynamic ram tolerance techniques that decrease aerospace vehicle vulnerability. Techniques to be developed include analytical tools to define and model hydrodynamic ram effects on composite fuel tanks.

(U) $767 Develop and evaluate process for affordable structural life for an increase in maintenance/durability of existing and future aerospace vehicles. Process includes noise suppression techniques as well as development of a composite repair process for damaged or cracked components.

(U) $153 Develop and assess affordable subsystem technologies that enhance aerospace vehicle safety and reliability and reduce cost. Continue to develop and assess technologies required to apply electric actuation to manned and unmanned aerospace vehicles.

(U) $1,784 Develop and assess technologies for aerospace vehicle energy management systems and components to reduce vehicle size and weight by

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics / PROJECT: 622402

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

(U) FY 2000 ($ in Thousands) Continued

developing high efficiency, lightweight thermal energy components and advanced heat transport techniques.

(U) $3,739 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 622401.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603106F, Logistics Systems Technology.

(U) PE 0603205F, Flight Vehicle Technology.

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

(U) PE 0604212F, Aircraft Equipment Development.

(U) PE 0604609F, Reliability and Maintainability Technology Insertion Program

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics		PROJECT: 622403

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622403 Flight Controls and Pilot-Vehicle Interface	16,733	12,194	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops technology to enable the pilot to obtain maximum performance from aerospace vehicles under all conditions, provide the pilot with the display of information from on-board subsystems and off-board intelligence sources for increased situational awareness leading to enhanced mission performance and flight safety, provide robust capability to control aircraft after damage and failures, and network synthetic environments for evaluation of advanced concepts. This project develops flight control technologies for both manned and unmanned aerospace vehicles.

(U) FY 1999 ($ in Thousands)

(U) $4,254 Developed and demonstrated advanced flight control techniques for manned and unmanned aerospace vehicles to provide air combat advantage by increasing performance while decreasing vulnerability, cost, and supportability requirements. Continued to develop flight test hardware of optical air data system that eliminates need for non-stealthy, expensive air data probes, vanes, and ports. Initiated development of advanced vehicle management system that exploits photonics to improve manned and unmanned aerospace vehicles subsystem communication data rates and life cycle upgrade potential.

(U) $4,345 Developed new flight control design methods and criteria that provide air combat advantage by increasing performance and decreasing vulnerability and cost. Completed algorithm development for battle-damage resistant flight control system for manned and unmanned aerospace vehicles and initiated development of unsteady aerodynamic modeling techniques for use in flight control system design.

(U) $1,938 Developed enhanced vehicle-pilot integration technologies to improve overall weapon systems performance and exploit real-time on-board/off-board data for human-machine technology interface. Specific technologies included advanced pilot air-to-air situation awareness and integrated technologies for in-flight mission planning and automated low-level flight.

(U) $3,318 Developed capabilities to evaluate technologies for increased aerospace vehicle performance, decreased vulnerability and cost, and improved probability of mission success. Initiated simulations to assess new unmanned aerospace vehicle technologies and confirm mission effectiveness and flight safety.

(U) $2,878 Initiated areodynamic control technology development that addresses the automatic maneuvering of unmanned aerospace vehicles in the terminal area to improve flight safety and combat effectiveness.

(U) $16,733 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics — PROJECT: 622403

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

(U) FY 2000 ($ in Thousands)

(U)	$3,197	Develop and demonstrate advanced flight control techniques for manned and unmanned aerospace vehicles to provide air combat advantage by increasing performance while decreasing vulnerability, cost, and supportability requirements. Complete flight demonstration of optical air data system and transition the capability to user. Continue development of advanced vehicle management system architecture concepts and identify key component demonstrations.
(U)	$2,813	Develop new flight control design methods and criteria that provide air combat advantage by increasing performance and decreasing vulnerability and cost. Complete algorithm development for on-board pilot-induced oscillation prevention.
(U)	$2,451	Develop capabilities to evaluate technologies for increased aerospace vehicle performance and decreased vulnerability and cost, and improved probability of mission success. Conduct mission technology assessments for manned vehicles and unmanned aerospace vehicles; determine design guides for effective mission management systems. Conduct aerospace vehicle technology simulations and identify controllability boundaries for safe aerospace vehicles flight.
(U)	$3,733	Continue to develop control technology for the autonomous maneuvering of unmanned aerospace vehicles in the terminal area to improve flight safety and combat effectiveness. Develop and integrate high integrity, four-dimensional precision trajectory generation and control algorithms. Continue autonomous flight control research in automated air collision avoidance, key laboratory demonstrations of lightweight photonic technologies, and identification of transatmospheric and aerospace vehicle control technologies for aircraft-like operations.
(U)	$12,194	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort moved to Project 622401.
(U)	$0	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0602204F, Aerospace Sensors
(U) PE 0603205F, Flight Vehicle Technology.
(U) PE 0603245F, Flight Vehicle Technology Integration.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics — PROJECT: 622403

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics		PROJECT: 622404

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622404 Aeromechanics and Integration	15,034	8,824	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops aerodynamic design integration technologies for current and future manned and unmanned aerospace flight vehicles, focusing on speed regimes ranging from low to high Mach. These technologies have potential to reduce costs, improve range to yield enhanced global force projection, improve maneuverability, and reduce observability. This project evaluates and develops technologies for manned and unmanned aerospace vehicles and aerospace vehicle design assessment and analysis tools.

(U) FY 1999 ($ in Thousands)

(U) $4,324 Conducted aerodynamic design, analysis, test, and performance assessments of advanced manned and unmanned aerospace vehicles consistent with signature and cost constraints. Performed validation tests of innovative aerodynamic control concepts for low signature, manned and unmanned aerospace vehicles.

(U) $3,788 Developed computational tools and techniques for predicting and optimizing aerodynamic and structural performance of advanced manned and unmanned aerospace vehicles. Continued development of computer design code addressing fluid/structural interactions. Initiated development of next generation, multi-disciplinary optimization computer design code integrating aerodynamic, structural, signature, and other scientific disciplines.

(U) $4,299 Developed and demonstrated affordable fixed-wing vehicle aerodynamic technologies to increase aerospace vehicle performance and decreased vulnerability. Initiated development of aerodynamic and structural integration including flow control in payload bays.

(U) $2,623 Developed conceptual designs and assessed technologies to determine impacts of integrating directed energy systems such as high power microwaves, high energy lasers, and kinetic energy weapons into aerospace vehicles.

(U) $15,034 Total

(U) FY 2000 ($ in Thousands)

(U) $1,331 Conduct aerodynamic design, analysis, test, and performance assessments of advanced tactical transport aircraft and aerospace vehicles consistent with signature and cost constraints.

(U) $3,386 Develop computational tools and techniques for predicting and optimizing aerodynamic and structural performance of advanced manned and unmanned aerospace vehicles. Complete development of computer design code addressing fluid/structural interactions. Continue development of next generation, multi-disciplinary optimization computer design code integrating aerodynamic, structural, signature, and other scientific disciplines

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics
	PROJECT 622404

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$4,107	Develop and demonstrate affordable fixed-wing vehicle aerodynamic technologies to increase aerospace performance and decrease vulnerability. Continue development of aerodynamic and structural integration including flow control in payload bays.
(U)	$8,824	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort moved to Project 622401.
(U)	$0	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0603205F, Flight Vehicle Technology.
(U) PE 0603260F, Hypersonic Technology Development
(U) PE 0603245F, Flight Vehicle Technology Integration.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602201F Aerospace Flight Dynamics — PROJECT: 624397

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624397 Air Base Technology	1,292	1,439	1,286	685	2,196	2,126	2,391	Continuing	TBD

(U) **A. Mission Description**

This project develops air base technologies for fixed and bare base operations, including airfield pavements, energy systems, air base survivability, air base recovery, protective shelter systems, airfield fire protection, and crash rescue. Payoffs include air base support operations that are affordable, easily transportable, and with increased survivability of personnel and facilities.

(U) FY 1999 ($ in Thousands)

(U) $568 Developed aircraft and air base fire fighting technologies (e.g., clean, environmentally safe fire fighting agents, vehicles, equipment, personnel protective clothing, fire risk assessment technologies, and fire fighting training systems) and improved fire fighting rescue technology with infrared imaging.

(U) $543 Developed utility and shelter technologies that improve air mobility systems performance and reduce airlift requirements. Developed a waste management system, in support of Air Expeditionary Force (AEF) operations.

(U) $181 Evaluated and developed air transportable shelters that are lightweight and suitable for AEF operations.

(U) $1,292 Total

(U) FY 2000 ($ in Thousands)

(U) $579 Develop aircraft and air base fire fighting technologies to improve fire fighting rescue using infrared sensor technology. Test safe fire fighting agents. Develop protective clothing, fire risk assessment technologies, and fire fighting training systems.

(U) $742 Develop utilities and shelters technologies that improve air mobility systems performance and reduce airlift requirements. Develop advanced waste management technologies that are lightweight and support of AEF operations.

(U) $118 Evaluate air transportable shelters that are lightweight and suitable for AEF operations. Develop air transportable shelter technologies for aircraft and flightline personnel.

(U) $1,439 Total

(U) FY 2001 ($ in Thousands)

(U) $526 Develop aircraft and air base fire fighting technologies to improve fire fighting rescue. Test new fire fighting agents that are non-corrosive and are not harmful to fire fighting personnel. Continue testing of advanced autonomous technologies for use in flightline fire fighting trucks.

(U) $672 Develop utilities, automation, and waste management technologies that reduce airlift requirements and improve air base operations and survivability for agile combat support. Begin evaluation of new ground power generation concepts that are highly efficient and lightweight.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics	PROJECT 624397

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$88	Evaluate air transportable protective shelter technologies that are lightweight, structurally strong, and are affordable and suitable for Air Expeditionary Force operations. Continue technology demonstration program for lightweight air inflatable shelters for aircraft and flightline personnel.
(U)	$1,286	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603205F, Flight Vehicle Technology.

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	61,243	70,494	62,619	60,301	59,720	65,780	68,758	Continuing	TBD
621123	Manpower, Personnel, and Training	12,293	16,578	11,956	11,567	11,078	12,927	13,450	Continuing	TBD
621710	Deployment and Logistics Technologies	3,198	5,805	6,367	7,877	7,337	7,244	7,338	Continuing	TBD
621900	Environmental Quality Technology	3,457	2,766	0	0	0	0	0	Continuing	TBD
627184	Crew Technology	30,220	36,844	33,657	29,993	30,335	35,130	37,204	Continuing	TBD
627757	Directed Energy Bioeffects	12,075	8,501	10,639	10,864	10,970	10,479	10,766	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2000, studies in support of Distributed Mission Training will move from Project 627184 to Project 621123, and the toxicology hazards research program will move from Project 627757 to Project 621710. Project 621900 was terminated after FY 1999, but Congress added funding in FY 2000.

(U) **A. Mission Description**

This program establishes technology feasibility and develops the technology base for Air Force human effectiveness requirement needs for weapon systems, operational readiness, and environmental quality. The program addresses crew systems interfaces, crew protection, warfighter training, deployment and sustainment of expeditionary forces, and environmental safety and quality. Crew technologies increase the performance of humans in weapon systems operation by improving aircrew life support systems, man-machine integration (to include aircraft information display systems), and protection from dynamic forces (acceleration/escape/windblast). Warfighter training technologies focus on the development and evaluation of new methods and technologies in support of Air Force training and education requirements. Deployment and sustainment technologies focus on reducing manpower required to operate and support weapon systems by increasing weapon systems supportability and affordability, improving wartime logistics planning, developing occupational and operational exposure safety guidelines for militarily relevant toxicants, and modeling human cognitive functioning on complex tasks to enhance operational performance. Directed energy bioeffect technologies focus on protection from militarily relevant electromagnetic radiations and directed energy systems (lasers and radio frequency emitting weapons, radars, and communication systems). Environmental quality technologies address detection, control, reduction, and disposal of pollutants from Air Force operations; and the clean-up of contaminated Air Force sites. Payoff from these technology development efforts is to improve combat effectiveness by expanding all parameters defining operational performance limits.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research

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

Note: In FY 2000, Congress added $0.8 million for Materials and Processes for Metal Cleaning, Corrosion Control and Coatings, $3.6 million for Behavioral Science Research under Air Force Research Laboratory, $3.0 million for Solid State Electrolyte Oxygen Generator, $1.7 million for Oxygen Research, $2.0 million for Environmental Quality Technology, $2.0 million for Sustained Operations, $0.7 million for Spatial Disorientation, $0.4 million for Altitude Protection, $1.2 million for Physiology, $2.4 million for Information Training, and $1.7 million for Space Training, which explains the perceived decrease in FY 2001 and out.

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

This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies. This Applied Research program establishes technology feasibility and develops the technology base for Air Force human interface needs required for weapon systems, operational readiness, and environmental quality.

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	58,114	51,512	56,629	
(U)	Appropriated Value	60,805	71,012		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2,691	-13		
	b. Small Business Innovative Research	-937			
	c. Omnibus or Other Above Threshold Reprogram		-255		
	d. Below Threshold Reprogram	4,409			
	e. Rescissions	-343	-250		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			5,990	
(U)	Current Budget Submit/FY 2001 PBR	61,243	70,494	62,619	TBD

(U) Significant Program Changes:

Increase in FY 2001 is due to increased emphasis on aviation safety to include countermeasures to warfighter fatigue, improving pilot performance under high gravitational forces, and countering spatial disorientation.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 621123

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621123 Manpower, Personnel, and Training	12,293	16,578	11,956	11,567	11,078	12,927	13,450	Continuing	TBD

(U) **A. Mission Description**

This project develops and evaluates new methods and technologies in support of Air Force training and education requirements in a variety of specific areas, including: aircrew training; technical training; logistics training; mission rehearsal; training in support of complex decision making; space operations training; information warfare training; and warfare readiness training. It investigates the spectrum of new and advanced training and education technologies for optimal ways to determine needs and deficiencies, design and implement training, and evaluate training effectiveness. It develops and evaluates specific training systems, desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation-based systems to determine how to achieve maximum learning effectiveness for specific needs at minimum cost. This project will contribute to a more highly trained and flexible cadre of personnel and reduce the cost of maintaining crew, aircraft, and support personnel readiness. This program develops technologies to increase operational readiness by providing more effective methods and approaches to classify, assign, train, assess, and retain personnel. This program focuses on reducing the manpower required to operate and support weapon systems and on improving the effectiveness of the operators, maintainers, and other support personnel for those systems.

(U) FY 1999 ($ in Thousands)

(U)	$5,780	Developed technologies required to enhance the integrated Distributed Mission Training (DMT) environment by incorporating space and information operations systems and by developing mission rehearsal training technologies, a more representative electronic combat environment and High Level Architecture (HLA) compliant systems.
(U)	$2,938	Developed Air Force training guidelines, instructional scenarios, and techniques for use in Air Force aircrew, space, and information operations mission training.
(U)	$2,714	Refined intelligent computer adaptive instruction authoring system based on knowledge representation/student modeling technologies and knowledge-based technologies for curriculum planning and media selection.
(U)	$861	Developed concept and technologies to enable a warfare operations center by creating performance specifications for a seamless, integrated information system consisting of mission planning, automated brief/debrief, simulation, academics, weapon systems, and Command, Control and Information systems.
(U)	$12,293	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 621123

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

(U) FY 2000 ($ in Thousands)

(U) $4,695 Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Research will increase and enhance the quality of training and mission rehearsal for the warfighter. Develop cockpit sensors, which replicate real world responses to outside stimuli. Explore requirements for long haul networking in the areas of computer bandwidth to see how many moving models can be on the database without causing performance degradation and latency, and to see how distance between simulators will affect performance. Complete the development of the threat library, which covers all known threats.

(U) $10,992 Develop Air Force training guidelines, instructional scenarios, and techniques by transitioning combat aerial training technologies and performance measurement systems into aircrew, space, and information operations environments. Methods and technologies will significantly improve the effectiveness and efficiency of aerospace operations, command and control, training development, mission rehearsal, and refresher training. Begin to develop an internet-based integrated team decision support system. Perform detailed task and functional analyses to specify the information requirements, sources, and levels of interoperability necessary to develop an integrated space mission control training and rehearsal system. Identify key training and operational knowledge, skills and tasks, and develop specifications for competency-based training and rehearsal for both DMT and operational flying training.

(U) $891 Develop concept and technologies to enable a Warfare Operations Center (WOC) by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Implement a deployable personal agent into an existing distributed command and control simulation for training, assessment, and aiding the warfighter.

(U) $16,578 Total

(U) FY 2001 ($ in Thousands)

(U) $5,988 Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Research will increase and enhance the quality of training and mission rehearsal for the warfighter. Conduct experiments to determine the extent to which various cues provided by simulator visual systems contribute to the effectiveness of the display imagery. Complete feasibility study and begin the establishment of a DMT networking standard to be employed by the entire DoD modeling and simulation community. Investigate new computer architectures and data manipulation to provide real-time modeling of multi-sensor imagery.

(U) $5,172 Develop tools and strategies for identifying and improving combat mission training and rehearsal and for distributing training and performance support to operational forces. Begin feasibility study to embed and evaluate instructional principles in DMT simulations. Complete feasibility study of integrated intelligence, surveillance, and reconnaissance (ISR) data utility for aircrew mission planning and execution. Conduct knowledge engineering for ground-based satellite controller training and develop initial capability for Space Based Infrared System operator

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 621123

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

(U) FY 2001 ($ in Thousands) Continued

training and performance support, and continue study of integrating command and control systems of the warfare operations center with the Distributed Mission Training (DMT) environment.

(U) $796 Develop Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Develop and implement tools and simulation for training and assessment of performance in two separate command and control information systems. Demonstrate new training and team dynamic protocols to operational users.

(U) $11,956 Total

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

Not Applicable.

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

(U) Related Activities:

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

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

(U) PE 0602727A, Non-System Training Devices Technology.

(U) PE 0602785A, Manpower, Personnel, and Training Technology.

(U) PE 0603106F, Logistics Systems Technology.

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

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

(U) PE 0604243F, Manpower, Personnel, and Training Development.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research	PROJECT: 621710

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621710 Deployment and Logistics Technologies	3,198	5,805	6,367	7,877	7,337	7,244	7,338	Continuing	TBD

(U) **A. Mission Description**

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

(U) FY 1999 ($ in Thousands)

(U) $670 Explored and defined highly reliable, low footprint, multi-function, rapid on-load/off-load, and ground movement technology concepts which will increase deployment speed and decrease airlift requirements in support of agile combat support and rapid global mobility goals.

(U) $1,082 Explored and developed technology options to improve agile combat support capabilities by assessing alternative input devices, such as electro-oculographic and electromyographic capabilities, to be used in various maintenance environments which are loud (prohibiting voice control capability), and requiring free hands (prohibiting manual control). Investigated advanced user interfaces to support wing level logistics decision making to enhance response time and unit capability in AEF operations.

(U) $1,446 Adapted and refined information technologies to enhance logistics and deployment planning capabilities by defining and evaluating advanced knowledge representation schemes and computational linguistics methods to automatically extract maintenance manual information for weapon systems design data.

(U) $3,198 Total

(U) FY 2000 ($ in Thousands)

(U) $297 Develop technologies for improved cargo handling and improved support of space assets to better support weapon systems and reduce logistics support costs. Complete feasibility analyses and development of initial technology concepts for improved cargo handling at aerial ports and deployed locations and for improved space systems supportability.

(U) $2,782 Develop logistics readiness and sustainment technology options and perform feasibility studies to support large scale advanced technology development programs. These experiments provide critical information for technology integration and application to advanced technology developments which support AEF initiatives. Identify diagnostic strategies and data requirements to support the advanced prognostic/diagnostic program which will reduce aircraft down time. Develop enabling technology for innovative software architectures for more accurate

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research
	PROJECT 621710

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

(U) FY 2000 ($ in Thousands) Continued

representation of human behavior in synthetic environments.

(U) $2,726 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risk associated with exposure to operational compounds and materials for force protection. Characterize the health hazard to flight operations personnel exposed to jet fuels (JP-8) and various additive compounds. Develop a science-based standard that accurately reflects the human health consequences of widespread contamination by solvent compounds used in maintenance processes.

(U) $5,805 Total

(U) FY 2001 ($ in Thousands)

(U) $1,805 Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs. Develop software architectures to transform procedural maintenance instructions into graphic-oriented computer simulations for validation analysis. Develop neural network concepts for application to high-leverage areas of depot repair parts demand and resource forecasting.

(U) $1,762 Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force (AEF) operations. Investigate various technology to retrofit aircraft with automated sensors to collect and record system performance data for enhanced capability to diagnose and predict component failures. Explore technology to automatically collect asset status information to provide real-time information for management of logistics processes and support of deployment operations.

(U) $2,800 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Establish a health-based exposure standard for an Air Force missile fuel oxidizer that has contaminated large areas of the western United States. Apply predictive tools to assist fuels developers in rapidly screening various additives for toxicity.

(U) $6,367 Total

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

Not Applicable.

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 621710

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

(U) Related Activities:

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

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

(U) PE 0603106F, Logistics Systems Technology.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 621900

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621900 Environmental Quality Technology	3,457	2,766	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

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

(U) FY 1999 ($ in Thousands)

(U) $980 Investigated and developed environmentally acceptable replacement materials and processes to reduce the cost of weapon systems sustainment by developing new selection criteria for Air Force industrial solvents and fuels, and by characterizing the air quality effects of Air Force volatile materials.

(U) $888 Developed environmental instrumentation for chemical detection and monitoring and process controls by identifying and correcting unnecessary Air Transport and Dispersion (ATD) launch holds and reducing liability risks. Developed techniques to accurately characterize Air Force-generated particulate matter and developed innovative instrumentation to detect chlorinated solvents, explosives, and other Air Force-monitored chemicals.

(U) $1,589 Reduced weapon systems sustainment costs and enhanced Air Force readiness by developing engineering tools to isolate and synthesize enzymes for perchlorate chlorate and chlorite reduction. Converted propellant from missiles and rockets to benign compounds. Characterized strategies for energy generation and water recovery from waste treatment systems. Enhanced DoD capability to contain and control regulated emissions from depainting and other corrosion-control operations. Studied environmental interactions of advanced fuels and solvents.

(U) $3,457 Total

(U) FY 2000 ($ in Thousands)

(U) $967 Develop filtration materials and processes to protect U.S. forces from long-term health consequences from exposure to hazardous materials. Develop advanced filter materials and processes to remove and destroy operationally generated hazardous organic materials and particulate contaminants. Define warfare agent interaction with Air Force unique materials.

(U) $1,111 Develop integrated materials technologies that demonstrate the capability to identify, monitor, and mitigate/neutralize toxic risks. Develop sensor materials for detection, mitigation, avoidance, and warning of operational toxic materials. Identify tracer emissions for detection and

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 621900

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

(U) FY 2000 ($ in Thousands) Continued

modeling of chemically-based atmospheric threats.

(U) $688 Discover and characterize novel enzymatic reactions for applications in biotransformations and biocatalytic synthesis of high-performance materials. Explore biotransformation and biocatalytic generation of Air Force unique materials.

(U) $2,766 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0601102F, Defense Research Sciences

(U) PE 0602102F, Materials

(U) PE 0602203F, Aerospace Propulsion.

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

(U) PE 0603211F, Aerospace Structure

(U) PE 0603723F, Environmental Engineering Technology.

(U) PE 0603716D, Strategic Environmental Research and Development Program.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 627184

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
627184 Crew Technology	30,220	36,844	33,657	29,993	30,335	35,130	37,204	Continuing	TBD

(U) **A. Mission Description**

This project develops the technology required to improve human performance, protection, and survivability in operational environments. This is accomplished by defining the physical and cognitive parameters, capabilities, and limits of systems operators; determining human responses to operational stresses such as noise, impact, vibration, sustained acceleration, spatial disorientation, altitude, workload, and sustained operations; and optimizing the human-machine interface. The project produces human-centered design criteria, guidelines, and automated design tools for the development of effective technologies for information display, team communications, crew scheduling and fatigue management, control interfaces, crew station layout and functional integration, emergency escape, crash protection, aircrew oxygen systems, acceleration protection, and aircrew life support.

(U) FY 1999 ($ in Thousands)

(U) $2,294 Continued to develop unobtrusive, reliable predictors of human system effectiveness based on crew workload and situational awareness and applied results to KC-135 cockpit upgrade. Completed international validation and selected predictive workload model to advance technology for human performance design assessment. Validated model and metrics with simulation of Unmanned Aerial Vehicle (UAV) control station, including assessment of UAV target localization and improved controller. Completed data collection for cockpit accommodation mapping of Air Force inventory aircraft, and transitioned accommodation method to fighter aircraft. Continued international whole-body three-dimensional size survey for new design tool, collecting data in the U.S., Canada, and the Netherlands.

(U) $5,610 Continued to develop system design technologies that integrate human factors data for workstations by developing process models to streamline the sharing of data among intelligence analysts and command centers, and by initiating development of multi-sensory adaptive control as a new design technology. Demonstrated 10-20% reduction in Air Tasking Order preparation time via speech command interface, and delivered cognitive task analysis to Air Intelligence Agency. Completed plan for international collaboration with Australia on multi-sensory technology.

(U) $7,548 Continued to develop visual display technology for improved human-machine interfaces and demonstrated adaptive interface technology, including integrated display and information processing standards, and design alternatives for next generation helmet-mounted sights/displays, ejection-safe, panoramic night vision goggles with external sensor inputs to enhance night operations, and a pilot-vehicle interface that adapts to pilot physiological and behavioral state. Developed standard test procedures for night vision goggles transmissivity, mapped the windscreen angular deviation for various fighter aircraft, and demonstrated multi-color stacked active matrix display advances.

(U) $1,964 Continued expansion of audio technologies to establish new information management methods to improve operator performance in high workload environments. Transitioned three-dimensional audio display and signal process technology to Cheyenne mountain operational

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research
	PROJECT 627184

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

(U) FY 1999 ($ in Thousands) Continued

environment. Demonstrated reduced cost sonic boom monitoring systems for environmental compliance.

(U) $1,442 Continued aircrew life support and performance research including the effect of high G on pilot color perception and the ability to discern color cues on head-up and head-down displays.

(U) $3,923 Developed tolerance criteria for assessing effects of forces experienced during escape, sustained, and transient accelerations on crew safety and performance while using head or helmet-mounted equipment.

(U) $2,314 Improved integrated mission rehearsal training technologies for aircrew and battlestaff in simulated and field extended/continued operations and information warfare application.

(U) $1,901 Continued development of operationally relevant cognitive performance assessment technologies and mathematical models that predict the impact of fatigue on decision making and operator performance during sustained operations; evaluated pharmaceuticals and other countermeasures as an aid to aircrew sleep management and alertness enhancement during sustained Global Attack and Global Mobility missions.

(U) $1,235 Continued development of high-altitude protection technologies and validated the altitude decompression sickness risk assessment model for use in mission planning; continued investigation of spatial disorientation mechanisms and evaluated candidate formats for attitude symbology in off-axis helmet-mounted displays.

(U) $1,989 Supported the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program.

(U) $30,220 Total

(U) FY 2000 ($ in Thousands)

(U) $3,973 Develop interface technologies for crew station and equipment accommodation, multi-sensory displays, adaptive controls, and performance metrics. Interface technologies promote cognitive and physical fit with air and ground control stations to enhance effectiveness and safety. Continue to develop reliable workload predictors and a near-real-time classification of crew overload and demonstrate a next-generation crew station under joint Air Force-France agreement. Demonstrate improved control station for uninhabited aerial vehicles. Plan validation of inventory cockpit accommodation maps and complete data analysis of U.S. part of multi-national whole-body three-dimensional survey.

(U) $3,013 Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Complete a cognitive task analysis and identify information requirements for an Information Warfare Watch Center. Demonstrate high-accuracy speech recognition in airborne C-135 environment and demonstrate speech countermeasures in an operational exercise. Integrate and demonstrate voice recognition and laser pointer/tracker technologies with large screen interactive display for command center operations.

(U) $3,839 Develop concepts for integrating human computer interface technologies, human performance modeling tools, and real-time simulations to

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 627184

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

(U) FY 2000 ($ in Thousands) Continued

affordably quantify operational benefit from new interface technologies. Explore new human-computer interface options for future unmanned vehicle control stations. Advance integrated control and display concepts for air operations, concentrating on effectively melding on-board data with off-board data, and on flight displays that support complex landing approaches. Draft a design notebook for tactical re-supply crew stations, and begin to develop integrated human performance models and analysis tools.

(U) $4,444 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding the effects of vision through display optics, vehicle transparencies, and synthetic vision. Visual display interface technologies enhance situation awareness, warfighter performance, combat effectiveness, and survivability. Conduct studies to understand the trade off of night vision goggle optical resolution with field-of-view. Identify ways to increase sunlight readable display efficiency. Conduct study of helmet-mounted display contrast requirements for color recognition.

(U) $2,336 Develop and demonstrate advanced audio displays including three-dimensional audio, active noise reduction, voice control, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Conduct a feasibility demonstration of an integrated three-dimensional audio headset with noise reduction and CD quality digital audio. Demonstrate the ability to reduce the acoustic signature for special operations aircraft. Begin a program to exploit the use of audio signals to add a new capability for remote threat detection in perimeter defense.

(U) $1,591 Conduct altitude protection and acceleration physiology research to maximize warfighter survivability and combat effectiveness in the aerospace flight environment. Research will define life support equipment design concepts and procedures to enable safe flight operations at high altitudes and high sustained accelerations. Determine risks for aircrews engaged in unpressurized flight at high altitude for extended periods of time. Investigate performance and comfort issues associated with pressure breathing technology for tactical aviators.

(U) $5,716 Develop human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Define human impact tolerance limits, and use these to design and validate mathematical or physical models of human response to impact environments. Research will focus on full aircrew accommodation issues, including definition of ejection seat haulback/retraction criteria and spinal injury criteria to minimize probability of injury. Develop multi-axis head and neck tolerance, response, and injury criteria to minimize injury risk during ejection with helmet-mounted devices. Evaluate helmet biodynamic properties in the sustained acceleration environment and assess the physiological effects of multi-axis maneuvering.

(U) $2,685 Conduct warfighter fatigue and spatial disorientation countermeasures research. Results will extend and enhance cognitive performance during long-range deployment, global attack, and around the clock surge operations and explore ways to reduce aircraft mishaps due to spatial disorientation. Establish feasibility of using newly developed alertness enhancing stimulants in Air Force missions and develop fatigue avoidance mission planning technologies. Characterize spatial disorientation problems related to helmet-mounted displays, night vision goggles, and agile

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 627184

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

(U) FY 2000 ($ in Thousands) Continued

aircraft flight profiles.

(U) $1,690 Develop technologies to self-produce, liquefy, store, and deliver both nitrogen enriched air and high purity oxygen for application on-board airlift aircraft. Technologies will enhance the inert gas fuel tank fire suppression system and improve capability to meet life support oxygen requirements during high altitude parachute operations. Develop miniaturized distillation column air separation techniques and cryogenic refrigeration technology and combine to generate both nitrogen and oxygen in a single integrated package.

(U) $2,983 Develop solid state electrolyte oxygen generation technologies for aircraft on-board oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Pursue improvements to increase oxygen flow rates, reduce power consumption, and decrease operating temperatures of existing ion conducting ceramics technology. Investigate requirements for utilization and integration of solid state electrolyte oxygen generators as on-board systems.

(U) $3,580 Provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.

(U) $994 Conduct international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Joint demonstration determines feasibility and matures technology for a class of affordable crew stations common to airborne early warning, attack aircraft, and unmanned vehicles by exploiting virtual controls and displays. Link Australia's airborne early warning and control simulator with Air Force Research Laboratory synthesized immersion research simulator for joint experiments. Begin to develop an integrated multi-sensory crew station to demonstrate the virtual air commander concept.

(U) $36,844 Total

(U) FY 2001 ($ in Thousands)

(U) $4,227 Develop interface technologies for crew station and equipment accommodation, multi-sensory displays, adaptive controls, and performance metrics. Interface technologies promote cognitive and physical fit with air and ground control stations to enhance effectiveness and safety. Complete workload classification algorithm and incorporate into laboratory demonstration of a multi-sensory control station for uninhabited aerial vehicle operable with reduced crew size. Validate cockpit accommodation maps of inventory aircraft. Begin to develop an intelligent, on-line physical accommodation information system to optimize equipment fit, and include Dutch anthropometric data from multi-national survey.

(U) $3,310 Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Develop and demonstrate new user-computer

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research — PROJECT: 627184

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

(U) FY 2001 ($ in Thousands) Continued

interface for intelligence analysts for faster and more accurate decision-making. Continue research on speech signal processing and speech-based countermeasures for information operations.

(U) $4,142 Develop concepts for integrating human computer interface technologies, human performance modeling tools, and real-time simulations to affordably quantify operational benefit from new interface technologies. Complete a feasibility evaluation of an integrated control interface for unmanned vehicles, demonstrating multi-vehicle per mission operation. Identify and compare alternative console concepts for advanced space operations. Develop integrated flight path and synthetic terrain concept for primary flight reference on helmet displays, and continue to develop integrated human performance models and analysis tools.

(U) $4,685 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding the effects of vision through display optics, vehicle transparencies, and synthetic vision. Visual display interface technologies enhance situation awareness, warfighter performance, combat effectiveness, and survivability. Establish helmet-mounted display symbology specifications for strike missions. Conduct study to determine the influence of helmet visor transmissivity and reflectivity on visual target detection.

(U) $2,642 Develop and demonstrate advanced audio displays including three-dimensional (3-D) audio, active noise reduction, voice control, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Complete a feasibility demonstration of an integrated 3-D audio headset with noise reduction and CD quality digital audio. Develop acoustic processing algorithms and an intuitive human centered interface to add a new capability for remote threat detection in perimeter defense. Develop auditory symbology design criteria handbook for improving situational awareness using 3-D audio displays.

(U) $3,480 Develop human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including emergency escape and crashes. Incorporate tolerance and injury criteria into the development of mathematical models to be used for injury assessment. Continue study to define multi-axis head and neck response during impact. Define male and female tolerance standards to improve injury prediction in dynamic environments and to optimize restraint concepts. Refine biodynamic performance assessment of helmet-mounted devices to optimize safe helmet-mounted system concepts.

(U) $6,476 Develop aviation safety enhancing technologies to alleviate warfighter fatigue, counter spatial disorientation, and improve pilot performance under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions, reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Expand the capabilities of the fatigue avoidance scheduling tool to predict the effects of pharmaceutical countermeasures on fatigue, and initiate efforts to extend the management of fatigue so as to apply its impact on decision making as a component of Information

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 627184

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

(U) FY 2001 ($ in Thousands) Continued

Warfare strategy. Evaluate effectiveness of candidate techniques to improve spatial orientation capabilities in aircrew wearing Night Vision Goggles. Evaluate feasibility of employing innovative pressure application techniques and advanced fabrics to improve pilot performance by reducing the bulk, weight, and thermal burden of existing acceleration protection ensembles.

(U) $3,195 Provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.

(U) $1,500 Conduct international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Joint demonstration determines feasibility and matures technology for a class of affordable crew stations common to airborne early warning, attack aircraft, and unmanned vehicles by exploiting virtual controls and displays. Perform international laboratory experiment using real-time simulators linked by distributed interactive simulation technology. Demonstrate feasibility of an integrated multi-sensory crew station for virtual air commanders tailored for early warning and control mission.

(U) $33,657 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602702F, Command, Control, and Communications
(U) PE 0603205F, Aerospace Vehicle Technology.
(U) PE 0603227F, Personnel, Training and Simulation Technology.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) PE 0603245F, Flight Vehicle Technology Integration.
(U) PE 0604227F, Distributed Mission Training (DMT).
(U) PE 0604703F, Aeromedical/Casualty Care Systems Development.
(U) PE 0604706F, Life Support Systems.

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 627757

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
627757 Directed Energy Bioeffects	12,075	8,501	10,639	10,864	10,970	10,479	10,766	Continuing	TBD

(U) **A. Mission Description**

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

(U) FY 1999 ($ in Thousands)

(U) $4,238 Conducted laser optical bioeffects research to enable countermeasures for optical hazards/threats by initiating development of guidelines for high energy laser safety and low energy systems for non-lethal use, and refining biological effects models to assess combat vulnerability to emerging optical threats.

(U) $5,617 Conducted bioeffects research to enable safe exploitation of lethal and non-lethal directed energy weapons, advanced communications systems, and radar by transitioning tri-Service High-Power Microwave (HPM) Ocular Hazards Study results to DoD and developed/provided data for policy review of Active Denial Technology (ADT) non-lethal weapon.

(U) $2,126 Developed and evaluated robust force protection bio-technology tools for Air Expeditionary Force commanders to assess chemical exposures and predict adverse human health and mission performance impacts.

(U) $94 Initiated multi-phase study of Photorefractive Keratectomy (PRK) as surgical method to reduce need for glasses or contact lenses for aircrew.

(U) $12,075 Total

(U) FY 2000 ($ in Thousands)

(U) $3,220 Conduct laser optical bioeffects laboratory experiments and field research. Enables exploitation of laser technology while providing countermeasures for optical hazards/threats, with and without laser eye protection. Pursue assessments/evaluations of foreign directed energy weapons to better define threats and countermeasures. Initiate experiments with Federal Aviation Administration to introduce safe active lasing into aircrew operational environments to assess impact, improve tactics development, and define specific mission training requirements. Explore optical technologies to achieve information warfare dominance.

(U) $4,735 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy weapons, communications, and radar.

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research
	PROJECT 627757

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

(U) FY 2000 ($ in Thousands) Continued

Provide data on cancer development and birth defects for revised human exposure standard for ultra-wide band pulsed microwaves. Begin Air Expeditionary Force Agile Combat Support Initiative for portable High Energy Microwave Active Denial Technology. Conduct wave propagation modeling for information warfare applications.

(U) $546 Evaluate Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collect and analyze first year post-operative data.

(U) $8,501 Total

(U) FY 2001 ($ in Thousands)

(U) $4,161 Conduct laser optical bioeffects laboratory experiments and field research. Enables exploitation of laser technology while providing countermeasures for optical hazards/threats, with and without laser eye protection. Initiate work with the United States Marine Corps Joint Non-Lethal Weapons Directorate to develop non-lethal laser use guidelines in compliance with DoD/International Policy while enhancing device effectiveness. Complete the personnel biological effects model to assess combat vulnerability to emerging optical threats. Develop and demonstrate technology to produce a safe, active lasing experience into aircrew simulators, leading to development and refinement of engagement tactics, countermeasures, and training requirements. Expand research in optical technology development for information warfare. Complete experiments with Federal Aviation Administration on safe active lasing.

(U) $5,978 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of lethal and non-lethal directed energy weapons and radar. Continue Air Expeditionary Force Agile Combat Support initiative for portable High Energy Microwave Active Denial Technology. Complete studies of millimeter effects on skin cancer and corneal eye damage for DoD exposure guidance. Continue wave propagation modeling for information warfare applications.

(U) $500 Evaluate Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collect and analyze second year post-operative data.

(U) $10,639 Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research
	PROJECT 627757

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

(U) Related Activities:

(U) PE 0602720A, Environmental Quality Technology.

(U) PE 0602777A, Systems Health Hazard Prevention Technology.

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

(U) PE 0604706F, Life Support Systems.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	66,259	77,007	116,262	127,333	134,980	138,426	138,792	Continuing	TBD
623012	Advanced Propulsion Technology	2,003	0	0	6,476	6,980	7,466	7,757	Continuing	TBD
623048	Fuels and Lubrication	11,246	11,399	8,016	9,390	14,082	14,364	14,564	Continuing	TBD
623066	Turbine Engine Technology	34,782	41,098	42,091	40,849	39,966	38,442	35,304	Continuing	TBD
623145	Aerospace Power Technology	18,228	24,510	15,561	21,226	23,818	24,152	24,392	Continuing	TBD
624847	Rocket Propulsion Technology	0	0	50,594	49,392	50,134	54,002	56,775	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: The decrease in Project 623048, Fuels and Lubrication, beginning in FY 2000 reflects deferral of high thermal stability fuels and engine technologies. The increase in Project 623145, Aerospace Power Technology, beginning in FY 2002 reflects increased emphasis on power components for space applications. As of FY 2001, all rocket propulsion efforts performed in PE 0602601F, Project 621011, Rocket Propulsion Technology, will be transferred to Project 624847, Rocket Propulsion Technology, in order to align projects with the Air Force Research Laboratory organization. In FY 2000, Project 623012, Aerospace Propulsion Technology, was terminated. However, in FY 2002, the hypersonics technology efforts currently being performed in PE 0602269F, Hypersonic Technology Program, will be shifted to Project 623012.

(U) **A. Mission Description**

This program develops aerospace propulsion and power technologies. The prime areas of focus are turbine engines, dual-mode ramjets, rocket propulsion, combined cycle engines, fuels, lubricants, and aerospace power technologies. Technology advances in turbine engine propulsion and lubrication systems are part of the Integrated High Performance Turbine Engine Technology (IHPTET) program and will increase engine performance, increase reliability, reduce specific fuel consumption, and lower cost of ownership. Dual-mode ramjet and combined cycle engines will increase weapon lethality and effectiveness against time-critical targets via high-speed propulsion systems. Fuels efforts will reduce system cost, maintenance, and the usage of hazardous cleaning materials while increasing aircraft performance and life through development of thermally stable and high heat sink fuels. Advances in power system technology, such as power generation, power conditioning, thermal management, and energy storage will enhance system reliability, survivability, and vulnerability, reduce weight, and lower life cycle costs for aircraft and spacecraft while enabling high power density sources for directed energy weaponry. In rocket propulsion, this PE develops technologies to demonstrate the Integrated High Payoff

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion

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

Rocket Propulsion Technology (IHPRPT) goals for booster orbit transfer satellite maneuvering, and tactical/ballistic missile rocket propulsion. Note: In FY 2000, Congress added $2.0 million for fuels, lubrication, and combustion; $0.6 million for high thermal stability fuel; $0.5 million for education of space scientists; $2.0 million for aircraft and weapons power; $2.0 million for high power, advanced low mass systems prototype; $4.0 million for magnetic bearing cooling turbine technology; $1.8 million for the More Electric Aircraft (MEA) program; $0.8M for thermophotovoltaics (TPV); and $2.0 million for variable displacement vane pump (VDVP).

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	68,329	62,012	66,607	
(U)	Appropriated Value	69,561	77,712		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1,232	-38		
	b. Small Business Innovative Research	-1,326			
	c. Omnibus or Other Above Threshold Reprogram		-316		
	d. Below Threshold Reprogram	-373			
	e. Rescissions	-371	-351		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			49,655	
(U)	Current Budget Submit/FY 2001 PBR	66,259	77,007	116,262	TBD

(U) Significant Program Changes:

As of FY 2001, all rocket propulsion efforts performed in PE 0602601F, Project 621011, Rocket Propulsion Technology, will be transferred to Project 624847, Rocket Propulsion Technology, in order to align projects with the Air Force Research Laboratory organization. The increase in FY 2001 will be used to restore the development of boost and orbit transfer vehicle technologies for the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program in order to demonstrate IHPRPT goals on schedule. This is part of an effort to restore the rocket propulsion program from the previous years reductions. As of FY 2002, the hypersonics technology efforts currently being performed in PE 0602269F, Hypersonic Technology Program, will be shifted to Project 623012.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion		PROJECT: 623012

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623012 Advanced Propulsion Technology	2,003	0	0	6,476	6,980	7,466	7,757	Continuing	TBD

(U) **A. Mission Description**

Establishes the technology base for advanced propulsion concepts including integral rocket ramjets for missile propulsion, combined/advanced-cycle engines, hydrocarbon fueled dual-mode combustion ramjets, and supersonic combustion ramjets (scramjets) for high-speed vehicles to support future missions such as rapid strike against time-critical targets, high-speed strike/reconnaissance vehicles, or affordable, on-demand access to space.

(U) FY 1999 ($ in Thousands)

(U) $753 Investigated unique concepts for combining advanced propulsion cycles which provide the capability for takeoff, acceleration, cruise, and target loiter for high-speed aerospace vehicles. This effort supports technology transition for next generation reconnaissance/strike vehicles (manned and unmanned) and airbreathing boosters.

(U) $400 Investigated, developed, and exploited Russian hypersonic technology. This effort supports technology transition for next generation hypersonic missiles and air vehicles to provide greater range and increased velocity which enhance weapon effectiveness.

(U) $850 Investigated unique pulse detonation engine concepts to provide the capability for takeoff, acceleration, cruise, and target loiter for high-speed aerospace vehicles. This effort supports technology transition for next generation reconnaissance/strike vehicles (manned and unmanned) and airbreathing boosters.

(U) $2,003 Total

(U) FY 2000 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion
PROJECT: 623012	

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

(U) Related Activities:

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

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion — PROJECT: 623048

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623048 Fuels and Lubrication	11,246	11,399	8,016	9,390	14,082	14,364	14,564	Continuing	TBD

(U) **A. Mission Description**

Develops advanced fuels, lubricants, and component technologies for use in aircraft, rockets, and missile engines. Conventional petroleum and alternate fuels are developed and evaluated for Air Force aerospace applications. Fuels and lubricants must be thermally stable, cost-effective, and operate at higher temperatures.

(U) FY 1999 ($ in Thousands)

(U) $4,214 Developed high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures for aircraft and missile systems. This technology is for current and future aircraft to reduce fuel systems fouling/coking, and provide cooling for increased avionics loads, higher engine temperatures, and reduced fuel consumption.

(U) $2,476 Developed high performance, low emissions, robust combustor concepts for advanced turbine engines to reduce the risk and cost associated with developing high performance, low maintenance engines that operate efficiently within air pollution guidelines and have high thrust-to-weight ratio and low specific fuel consumption.

(U) $4,556 Developed lubrication technology to permit efficient high-speed rotation of turbine engine components. This technology includes conventional and advanced lubricants, and mechanical systems extended to their highest temperature limitations and approaches, such as magnetic levitation and solid and vapor lubrication for advanced engines with operating conditions that exceed the capabilities of conventional approaches.

(U) $11,246 Total

(U) FY 2000 ($ in Thousands)

(U) $4,231 Develop and test high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emissions and signatures for aerospace systems. This technology will result in reduced fuel system fouling/coking (reduced maintenance costs), provide cooling for increased heat load generated by avionics, engines, and other vehicle subsystems, enable reduced fuel consumption (supportability), and reduce vehicle pollutant emissions and signature (reduce environmental impact and improve vulnerability). Low-cost fuel additives will be formulated that increases the thermal stability by 225 degrees Farenheit and heat sink by five-fold. In addition, low-cost fuel additives that reduce pollutant emissions (particulates) by 50% will be formulated. Additives will be evaluated in small-scale laboratory devices.

(U) $3,600 Design, evaluate, and mature high-performance, low emission, robust combustor concepts for advanced airbreathing engines. Mature trapped vortex combuster technology to provide dramatically improved thrust-to-weight, reduced development, production and maintenance costs, and lower specific fuel consumption. Transition to full-annular combuster design. Conduct breadboard pulsed detonation engine testing and model development to quantify actual engine performance and military payoffs. Develop and apply advanced laser diagnostics to fundamental flames

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 623048

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

(U) FY 2000 ($ in Thousands) Continued

and advanced military combusters to determine in situ combuster performance.

(U) $3,568 Develop lubrication and systems diagnostics technologies to permit efficient high-speed rotation of turbine engine components. This technology includes conventional and advanced lubricants and mechanical systems extended to their highest temperature limitations and approaches, such as magnetic levitation and solid and vapor lubrication for advanced engines. Emphasis will be placed on fabricating test rigs for full-scale demonstration of magnetic bearings for Integrated High Performance Turbine Engine Technology Phase III engines. Also, small prototype diagnostic units will continue to be developed in the laboratory for engine health monitoring.

(U) $11,399 Total

(U) FY 2001 ($ in Thousands)

(U) $2,510 Continue development of high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emissions and signatures for aerospace systems. This technology will result in reduced fuel system fouling/coking (reduced maintnenance costs), provide cooling for increased heat loads generated by avionics, engines, and other vehicle subsystems, enable reduced fuel consumption (supportability), and reduce vehicle pollutant emissions and signature (reduce environmental impact and improve vulnerability). In FY 2001, a low-cost fuel additive identified in FY 2000 that increases the thermal stability by 225 degrees Farenheit and heat sink by five-fold will be tested in small-scale laboratory devices and reduced scale fuel system simulators. In addition, low-cost fuel additives that reduce pollutant emissions (particulates) by 50% will be tested in research scale combusters and particulate emissions measured.

(U) $3,100 Develop revolutionary combustor concepts for combined cycle engines and pulsed-detonation engines. Continue development of novel gas turbine combuster designs including near-constant-temperature-cycle inter-turbine burner. Complete optimization of trapped vortex combuster for inclusion in high performance, low emissions gas turbine engine demonstrators. Develop and test multi-tube, high frequency, pulsed detonation engines for use as high- performance, low-cost propulsion systems. Demonstrate the near-constant-temperature turbine burner concept at representative engine operating conditions. Conduct preliminary design and development of a combined-cycle engine for high-speed military applications. Demonstrate advanced optical diagnostic techniques for health monitoring and control of advanced military combustors.

(U) $2,406 Continue development of lubrication and diagnostic systems technologies to permit efficient high-speed rotation of turbine engine components. This technology includes conventional and advanced lubricants and mechanical systems extended to their highest temperature limitations and approaches, such as magnetic levitation and solid and vapor lubrication for advanced engines with operating conditions that exceed the capabilities of conventional approaches. Emphasis will be placed on demonstrating full-scale magnetic bearing hardware at engine conditions projected for IHPTET Phase III engines. Also, small prototype diagnostic units will continue to mature based on requirements of near-term production and demonstrator engines.

(U) $8,016 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 623048

(U) **B. Project Change Summary**
Not Applicable.

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

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion		PROJECT: 623066

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623066 Turbine Engine Technology	34,782	41,098	42,091	40,849	39,966	38,442	35,304	Continuing	TBD

(U) **A. Mission Description**

Develops technology to increase propulsion system operational reliability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental efforts are conducted in fans/compressors, high temperature combustors, turbines, internal flow systems, controls, exhaust systems, and structural design. This project supports the Integrated High Performance Turbine Engine Technology (IHPTET) program.

(U) FY 1999 ($ in Thousands)

(U) $24,335 Developed core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Completed detail design of state-of-the-art four-stage compressor through use of advanced blading and endwall contours yielding lower ownership costs. Completed design of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Completed testing of a dual-spool, vaneless, counter-rotating turbine yielding increased performance, reduced hardware, and reduced cooling flow.

(U) $5,809 Developed turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cyle cost. Completed testing of a survivable affordable, lightweight, integrated exhaust nozzle. Completed design of a variable displacement vane pump which eliminates fuel recirculation to tanks, thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system.

(U) $2,388 Developed components for expendable engines for missile and unmanned air vehicle applications. These components will provide expendable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles.

(U) $2,250 Developed components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Completed design of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin

(U) $34,782 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion — PROJECT: 623066

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

(U) FY 2000 ($ in Thousands)

(U)	$28,548	Develop core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Complete fabrication and initiate rig testing of state-of-the-art four-stage compressor through use of three-dimensional aeromechanical blading and endwall contours. Complete fabrication of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Complete blade damping model development which includes three-dimensional shroud contact capability among a spectrum of other friction constraints. Test advanced high-work turbine yielding heat transfer characterization for reduced cooling flow and increased durability.
(U)	$6,958	Develop turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cyle cost. Fabricate exhaust nozzle hardware capable of fluidic injection deleting the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricate variable displacement vane pump which eliminates fuel recirculation to tanks thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system. Complete design of a non-linear control system which simplifies control logic development and provides component performance trend data.
(U)	$3,769	Develop components for expendable engines for missile and unmanned air vehicle applications. These components will provide expendable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles.
(U)	$1,823	Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Fabricate a splittered, forward swept compressor rotor with high efficiency and high stage loadings that will reduce fuel consumption and production and maintenance costs with fewer parts. Fabricate prototype high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin.
(U)	$41,098	Total

(U) FY 2001 ($ in Thousands)

(U)	$27,568	Develop core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Complete rig testing of state-of-the-art four-stage compressor and deliver to core engine for complete environmental characterization. Complete compressor rig testing of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Develop a reduced order model for intentional mistuning validation and initiate experimental validation. Fabricate the spar/shell turbine blade with enhanced internal convection and limited transpiration cooling technologies

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion
PROJECT: 623066	

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

(U) FY 2001 ($ in Thousands) Continued

and three-dimensional features yielding reduced cooling air at higher design operating temperatures.

(U) $7,086 Develop turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components will provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cyle cost. Rig test exhaust nozzle hardware capable of fluidic injection deleting the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricate contoured ceramic composite exhaust nozzle hardware. Elevated fuel temperature rig testing of the variable displacement vane pump which eliminates fuel recirculation to tanks thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system. Complete fabrication of the non-linear control system which simplifies control logic development and provides component performance trend data.

(U) $3,849 Develop components for expendable engines for missile and unmanned air vehicle applications. These components will provide expendable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles. Fabricate low-cost ceramic turbine blades yielding reduced cooling air and higher performance.

(U) $1,861 Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Begin rig testing of splittered, forward swept compressor rotor to validate high efficiency, high stage loading design, leading to engines with reduced fuel consumption and lower production and maintenance costs with fewer parts.

(U) $1,727 Design, develop, and test propulsion components to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency (DARPA) missile demonstration. Continue testing of scramjet engine components (e.g., inlet, combustor, and nozzle) capable of demonstrating positive thrust at Mach 4-8 while withstanding severe internal conditions.

(U) $42,091 Total

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

Not Applicable.

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

(U) Related Materials:

(U) PE 0602102F, Materials.

(U) PE 0603202F, Aircraft Propulsion Subsystem Integration.

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

(U) PE 0602122N, Aircraft Technology.

(U) PE 0603210N, Aircraft Propulsion.

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion
PROJECT: 623066	

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

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion		PROJECT: 623145

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623145 Aerospace Power Technology	18,228	24,510	15,561	21,226	23,818	24,152	24,392	Continuing	TBD

(U) **A. Mission Description**

Develops technologies for aerospace power generation, conversion, energy storage, and transmission systems including advanced electrical power component and subsystem technologies. Power components are developed for aircraft and flight line equipment to increase reliability, maintainability, commonality, and supportability. This project supports an initiative which uses electrical power to replace hydraulic and pneumatic power and their costly logistics support. These electrical power technologies are necessary to meet the 10-20 year long-term storage requirements of Air Force uninhabited combat aerial vehicles (UCAVs). Electrical power generation technologies developed are enabling technologies for all future military directed energy (DE) weapon systems. This project supports development of very high output power systems that are suitable for applications such as air moving target indication (AMTI) radar, space-based laser and orbiting/manueuvering vehicles. Lightweight power systems suitable for other space applications are also developed. Essentially all power electronics (conversion) technologies being developed here have dual-use opportunities.

(U) FY 1999 ($ in Thousands)

(U) $16,009 Developed power generation components for aircraft systems. These components improve aircraft self-sufficiency, reliability, maintainability, and supportability.

(U) $1,733 Developed power source components for use in navigational aids, radios, and sensors for special operations forces. Power sources with higher power density, longer life, and increased reliability provided special operations forces with greater reliability and reduced maintenance costs.

(U) $486 Developed special purpose power components for advanced surveillance and communications systems, as well as ground power applications.

(U) $18,228 Total

(U) FY 2000 ($ in Thousands)

(U) $8,920 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These components improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. Design Inverter Converter Controller (ICC) for starter/generator systems that doubles power density, thus enabling the use of these systems on manned and unmanned aircraft. Develop high energy density lithium ion cell and maintenance-free battery technology to achieve aircraft-level weight savings and meet increasing power demands in limited envelopes.

(U) $6,465 Develop thermal management, energy storage and power conditioning components and subsystem technologies for AMTI radar, space-based laser, and orbiting/maneuvering vehicles. Specifically develop high energy density polycrystalline capacitors, high voltage/high power diamond switches and distributed power for laser diodes to enable the use of high power lasers on space platforms. Develop small scale heat pipes for

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 623145

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

(U) FY 2000 ($ in Thousands) Continued

passive power electronics cooling for improved power density. Design space mission enabling high energy density lithium ion cells and batteries.

(U) $515 Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement for delivery of high power for operation of directed energy weapons. This includes a feasibility study of high temperature superconducting (HTSC) high power generator technology that is developing Yittrium Barium Copper Oxide (YBCO) coated conductors. This HTSC technology is enabling for ground mobile, airborne, and space-based directed energy power sources.

(U) $2,740 Develop alternative energy conversion techniques for ground and space applications. These techniques will include such technologies as thermal photovoltaics and thermionic energy converters, which could either be powered by energy from the sun or traditional combustion techniques.

(U) $5,870 Develop alternative secondary power system related technologies that will help transition more electric technology to current and future aircraft. Specific development efforts will focus on air-driven power generation, magnetic bearing coolers, and variable displacement fuel pumps.

(U) $24,510 Total

(U) FY 2001 ($ in Thousands)

(U) $5,872 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These components improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. Fabricate Inverter Converter Controller (ICC) to demonstrate power density improvements. Continue development of high energy density lithium ion cell and maintenance free battery technology by testing cells and batteries to load profiles specified in performance requirements for aircraft.

(U) $9,189 Develop thermal management, energy storage and power conditioning components, and subsystem technologies for air moving target indication (AMTI) radar, space-based laser, and orbiting/maneuvering vehicles. Specifically initiate design of integrated Power Management and Distribution (PMAD) for space-based distributed power systems that are half the weight and volume of conventional approaches. Continue development of high energy density polycrystalline capacitors, high voltage/high power diamond switches and distributed power for laser diodes to enable the use of high power lasers on space platforms. Develop small scale heat pipes for passive power electronics cooling for improved power density. Test cycle life for long-term space applications of high energy density lithium ion cells and batteries.

(U) $500 Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement for delivery of high power for operation of directed energy weapons. This includes expanding the development of YBCO coated conductors to include coils for high temperature superconducting high power generator development.

(U) $15,561 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 623145

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

Not Applicable.

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

(U) Related Activities:

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion		PROJECT: 624847

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624847 Rocket Propulsion Technology	0	0	50,594	49,392	50,134	54,002	56,775	Continuing	TBD

(U) **A. Mission Description**

The technologies developed in this project are boost and orbit transfer, satellite maneuvering, and tactical and ballistic missile rocket propulsion. This project develops technologies and provides technology options for rocket propulsion advanced demonstrations, components, or subsystems. Technologies of interest are those which will improve reliability, operability, survivability, affordability, environmental compatibility, and performance of future space and missile launch sub-systems while reducing material, manufacturing, and support costs. Technology will be developed to reduce the weight and cost of components using new materials, improved designs, and improved manufacturing techniques. All efforts in this project are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) initiative; a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus rocket propulsion technology on national needs.

(U) FY 1999 ($ in Thousands)

(U) $0 Previously accomplished in PE 0602601F.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Previously accomplished in PE 0602601F.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $6,590 Develop high-energy density and non-toxic propellants for increased payload capability. Continue development of promising propellants and new high-energy propellants for future development. Refine production of lab-scale quantities of high-energy density propellants with additives at desired concentrations in preparation for scale-up to maximize future propulsion system performance. Scale-up selected propellants for testing and evaluation. Continue to develop, characterize, and model new and advanced propellants for scale-up and testing. Optimize synthetic routes for polymer binders and fuel formulations with specific impulses exceeding that available from current systems. Develop high-energy oxidizer formulations for combustion with high-energy fuels to yield greatly enhanced performance. Continue research in the area of low-cost, non-toxic mono-propellants for current and future launch systems. Characterize and study/evaluate selected propellants in advanced combustion devices to determine compatibility and performance. Develop and characterize advanced propellants for use in revolutionary launch and spacecraft propulsions systems. Provide technical expertise for the development and continued use of energetic chemical rocket propellants.

(U) $4,151 Develop advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engines uses in heavy lift space vehicles. Continue to characterize, study/evaluate injector performance with application to combustor

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	PROJECT 624847

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

(U) FY 2001 ($ in Thousands) Continued

chamber/injector compatibility to prevent damage to test and operational combustion devices; continue to support commercially developed injectors using unique Air Force test facilities; complete the development of health monitoring techniques using non-intrusive, real-time, in situ measurements techniques, which will be used to avoid catastrophic failure and destruction of launch assets due to a failing engine component. Develop, analyze, and model advanced combustion devices and injectors that are compatible with new energetic propellants. Develop and evaluate through analysis and modeling advanced/revolutionary propulsion concepts with enhanced performance and reliability. Report through technical papers, reports, and presentations the scientific research and results obtained from these efforts.

(U) $6,939 Develop advanced material technology for lightweight components and material property enhancements for use in launch and space systems. Develop advanced ablative components using hybrid polymers for use in current and future launch systems. Characterize and develop new high temperature polymers and carbon-carbon materials for use in advanced combustion devices and advanced propulsion systems, for lower weight and increased strength requirements. Develop advanced materials for use with high energy propellants. Transition advanced high temperature materials to the commercial industry and Air Force systems for reduced system weight/cost and increased performance.

(U) $2,100 Develop analytical tools for prediction of propellant life. Complete and transition to industry the tools and techniques used to determine the age life of strategic systems and other solid rocket motors.

(U) $16,832 Develop propulsion component technology for reliable safe and low-cost boost and orbit transfer systems. Continue to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Continue development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Begin development of a low-cost, high discharge pressure turbopump for advanced cryogenic engines. Continue to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles. These technologies will significantly reduce the life cycle cost of expendable and reusable liquid rocket engines. Continue developing and demonstrating advanced materials for rocket engine components and continue to develop turbomachinery, combustion devices, and propellant management devices for solid and liquid rockets. Continue development of high temperature oxygen rich turbine materials for applications to oxidizer rich turbomachinery. Continue application of advanced Aluminum Metal Matrix Composite Materials to rocket turbomachinery housings and rocket structural hardware. Continue characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions. Continue to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Continue development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Verify performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continue to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles. These technologies will significantly reduce the life cycle cost of expendable and reusable liquid rocket engines. Continue developing advanced turbomachinery, combustion devices, and propellant management devices for solid and liquid rockets.

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 624847

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

(U) FY 2001 ($ in Thousands) Continued

Continue to demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket space boosters and missiles. Fabricate and test advanced lightweight rocket engine nozzle for upper stage and space booster applications. Continue characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions.

(U) $7,000 Develop missile propulsion technology, aging and surveillance technology, and Post Boost Control Systems (PBCS) for sustainment of current Intercontinental Ballistic Missile (ICBM) fleet. Complete development of compatible case/liner, insulator and case systems for higher combustion temperature propellants. Complete design and begin fabrication of solid rocket motor test hardware. Initiate a project to develop an advanced lightweight solid rocket motor. Continue development of tools to increase the capability to determine the service life of strategic systems and other solid rocket motors. Complete the development of the advanced PBCS. Continue to develop technologies that are readily available over the life of strategic systems, which may also be potentially advantageous to the development of the next generation strategic systems.

(U) $6,982 Develop solar electric and solar thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer appropriate for large communication satellites and satellite constellations. Payoffs include orders of magnitude increases in on-orbit life and repositioning capability increasing the warfighter's ability to utilize and control space. Continue all Hall thruster development efforts currently being leveraged by contractor contribution, 50% cost share. Hall thrusters meet the Air Force need for Low Earth Orbit to Geosynchronous Earth Orbit transfers using electric propulsion. Continue development of propulsion systems, including pulsed plasma thrusters, for micro satellites (< 25 kg) needed for advanced Air Force imaging missions. Continue developing solar thrusters and concentrators for future orbit transfer vehicle systems. Perform preliminary characterization of concentrator surface roughness. Fabricate an advanced solar thermal thrusters and integrate with an inflatable concentrator.

(U) $50,594 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602111N, Anti-Air/Anti-Surface Warfare Technology.

(U) PE 0602303A, Missile Technology.

(U) PE 0603302F, Space and Missile Launch Technology.

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

(U) PE 0603311F, Ballistic Missile Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	61,336	63,922	65,644	69,294	74,066	79,203	81,070	Continuing	TBD
622000	Electronic Countermeasures Technology	14,555	15,862	0	0	0	0	0	Continuing	TBD
622001	Electro-Optical Technology	448	492	0	0	0	0	0	Continuing	TBD
622002	Electronic Component Technology	8,820	6,900	17,406	16,494	16,910	16,919	17,249	Continuing	TBD
622003	EO Sensors & Countermeasures Tech	9,026	9,330	11,855	13,967	15,888	18,195	18,225	Continuing	TBD
626095	Sensor Fusion Technology	11,008	11,859	13,312	14,325	14,821	15,798	16,063	Continuing	TBD
626096	Microelectronics Technology	8,840	10,612	0	0	0	0	0	Continuing	TBD
627622	RF Sensors & Countermeasures Tech	8,639	8,867	23,071	24,508	26,447	28,291	29,533	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001 and out, work performed under Project 622000 moves to Projects 622002, 622003, and 627622. Project 622001 work moves to Project 622003. Project 626096 work moves to Project 622002. Portions of work previously performed in PE 0602702F, Project 624506 move to this PE, Project 627622. Apparent project ramps are due only to realignment of the projects. This realignment aligns projects with the Air Force Research Laboratory organization. Project realignment does not affect work planned for the overall program element or the budget topline.

(U) **A. Mission Description**

This program develops the technology base for Air Force aerospace sensors. Advances in aerospace sensors are required to increase combat effectiveness by providing 'anytime, anywhere' surveillance, reconnaissance, precision targeting, and electronic warfare capabilities. These advances will also reduce life cycle costs, facilitate affordable modernization of aging and future aerospace platforms, and provide protection against emerging hostile threats. Meeting these needs necessitates simultaneous advances in multiple, interrelated disciplines including: Radio frequency (RF) sensors (e.g., radar, threat warning, jamming); electro-optical (EO) sensors (e.g., laser countermeasures, ladars, forward looking infrared, hyperspectral imagers); multi-function high-power electronic devices; target detection, classification, and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors

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

recognition; fire control; sensor fusion; communication and navigation subsystems; and electronic warfare. Note: In FY 2000, Congress added $3.0 million for Collaboration Infrastructure, $1.4 million for Space Protection, and $1.8 million for Automatic Target Recognition.

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	63,719	64,988	69,245	
(U)	Appropriated Value	65,549	64,331		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1,830	-42		
	b. Small Business Innovative Research	-902			
	c. Omnibus or Other Above Threshold Reprogram		-225		
	d. Below Threshold Reprogram	-1,139			
	e. Rescissions	-342	-142		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-3,601	
(U)	Current Budget Submit/FY 2001 PBR	61,336	63,922	65,644	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

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COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622000 Electronic Countermeasures Technology	14,555	15,862	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This program determines the feasibility of active and passive electronic countermeasure technologies and explores, develops, expands, and refines the most promising and cost-effective candidates. Technologies pursued support passive sensing of the entire electromagnetic spectrum to improve signal collection, detection, recognition, analysis, identification, location, and countering of enemy electronic emissions whether intentional or unintentional. This project also includes development of countermeasure concepts against radar, infrared (IR), and electro-optical threat weapon systems as well as against networks for communication, command, and control. Various links and sensors of threat air defense systems are analyzed and a database of countermeasure techniques and technologies is generated from which specific self-protection or support countermeasures equipment can be developed. Specifically, the program exploits emerging technologies to provide increased capability for: 1) radar warning, radio frequency (RF) electronic warfare, and electronic intelligence applications; 2) IR detection for passive missile warning, IR signature exploitation, and IR countermeasures; 3) laser detection for threat warning and countermeasures; 4) passive and combined passive/active off-board expendables (chaff, decoys, etc.); and 5) hardware and software for associated processing and technology integration needs. Advanced countermeasure capabilities are vital for survival of operational aerospace platforms facing future threats in hostile environments.

(U) FY 1999 ($ in Thousands)

(U) $3,332 Developed countermeasure technologies for on-board and off-board (active IR decoys) to counter IR-guided missiles and electro-optic threats. Evaluated techniques against imaging missile seekers. Developed cooperative jammer and decoy concepts. Demonstrated night vision device countermeasure concepts.

(U) $2,663 Developed affordable RF jamming technology and concepts to degrade enemy radar, missile, and command and control systems. Completed covert featureless waveform study. Developed advanced deception countermeasures techniques. Developed techniques for degrading enemy modern communication networks. Evaluated RF countermeasure techniques in the laboratory.

(U) $510 Developed off-board (expendable) RF and combined IR/RF countermeasure concepts. Developed design tools and analytic methods to predict effectiveness of advanced decoys.

(U) $2,081 Developed technology for generic software modules to enable low-cost block upgrades to electronic warfare receivers. Tested combined de-interleaving, correlation, and threat identification software modules.

(U) $4,675 Developed affordable antenna technology for use in operational and future aircraft. Demonstrated first wideband digital receiver. Developed new techniques for wideband to narrowband cueing. Investigated electromagnetic characterization of and demonstrated dual-use conformal array technology.

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

(U) FY 1999 ($ in Thousands) Continued

(U)	$1,294	Developed missile and laser warning technology to accurately cue countermeasures and improve survivability. Developed laser warning techniques. Evaluated infrared (IR) clutter rejection techniques.
(U)	$14,555	Total

(U) FY 2000 ($ in Thousands)

(U)	$3,508	Develop countermeasure technologies against IR-guided missiles and electro-optical threats. Continue evaluating techniques against imaging missile seekers and demonstrating cooperative jammer and decoy concepts. (In FY 2001, this work will transfer to Project 622003.)
(U)	$2,991	Develop affordable radio frequency (RF) jamming technology and concepts that enhance aircraft survivability by degrading enemy radar, missile, and command and control systems. Complete evaluation of alternative methods for covert featureless waveform detection. Optimize advanced deceptive countermeasure techniques. Continue to develop techniques for degrading enemy modern communication networks. (In FY 2001, this work will transfer to Project 627622.)
(U)	$475	Develop off-board (expendable) RF and combined IR/RF countermeasure concepts for affordable survivability. Demonstrate countermeasure effectiveness of advanced decoys against dual-mode missile seekers. (In FY 2001, this work will transfer to Project 622003.)
(U)	$2,325	Develop technology for generic software modules to enable low-cost block upgrades to electronic warfare (EW) receivers. Complete tests of combined de-interleaving correlation and threat identification software modules for aerospace EW receivers. (In FY 2001, this work will transfer to Project 627622.)
(U)	$3,029	Develop affordable RF receiver technology for use in operational and future EW receivers. Continue to demonstrate a wideband digital receiver brassboard. Evaluate narrowband receiver technology. Develop wideband analog-to-digital circuits. (In FY 2001, this work will transfer to Project 622002.)
(U)	$2,042	Develop affordable antenna technology for use in operational and future aerospace platform electronic receivers and apertures. Develop low-frequency direction-finding antennas. Demonstrate advanced pattern control of multimode/multifunction antennas. Demonstrate phase shifters and transmit/receive module technology. (In FY 2001, this work will transfer to Project 627622.)
(U)	$1,492	Develop aerospace missile and laser warning technologies to accurately cue countermeasures. Devise laser warning discrimination methods. Assess hyperspectral imaging technology for missile warning. Demonstrate infrared clutter rejection techniques. (In FY 2001, this work will transfer to Project 622003.)
(U)	$15,862	Total

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PROJECT: 622000	

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

(U) FY 2001 ($ in Thousands)

(U)	$0	Efforts transferred to Projects 622002, 622003, and 627622.
(U)	$0	Total

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

Not Applicable.

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

(U) Related Activities:

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors		PROJECT: 622001

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622001 Electro-Optical Technology	448	492	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project focuses on the development of military unique and essential devices and components for aerospace optical sensing, optical processing, and integration of electro-optical (EO) technology into avionics sensor systems. EO technologies provide faster, more accurate detection and targeting capability combined with the benefits of low weight and power requirements. The results of this technology provide the warfighter with increased situational awareness, enhanced defense suppression, and improved precision weapon delivery.

(U) FY 1999 ($ in Thousands)

(U) $448 Developed advanced EO sensor technologies, including non-mechanical beam steering techniques, for a single compact, affordable navigation and targeting sensor.

(U) $448 Total

(U) FY 2000 ($ in Thousands)

(U) $492 Develop optical transmitter technology capable of sensing multiple target characteristics to provide robust non-cooperative combat identification. Perform proof-of-concept demonstrations. Complete critical design of transmitters for imaging and non-imaging applications. (In FY 2001, this work will be performed in Project 622003.)

(U) $492 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort transferred to Project 622003.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603203F, Advanced Aerospace Sensors.

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

(U) PE 0603270F, Electronic Combat Technology.

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	PROJECT 622001

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

(U) PE 0602712E, Materials and Electronics Technology.

(U) PE 0603739E, Advanced Electronics Technology.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors — PROJECT: 622002

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622002 Electronic Component Technology	8,820	6,900	17,406	16,494	16,910	16,919	17,249	Continuing	TBD

(U) **A. Mission Description**

This project focuses on the generation, control, reception, and processing of electronic and photonic signals for radio frequency (RF) sensor aerospace applications. Typical technologies include: solid state and vacuum electronic power devices and amplifiers; low noise and signal control components; high-temperature electronics; photonic components for RF links; signal control/distribution/processing; multi-function monolithic integrated circuits; high-speed analog-to-digital and digital-to-analog circuits; power distribution; multi-chip modules; and high density packaging and interconnect technologies. This project also covers design, development, fabrication, and evaluation of techniques for integrating these technologies. The aim is to demonstrate significantly improved military sensors with 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 and based on Air Force and other DoD weapon systems requirements in the areas of radar, communications, electronic warfare (EW), navigation, and smart weapons.

(U) FY 1999 ($ in Thousands)

(U) $2,261 Developed compact, affordable, mixed-mode, multi-function receiver and phased array components for radar and EW. Designed miniature digital receiver components. Refined advanced component evaluation methods to reduce non-recurring engineering costs.

(U) $2,493 Developed high-power (1 to 100 watts), military unique, solid state transmitters for radar and communications applications. Developed transmit amplifiers to improve range and kill probability of precision guided munitions and advanced microwave amplifiers for improved power dissipation and reliability.

(U) $2,820 Developed high yield process technologies to enable high-operating-temperature, military essential, solid state microwave transmitters used in ground-based and airborne radar applications. Evaluated candidate materials for improved transistor reliability. Demonstrated integrated circuits and high power internally matched transistors.

(U) $1,246 Developed military unique, very high-power (100 to 1,000 watts) vacuum electronics devices and components for affordable microwave and millimeter wave transmitters. Designed advanced microwave tube components.

(U) $8,820 Total

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 622002

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

(U) FY 2000 ($ in Thousands)

(U)	$4,460	Develop compact, affordable, mixed-mode, multi-function receiver and phased array components for radar and electronic warfare (EW). Fabricate miniature digital receiver components, direct digital waveform transmitters, and very low power (<0.5W) analog-to-digital converters for space-based sensors. Refine advanced component evaluation methods.
(U)	$332	Develop microwave technologies to enable high operating temperature, solid state microwave transmitters used in military ground-based and airborne radar applications. Develop robust high-speed, high-power III-nitride transistors.
(U)	$318	Demonstrate high-power, internally matched transistors that will allow replacement of S-band vacuum tube transmitters to increase the reliability and lower the life cycle cost of high-power, ground-based radars.
(U)	$903	Develop aerospace surface protective coatings and packaging technologies for high-performance, mixed analog/digital microwave circuits to improve reliability and lower the cost of components that operate in harsh military environments. Develop advanced packaging and interconnect processes for phased array antennas and EW transmitters. (In FY 2000, this work moved from Project 626096.)
(U)	$887	Develop military unique, very high-power (100 to 1,000 watts) vacuum electronics devices and components for compact, affordable microwave and millimeter wave transmitters used in EW, radar, and communications applications. Fabricate advanced microwave tube components.
(U)	$6,900	Total

(U) FY 2001 ($ in Thousands)

(U)	$5,233	Develop compact, affordable, multi-function receiver and phased array components for radar, electronic warfare, and other intelligence, surveillance, and reconnaissance (ISR) sensors. Demonstrate miniature airborne digital receiver components. Fabricate direct digital waveform transmitters and high-resolution (10 bit), ultra-low power (<1.0W) analog-to-digital converters. Demonstrate and refine advanced component evaluation methods. (In FY 2000, portions of this work were performed in Project 626096.)
(U)	$4,544	Develop microwave technologies for advanced radio frequency apertures and phased array antennas used in military ISR sensors. Fabricate a high operating temperature, high-efficiency power amplifier to allow dispersed placement of active arrays. Demonstrate S-band (2-4 GHz) silicon carbide transistors for air defense networks. Demonstrate advanced vacuum electronics components. Conduct a reliability evaluation of high-power heterojunction bipolar transistors for ground and airborne radars and EW transmitters. (In FY 2000, portions of this work were performed in Project 622000.)
(U)	$3,854	Develop packaging and integration technologies for high performance aerospace radio frequency (RF) sensor components. Demonstrate device and multi-chip module surface protective coatings and mixed analog/digital microwave circuits to improve reliability and lower the cost of components operating in harsh military environments. Test advanced packaging and interconnect processes for phased array antennas and EW transmitters. (In FY 2000, portions of this work were performed in Project 626096.)
(U)	$1,114	Develop signal control components and techniques to meet RF loss levels required for future radar, electronic warfare, and ISR sensors. Design

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	PROJECT: 622002

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

(U) FY 2001 ($ in Thousands) Continued

micro-electro-mechanical phase shifters with a 300% improvement in radio frequency (RF) loss performance. Develop miniature filters for high performance channelized radar and electronic warfare receivers.

(U) $2,661 Develop RF photonics technologies to demonstrate compact, affordable, wide bandwidth, high data rate aerospace sensors. Fabricate photonic components for high performance digital receivers and processors. (Prior to FY 2001, this work was performed in Project 626096.)

(U) $17,406 Total

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

Not Applicable.

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

(U) Related Activities:

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors — PROJECT: 622003

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622003 EO Sensors & Countermeasures Tech	9,026	9,330	11,855	13,967	15,888	18,195	18,225	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates technical feasibility of advanced electro-optical (EO) aerospace sensor technologies for a variety of offensive and defensive functions. Sensor technologies under development range from the ultraviolet (UV) 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 main goals of this project is to improve EO technologies for the detection, tracking, and identification of 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 the presence of severe weather. These sensor technologies are critical to future air and space-based surveillance and targeting capabilities. Other project goals include the improvement of the technology bases for advanced EO threat warning and countermeasures.

(U) FY 1999 ($ in Thousands)

(U) $2,324 Developed software engineering technologies to promote assured performance and affordability of complex existing and next-generation air and space platform software. Demonstrated automated means to ensure correctness of cockpit display and console software. Developed capability for performing in-flight self-checking of mission critical weapons and information systems software. Developed new techniques for rapidly incorporating new functions and hardware into scaleable systems.

(U) $3,812 Developed advanced machine intelligence technologies to provide a capability for enhanced management of critical on-board sensors and detection/recognition of targets. Demonstrated enhanced, real-time embedded avionics database management system. Demonstrated advanced multi-target, multi-source identification capability. Demonstrated an advanced tactical surveillance sensor manager. Developed and applied efficient target recognition and combat information fusion techniques.

(U) $2,890 Developed and demonstrated avionics integration technologies that allow rapid re-allocation of avionics hardware to meet changing operational requirements. These technologies dramatically reduce warfighter timelines for interoperability and adaptability in changing threat environments.

(U) $9,026 Total

(U) FY 2000 ($ in Thousands)

(U) $2,292 Develop software engineering technologies to promote assured performance and affordability of complex existing and next-generation air and space platform software. Continue to demonstrate automated means to ensure correctness of cockpit display and console software. Develop and apply capability for performing in-flight self-checking of mission critical weapons and information systems software. Continue to develop new techniques for rapidly incorporating new hardware/software functions into scaleable, plug-and-play systems.

(U) $2,560 Develop sensor component technologies to detect, locate, and identify low-contrast ground and aerospace targets from high altitude and space.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 622003

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

(U) FY 2000 ($ in Thousands) Continued

Develop aerospace infrared hyperspectral sensor components and fusion algorithms. Validate sensor target models.

(U) $1,113 Develop technology for non-cooperative identification of airborne and ground-based platforms. Investigate target background and atmospheric phenomenology effects on sensor performance. Generate multi-dimensional/multi-functional sensor platform concepts. Develop coherent image processing/extraction algorithms.

(U) $1,833 Develop electro-optical (EO) technology to enable passive or active targeting of difficult targets. Investigate ways of mitigating atmospheric phenomenology effects on extended range aerospace sensors. Develop turbulence compensation techniques for precision targeting, target signatures, and phenomenology models. Select multifunction sensor target characteristics.

(U) $445 Develop military-unique optical transmission components to enable information dominance. Fabricate laboratory high-speed optical communication subsystem.

(U) $1,087 Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions. Fabricate components for active multispectral imaging. Assess active imaging systems for their ability to penetrate weather and obscurants and improve capabilities in existing systems.

(U) $9,330 Total

(U) FY 2001 ($ in Thousands)

(U) $2,305 Develop day/night electro-optical sensor component technologies to detect, locate, and identify low contrast ground and aerospace targets from high altitude and space. Develop imaging spectrometer techniques and multispectral focal plane array components. Perform laboratory and field tests on techniques and components. Assess performance.

(U) $1,779 Develop technology for non-cooperative identification of airborne and ground-based platforms. Design long-range sensors. Test coherent image processing/extraction algorithms. Flight demonstrate a multifunction ladar.

(U) $673 Develop military-unique optical transmission components to enable information dominance. Demonstrate useful commercial-off-the-shelf technologies integrated with military-unique components.

(U) $1,239 Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions. Fabricate components for active multispectral imaging. Assess active imaging systems for their ability to penetrate weather and obscurants. Design generic modules to improve capabilities of existing systems. Analyze and demonstrate concepts based on high precision pointing, range gating, and image processing.

(U) $3,506 Develop countermeasure technologies against infrared-guided missiles and electro-optic threats. Design components and refine techniques to defeat imaging missile seekers. (Prior to FY 2001, this work was conducted in Project 622000.)

(U) $1,859 Develop aerospace missile and laser warning technologies to accurately cue countermeasures. Develop temporal and spectral tracking algorithms, advancing from two-color to multispectral imaging techniques. Test advanced sensor hardware. (Prior to FY 2001, this work was

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors — PROJECT: 622003

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

(U) FY 2001 ($ in Thousands) Continued

conducted in Project 622000.)

(U) $494 Develop optical transmitter technology capable of sensing multiple target characteristics to provide robust non-cooperative target identification. Fabricate a single imaging and non-imaging transmitter. (Prior to FY 2001, this work was conducted in Project 622001.)

(U) $11,855 Total

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

Not Applicable.

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

(U) Related Activities:

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors		PROJECT: 626095

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
626095 Sensor Fusion Technology	11,008	11,859	13,312	14,325	14,821	15,798	16,063	Continuing	TBD

(U) **A. Mission Description**

Develops the baseline technologies required to perform management and fusion of on-board sensor information for timely, comprehensive situation awareness, automatic target recognition (ATR), integrated fire control, and bomb damage assessment. This project determines the feasibility of technologies and concepts for fire control to aid in precisely locating, identifying, and targeting airborne and surface targets. The emphasis is on finding reduced signature targets and targets of opportunity and enabling new covert tactics for successful air-to-air and air-to-surface strikes.

(U) FY 1999 ($ in Thousands)

(U)	$1,207	Developed, evaluated, and demonstrated air-to-air single and multisensor tracking, sensor management, fire control, situation awareness, and identification algorithms to dramatically improve air combat capability.
(U)	$5,049	Developed, evaluated, and demonstrated air-to-ground single and multi-sensor tracking, sensor management, fire control, situation awareness, and identification algorithms to dramatically improve reconnaissance, surveillance, and strike operations.
(U)	$2,759	Developed, evaluated, and demonstrated feasibility of single and multi-sensor ATR algorithms to dramatically improve capability to recognize hostile ground forces.
(U)	$1,203	Developed and demonstrated ATR enabling technologies for long-range, high-altitude air and space vehicles.
(U)	$790	Developed precision time, position, and velocity sensors to generate a common precision reference and enable platforms to share sensor data.
(U)	$11,008	Total

(U) FY 2000 ($ in Thousands)

(U)	$4,210	Develop, evaluate, and demonstrate single and multisensor lethality algorithms to dramatically improve air combat capability. Perform a ground station emulation. Simulate targeting with real-time information-into-the-cockpit. Develop adaptive resource allocation.
(U)	$4,010	Develop, evaluate, and demonstrate air-to-ground single and multi-sensor radar target signature models to support automatic target recognition in strike operations. Investigate computational electromagnetics techniques. Generate geometric target models. Characterize clutter.
(U)	$2,149	Develop, evaluate, and demonstrate feasibility of multi-sensor ATR algorithms for on- and off-board sensor-to-shooter image and data fusion to rapidly attack time-critical targets. Complete evaluation of a sensor-to-shooter algorithm. Devise multi-sensor performance metrics. Evaluate multisensor ATR algorithms.
(U)	$1,490	Develop precision time, position, and velocity sensors capable of operating in jamming environments enabling multiple platform sensor to shooter operations. This includes simultaneous localization using diverse power level reference signals and optimal co-location of reference

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 626095

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

(U) FY 2000 ($ in Thousands) Continued

sensors as the key to the next generation jam resistant technology.

(U) $11,859 Total

(U) FY 2001 ($ in Thousands)

(U)	$4,137	Develop, evaluate, and demonstrate single and multi-sensor lethality algorithms to dramatically improve air combat capability. Perform a live-feed to ground station emulation to evaluate real-time information-into-the-cockpit targeting schemes, and to optimize adaptive resource allocation methods. Complete demonstration of real-time, on-board automatic target recognition (ATR) and information fusion using live threat emitter data.
(U)	$3,889	Develop, evaluate, and demonstrate single and multi-sensor radar target signature models to support ATR in strike operations. Transition the ground target signature database to an operational air-to-ground ATR system. Develop physics-based dynamic complex synthetic aperture radar (SAR) scene simulation capability using advanced modeling and simulation (M&S) techniques. Develop innovative target recognition techniques using advanced scattering phenomenology analysis. Transition advanced phenomenology-based target recognition techniques to the intelligence community.
(U)	$2,144	Develop, evaluate, and demonstrate feasibility of multi-sensor ATR algorithms for on- and off-board sensor-to-shooter image and data fusion to rapidly attack time-critical targets. Develop full, collaborative sensor-to-shooter algorithm environment utilizing the most advanced DoD laboratory capabilities from across the country. Evaluate sensor-to-shooter technologies and develop operational concepts.
(U)	$2,508	Develop and demonstrate enabling ATR technologies for future intelligence, surveillance, and reconnaissance (ISR) applications. Evaluate physics-based and adaptive learning techniques to reduce cost and increase capabilities of follow-on ISR systems. Using ground-based technology demonstrations and hardware-in-the-loop simulations, continue developing high-impact technologies needed to provide extremely high altitude, long-range targeting and attack capabilities.
(U)	$634	Develop sensors to provide precise time, position, and velocity measurements to enable multiple-platform, sensor-to-shooter operations in jamming environments. Develop Global Positioning System (GPS) specific jamming mitigation techniques for operation in hostile radio frequency environments. Assess the advantages for signal tracking of collocating an inertial measurement unit with the phase center of a GPS antenna, and devise techniques to exploit this capability for navigation and strike. Design and implement methods to enable GPS receivers to simultaneously handle strong signals from nearby differential reference sources and the weak signals from GPS satellites to improve jam-resistance and positional accuracy.
(U)	$13,312	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors
	PROJECT 626095

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(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 Guidance Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors / PROJECT: 626096

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
626096 Microelectronics Technology	8,840	10,612	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project focuses on military unique, sensor aspects of microelectronics and radio frequency (RF) photonics such as photonic sub systems and components for the control and distribution of RF signals; high-speed devices and circuits; packaging and power distribution; design tools; and hardware design languages. The warfighter requirements for technology developments are based on Air Force and other DoD weapon systems needs in the areas of radar, communications, electronic warfare (EW), navigation, and smart weapons applications. Future surveillance and sensor information processing systems will require very small, environmentally robust, high-speed, low power, lightweight components and subsystems using both microelectronics and photonics in the following areas: electronic and photonic analog-to-digital converter circuits, fiber optic signal control and distribution sub-systems, high-temperature electronics, multi-function monolithic integrated circuits, high density photonic interconnects, and RF distributions and radar beamforming. Computer-aided engineering technology is key to addressing the low-cost, very high performance, low power, tough environmental, multi-organization development, and high complexity challenges of our warfighting electronics. The developed technology is unavailable through commercial sources.

(U) FY 1999 ($ in Thousands)

(U)	$2,934	Developed advanced high-speed devices and fabrication processes for digital integrated circuits (e.g., very high-speed, analog-to-digital converters and digital RF memory chips) to allow high-speed military sensors to interface with slower commercial processors, thereby eliminating bulky, costly, and temperature-sensitive down-conversion electronics. Demonstrated fabrication processes and devices for a transceiver chip set and augmented analog-to-digital conversion circuits to enable use of commercial-of-the-shelf components in radar, EW, and other sensors.
(U)	$2,596	Developed surface protective coatings and packaging technologies for high performance, mixed analog/digital microwave circuits to improve reliability and lower component cost for space sensor components. Developed advanced packaging and interconnect processes for phased array antennas and electronic warfare transmitters and receivers. (In FY 2000, this work moves to Project 622002.)
(U)	$2,515	Developed advanced design tools to reduce the cost and time required to create complex Air Force electronic systems. Assessed and refined tools for next-generation 'systems-on-a-chip' and reconfigurable computer design.
(U)	$795	Developed next generation design representations and system-level modeling and simulation capability to support the complexity in implementing the Air Force's 'system of systems' vision. Developed extensions to industry standard hardware description and design language tools for complex military information systems.
(U)	$8,840	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors
PROJECT: 626096	

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

(U) FY 2000 ($ in Thousands)

(U)	$2,468	Develop advanced high-speed device technologies to enable affordable, compact space-based sensors. Design radio frequency components and analog-to-digital converters for high dynamic range, high sensitivity micro-receivers. (In FY 2001, this work will be performed in Project 622002.)
(U)	$1,752	Develop advanced design tools to reduce the cost and time required to create complex Air Force electronic systems such as mixed analog and digital systems. Demonstrate tools for reconfigurable computers and for describing hardware behavior. (In FY 2001, this work will be performed in Project 622002.)
(U)	$3,756	Develop next-generation design representations and system-level modeling and collaborative engineering capability to support the complexity in implementing the Air Force's 'system of systems' vision. Specify required representations. Develop advanced techniques for analyzing life cycle cost/performance trade offs.
(U)	$2,251	Develop radio frequency photonics technologies to demonstrate compact, affordable, wide bandwidth, high data rate sensors. Design photonic interconnect architectures for high performance digital receivers and processors. (Prior to FY 2000, this work was performed under PE 0602702F, Project 624600. Beginning in FY 2001, this work will be performed in PE 0602204F, Project 622002.)
(U)	$385	Develop, as part of an international cooperative effort, the three-dimensional multilayer microwave packaging and interconnect multichip assembly technologies needed for next-generation airborne moving target indicator radars. (In FY 2001, this work will transfer to Project 622002.)
(U)	$10,612	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort transferred to Project 622002.
(U)	$0	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603270F, Electronic Combat Technology.

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

(U) PE 0602705A, Electronics and Electronic Devices.

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors
	PROJECT: 626096

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

(U) PE 0602234N, Materials, Electronics and Computers.

(U) PE 0602712E, Materials and Electronics.

(U) PE 0603739E, Manufacturing Technology.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors		PROJECT: 627622

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
627622 RF Sensors & Countermeasures Tech	8,639	8,867	23,071	24,508	26,447	28,291	29,533	Continuing	TBD

(U) **A. Mission Description**

Determines feasibility of technology for reliable, all-weather, reconnaissance and precision strike radio frequency (RF) sensors and electronic combat systems. Emphasis is on acquisition of surface and airborne targets with difficult to detect signatures due to reduced radar cross sections, concealment and camouflage measures, severe clutter, and/or heavy jamming. This project also develops the RF warning and countermeasure technology for advanced electronic combat applications. Specifically, it analyzes the links and sensors of threat air defense systems and command and control networks and develops appropriate countermeasure techniques and technologies. The program also exploits emerging technologies to provide increased capability for radar warning, RF electronic combat, and electronic intelligence applications.

(U) FY 1999 ($ in Thousands)

(U) $3,570 Developed advanced microwave sensor technologies, such as electronic protection, multi-dimensional image processing, and adaptive algorithms for high-performance, lower life cycle cost air-to-air radar and target detection. Tested integrated RF techniques. Developed adaptive algorithms for interference and lobe cancellation. Developed radar engineering tools to evaluate targeting errors.

(U) $3,650 Developed advanced airborne sensors for air-to-ground targeting and attack with robust performance in adverse weather, severe jamming, natural clutter, or concealment by foliage or camouflage. Developed improved targeting scenes for synthetic aperture radars (SAR). Developed analytical tools to predict SAR performance.

(U) $1,419 Developed technology for information transmission between airborne vehicles and cooperating assets with high fidelity, low probability of detection, and high jam resistance to improve strike effectiveness. Integrated a communication asset management system. Completed a preliminary design for a non-linear adaptive interference limiter to reduce interference.

(U) $8,639 Total

(U) FY 2000 ($ in Thousands)

(U) $1,256 Develop aerospace microwave sensor technologies for air-to-air radar and target detection that supports surveillance, reconnaissance, protection, targeting, attack, and electronic warfare. Design electromagnetic interference mitigation techniques. Validate advanced radar performance/cost analysis tools.

(U) $1,748 Develop adaptive microwave processing algorithms for detecting and locating advanced cruise missiles and slow airborne and ground targets. Design techniques to mitigate clutter and jamming on airborne monostatic and bistatic radars.

(U) $1,566 Develop advanced aerospace sensors for air-to-ground targeting and attack, providing synthetic aperture radar targeting solutions for

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors
	PROJECT: 627622

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

(U) FY 2000 ($ in Thousands) Continued

maneuvering tactical aircraft in a hostile environment. Perform an independent assessment of various current and future airborne and space surveillance sensors.

(U) $732 Develop technology for detecting and attacking concealed targets. Develop innovative foliage- and ground-penetrating radar waveforms and targeting algorithms.

(U) $980 Develop technology to accurately determine algorithm and sensor performance from airborne and space-based platforms in realistic airborne surveillance and combat scenarios. Test bistatic adjuncts on unmanned aerial vehicles. (Prior to FY 2000, this work was performed in PE 0602702F, Project 624506.)

(U) $1,190 Develop electromagnetic technologies for advanced surveillance systems applications for the detection of low-observable airborne targets within severe clutter from airborne or space-based surveillance platforms. (Prior to FY 2000, this effort was conducted under PE 0602702F, Project 624600.)

(U) $1,395 Develop radio frequency (RF) space protection technology. Investigate techniques to provide warning and countermeasures against RF interference with satellite operations.

(U) $8,867 Total

(U) FY 2001 ($ in Thousands)

(U) $4,169 Develop aerospace microwave sensor technologies for detecting, locating, and engaging airborne and ground targets. Develop high fidelity analytical tools for evaluating and predicting the performance of integrated air moving target indication, ground moving target indication, and synthetic aperture radar modes. Conduct airborne radar data collection. Perform laboratory analysis for application of advanced surveillance techniques. (This effort incorporates work previously performed under PE 0602702F, Project 624506.)

(U) $3,544 Develop aerospace microwave processing algorithms for detecting and locating advanced cruise missiles and slow airborne targets, as well as stationary and moving ground targets in severe clutter and jamming environments. Analyze individual algorithms for improved air and ground moving target indication algorithm performance. Develop adaptive processing techniques that incorporate knowledge-based approaches.

(U) $3,849 Develop technology for detecting and attacking concealed targets. Evaluate innovative foliage- and ground-penetrating radar waveforms and targeting algorithms, devising techniques to prevent discovery by the enemy, and assessing potential for detecting buried command and control centers.

(U) $2,970 Develop affordable RF jamming technology and concepts that enhance aerospace vehicle survivability by degrading enemy radar, missile, and command and control systems. Evaluate ability to detect covert/featureless waveforms. Test optimized deception countermeasure techniques, and techniques to degrade modern communication networks. (Prior to FY 2001, this work was conducted in Project 622000.)

(U) $2,555 Develop technology for generic software modules to enable low-cost block upgrades to electronic warfare receivers. Design threat identification

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602204F Aerospace Sensors
	PROJECT: 627622

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

(U) FY 2001 ($ in Thousands) Continued

software modules for next-generation threat warning receivers. (Prior to FY 2001, this work was conducted in Project 622000.)

(U) $5,984 Develop affordable antenna technology for use in operational and future aerospace platform electronic receivers and apertures. Laboratory demonstrate an integrated ensemble of low-frequency direction-finding antennas. Develop highly precise, wideband, interferometric multimode direction-finding antennas. Demonstrate a micro-electro-mechanical phase shifter controlled array. Demonstrate design tools to predict antenna performance. (Prior to FY 2001, this work was conducted in Project 622000.)

(U) $23,071 Total

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

Not Applicable.

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

(U) Related Activities:

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602269F Hypersonic Technology Program

PROJECT: 621025

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621025 Hypersonic Technology Program	16,031	15,808	0	0	0	0	0	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2000, this program was terminated by the Air Force. However, Congress added $16.0 million in FY 2000 to restore the program. In FY 2001, funding for this program is contained in PEs 0602203F Aerospace Propulsion, 0603202F, Aerospace Propulsion Subsystems Integration, and 0603216F, Aerospace Propulsion and Power Technology. Beginning in FY 2002, these efforts will be shifted to PE 0602203F, Aerospace Propulsion.

(U) **A. Mission Description**

This program develops advanced hypersonic technologies that will provide revolutionary propulsion options to satisfy Air Force needs for future hypersonic weapons and space launch concepts. This program will focus on hydrocarbon fueled hypersonic vehicle technologies and demonstrate their feasibility. Technologies developed under this program will be dual-use and applicable to both Department of Defense and National Aeronautical and Space Agency requirements. Planned efforts include analyses, hypersonic materials/structures, airbreathing propulsion, hydrocarbon fuels, and integrated technology test demonstrations.

(U) FY 1999 ($ in Thousands)

(U) $14,127 Designed, developed, and tested propulsion components, structures, and integrated propulsion designs to demonstrate performance and durability of advanced hypersonic propulsion concepts.

(U) $1,063 Designed, developed, and tested advanced high-temperature, high-strength materials and structures for durability in hypersonic applications.

(U) $392 Developed technologies for instrumentation and test in realistic hypersonic conditions to enable appropriate system testing.

(U) $349 Developed and extended computational technologies for supersonic combustion flow paths, validated these technologies, and applied them to predict internal flows and performance of scramjet engines for accurate prediction of system performance.

(U) $100 Conducted feasibility studies, design trades, and simulations to integrate hypersonic technologies into advanced vehicle designs for hypersonic applications that will improve warfighting capability and satisfy the requirements of Global Reach/Global Power.

(U) $16,031 Total

(U) FY 2000 ($ in Thousands)

(U) $15,028 Design, develop, and test propulsion components, structures, and integrated propulsion devices for advanced hypersonic propulsion concepts. Continue testing of scramjet engine components (e.g., inlet, combustor, and nozzle) capable of demonstrating positive thrust at Mach 4-8 while withstanding severe internal conditions. Complete demonstration of heavyweight scramjet engine in freejet. Initiate fabrication and testing of flight type scramjet combustor and inlet.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602269F Hypersonic Technology Program
	PROJECT 621025

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$405	Develop technologies for instrumentation and test in realistic hypersonic conditions. Continue application of hypersonic test instrumentation to freejet engine configurations and establishment of test instrumentation protocol for freejet testing.
(U)	$275	Develop and extend computational technologies from low-speed and supersonic flight to the hypersonic environment. Continue validation of computational methods in instrumented engine flowpath test rigs.
(U)	$100	Conduct feasibility studies, system design trades, and simulations to integrate hypersonics technologies into advanced vehicle designs for hypersonic applications that will improve warfighting capability and satisfy the requirements of Global Reach/Global Power. Continue mission analyses to characterize user requirements and technology maturity. Update detailed missile design to guide complex interdisciplinary technology requirements definition and development of integrated hypersonic vehicles to support Defense Advanced Research Projects Agency's affordable rapid response missile demonstrator program.
(U)	$15,808	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort moved to PE 0602203F, PE 0603202F, and PE 0603216F.
(U)	$0	Total

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

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

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

	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget (FY 2000 PBR)	16,586	0	0	
(U) Appropriated Value	16,649	16,000		
(U) Adjustments to Appropriated Value				
a. Congressional/General Reductions	-63			
b. Small Business Innovative Research	-465			
c. Omnibus or Other Above Threshold Reprogram		-87		
d. Below Threshold Reprogram				
e. Rescissions	-90	-105		
f. Other				

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602269F Hypersonic Technology Program / PROJECT: 621025

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

	FY 1999	FY 2000	FY 2001	Total Cost
(U) Adjustments to Budget Years Since FY 2000 PBR				
(U) Current Budget Submit/FY 2001 PBR	16,031	15,808	0	TBD

(U) Significant Program Changes:
In FY 2000, this program was terminated by the Air Force. However, Congress added $16.0 million in FY 2000 to restore the program. In FY 2001, funding for this program is contained in PEs 0602203F Aerospace Propulsion, 0603202F, Aerospace Propulsion Subsystems Integration, and 0603216F, Aerospace Propulsion and Power Technology. Beginning in FY 2002, these efforts will be shifted to PE 0602203F, Aerospace Propulsion.

(U) D. Other Program Funding Summary ($ in Thousands)
(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602201F, Flight Dynamics
(U) PE 0602203F, Aerospace Propulsion
(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) E. Acquisition Strategy
Not Applicable.

(U) F. Schedule Profile
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	122,170	146,021	57,687	54,495	55,743	62,943	69,602	Continuing	TBD
621010	Space Systems Protection Technology	24,351	21,596	18,290	11,646	11,641	16,473	17,935	Continuing	TBD
621011	Rocket Propulsion Technology	33,594	41,600	0	0	0	0	0	Continuing	TBD
623326	Lasers and Imaging Technology	15,614	19,039	0	0	0	0	0	Continuing	TBD
624846	Spacecraft Payload Technologies	0	0	8,395	11,785	10,499	9,866	13,918	Continuing	TBD
625797	Advanced Weapons and Survivability Technology	14,730	18,530	0	0	0	0	0	Continuing	TBD
628809	Spacecraft Vehicle Technologies	33,881	45,256	31,002	31,064	33,603	36,604	37,749	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, spectral sensing (intelligent satellite systems and hyperspectral technology) efforts in Project 623326 move into Project 628809. In FY 2001, in order to align projects within the Air Force Research Laboratory organization, all rocket propulsion efforts performed in Project 621011 were transferred to PE 0602203F, Project 624847, and all lasers and imaging efforts in Project 623326 and all advanced weapons and survivability technology efforts in Project 625797 were transferred to PE 0602605F, Projects 624866 and 624867. In FY 2001, Project 628809 has been split with spacecraft payload technology being moved into Project 624846. In FY 2001, the satellite protection related work currently in Project 628809 moves into Project 621010.

(U) **A. Mission Description**

This is the Applied Research program for geophysics, space, and directed energy technologies for the Air Force Research Laboratory. In geophysics, this PE develops technologies to understand, mitigate, and exploit effects of weather and geophysics environments on the design and operation of Air Force systems. This includes defining, modeling, and developing techniques to predict the phenomena of solar and space environments. In lasers, this PE examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts required for Air Force missions. Technologies researched include high power solid state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, techniques for laser target vulnerability assessments, and nonlinear optics processes and techniques. Advanced weapons examines high power microwave and other unconventional weapon

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology

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

concepts using innovative technologies such as compact toroids. This also provides for vulnerability assessments of representative U.S. strategic and tactical systems to directed energy weapons, directed energy weapon technology assessment for specific Air Force missions, and directed energy weapon lethality assessments against foreign targets. Spacecraft payload technologies focus on the improvement of satellite payload operation by improving component and subsystem capabilities. This project concentrates on development of advanced, space-qualified, survivable electronics and electronics packaging technologies, advanced space sensors and satellite antenna technologies, and high fidelity space simulation models to support space-based surveillance and space asset protection technologies. In space and missiles, this PE contains the following technologies: spacecraft platform (e.g., structures, controls, power, and thermal management); space-based payload (e.g., sensors, satellite communications, and survivable electronics); satellite control (e.g., spacecraft software); ballistic missile/launch vehicle-specific (e.g., astrodynamics and guidance, navigation, and control avionics); and integrated experiments of advanced technologies for transition to planned systems (e.g., payload/platform/launch vehicle merging). Note: In FY 2000, Congress added $10.0 million for the High-frequency Active Auroral Research Program, $5.0 million for the Terabit fiber optic technology program, $2.0 million for Post Boost Control Systems, $1.2 million for missile propulsion technology, $2.5 for radio frequency (RF) applications development, $2.3 million for tactical missile propulsion, $2.8 million for Integrated High Payoff Rocket Propulsion Technology, $1.7 million for orbit transfer propulsion, $2.5 million for tropo-weather, $0.6 million for space survivability, $4.5 million for hyperspectral imaging, $0.6 million for hyperspectral sensing, $0.8 million for space optics relay mirror concept, and $1.2 million for laser remote optical sensing.

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	125,585	115,313	110,811	
(U)	Appropriated Value	129,139	147,118		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-3,554	-73		
	b. Small Business Innovative Research	-2,632			
	c. Omnibus or Other Above Threshold Reprogram		-546		
	d. Below Threshold Reprogram	-101			
	e. Rescissions	-682	-478		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-53,124	
(U)	Current Budget Submit/FY 2001 PBR	122,170	146,021	57,687	TBD

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

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to Program Element and Project realignment.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology / PROJECT: 621010

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621010 Space Systems Protection Technology	24,351	21,596	18,290	11,646	11,641	16,473	17,935	Continuing	TBD

(U) **A. Mission Description**

This project develops the technologies to exploit the aerospace environment to the warfighter's benefit. The project focuses on characterizing the battlespace environment for realistic space system design, modeling, and simulation. It includes technologies to specify and forecast the environment 'mud to sun' for planning operations and ensuring uninterrupted system performance. Finally, it includes technologies that allow the opportunity to mitigate or exploit the aerospace environment for both offensive and defensive operations.

(U) FY 1999 ($ in Thousands)

(U) $4,400 Validated models and decision aids for specifying and forecasting space environmental hazards such as plasma hazards to satellite systems. Continued development of hardware and software for the Improved Solar Optical Observation Network (ISOON) system.

(U) $5,683 Explored and developed techniques to detect and track low-signature ballistic and cruise missiles and to optimize design of new surveillance sensors, including hyperspectral sensors. Explored instruments and techniques to detect theater ballistic missiles through clouds, haze, smoke, and dust to optimize the performance of operational laser weapon systems.

(U) $5,526 Defined and developed systems such as the space-based Communications/Navigation Outage Forecasting System (C/NOFS), sensors, and decision aids to measure, specify, and predict the effects of ionospheric disturbances on the operation of DoD space systems.

(U) $8,742 Expanded the infrastructure at the High Frequency Active Auroral Research Program's (HAARP) Alaska facility through construction of a control center and installation of radio and optical diagnostic instruments. Used the HAARP facility to assess new concepts for imaging underground structures and to generate ionospheric irregularities and high frequency sources for evaluation of their efforts on military space communication, surveillance, and navigation systems.

(U) $24,351 Total

(U) FY 2000 ($ in Thousands)

(U) $2,930 Develop technologies for monitoring, predicting, and controlling space environmental conditions hazardous to DoD operational space systems. Leads to improved space system design, lifetime, and operational capabilities and aid in anomaly resolution. Demonstrate on-orbit hazardous radiation monitoring using miniaturized radiation sensing technology. Complete analysis of interaction of transmitted radio waves with radiation belts to assess potential for mitigation of hazardous radiation levels.

(U) $2,489 Develop real-time infrared background clutter code, target detection techniques, and decision aids for application to space-based surveillance, laser weapons, and countermeasure systems, including detection of low-observable targets. Complete all-altitude background clutter prediction

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 621010

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

(U) FY 2000 ($ in Thousands) Continued

code to extend capability to all lines-of-sight for space-based sensors to support design of next generation surveillance satellites. Complete measurements of the visibility of surrogate missile target signatures through clouds to support earliest warning of missile launches. Perform measurements of atmospheric optical turbulence in theaters of interest, and develop deployment aids and performance prediction models to minimize operational impacts of optical turbulence on laser weapons. Validate atmospheric turbulence effects on operational laser systems.

(U) $2,618 Provide forecasts of outages of communication and navigation systems caused by ionospheric scintillation. This forecasting capability will support the warfighter through situational awareness, allowing operators to use alternate links or systems in times of outages. Design, fabricate, and begin test of Communications/Navigation Outage Forecasting System (C/NOFS) planar Langmuir probe sensor for measuring ionospheric plasma levels. Begin design and fabrication of neutral wind sensor for C/NOFS.

(U) $9,897 Expand experimental research capabilities to characterize and control the physical processes produced in space via interactions with very high power radio waves at the High Frequency Active Auroral Research Program's (HAARP) Alaska facility. Focus experimental research to assess concepts for imaging underground structures, providing new radio wave propagation modes via the generation of irregularities in the ionosphere, and for characterizing the space weather environment under both normal and naturally disturbed conditions. Transfer the operations center at HAARP facility from a temporary to a modern control center. Install additional on- and off-site diagnostic instruments. Develop software to provide real-time access to diagnostic data via the internet. Support basic, exploratory development, and related applications.

(U) $2,474 Develop software to predict impacts of weather on precision-guided munitions (PGMs) and navigation and surveillance systems and to predict weather effects uniquely impacting DoD military operations. Develop and transition: target acquisition weather software which provides pilots with PGM target detection and lock-on ranges; night vision goggles (NVG) operations weather software which provides pilots with NVG detection ranges; weather automated mission planning software; infrared target-scene simulation software; and contrail and cloud forecasts software.

(U) $594 Develop algorithms to facilitate the military applications of spectral detection from space with emphasis on target detection and terrain classification. Hyperspectral imaging will allow improvements and new capabilities in target detection, terrain classification, and other surveillance tasks using space-based surveillance assets. Develop and validate atmospheric compensation and image analysis algorithms needed to exploit data collected by space-based hyperspectral sensors. Adapt backgrounds data processing system to support analysis and exploitation of data collected by space-based hyperspectral sensors to assess military utility of space-based hyperspectral sensors.

(U) $594 Perform measurements to quantify effects of current solar cycle maximum on Global Positioning System (GPS) navigation links, developing associated algorithm for specifying GPS link outages, and upgrade and validate ionospheric effects specification model. Specification of outages to GPS navigation links caused by ionospheric scintillation will allow operators to select alternate systems and will provide situational awareness of degraded accuracy of GPS. Improved and validated ionospheric specification provides increased situational awareness for GPS navigation

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

(U) FY 2000 ($ in Thousands) Continued

accuracy, communications outages, high frequency communications connectivity, errors and clutter on surveillance radars, and geo-location accuracy. Develop GPS outage nowcasting system using ground-based sensors and advanced algorithms that include effect of solar cycle. Develop assimilation model for ionospheric specification that uses real-time data from ground and space sensors and is upgradeable to a forecasting capability.

(U) $21,596 Total

(U) FY 2001 ($ in Thousands)

(U) $5,578 Develop technology to predict space environmental hazards, including solar disturbances and the earth's radiation belts, and the resultant disruptions of operational space systems. Develop technology to control hazardous space particle populations in extreme environments resulting from natural or adversary actions. Begin algorithm development for predicting solar disturbances impacting Air Force systems using all-sky images from new space-based detector system. Develop time-dose probability codes for improved space system design using data from new compact environment anomaly sensors. Begin detailed design of active space particle control experiment to demonstrate feasibility of space-based mitigation technologies.

(U) $4,211 Develop real-time infrared background clutter code, target detection techniques, and decision aids for application to space-based surveillance, laser weapons, and countermeasure systems, including detection of low-observable targets. Validate all-altitude background clutter prediction code using space-based sensor data. Complete deployment aids and performance prediction models to minimize operational impacts of atmospheric optical turbulence on laser weapons. Complete assessment of advanced missile detection technologies for earliest detection of theater ballistic missiles in boost phase.

(U) $6,428 Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting and space-based geo-location demonstrations. Communications/navigation outage forecasting will provide the warfighter with situational awareness and will permit operators to use alternate links or systems in times of outages. Complete the fabrication and test of instrumentation for communication/navigation outage forecasting system demonstration. Develop algorithms for correcting ionospheric effects on geo-location accuracy.

(U) $2,073 Develop key satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize acquired intentional and unintentional ground-based radio frequency and laser signals. Satellite threat warning technologies enable the warfighter to increase knowledge of possible hostile acts directed at mission critical satellites and aid in satellite anomaly resolution. Design key satellite protection technologies such as geo-location algorithms, radio frequency antennas, laser sensors, and miniaturized sensor and processing electronics for advanced satellite threat warning/attack reporting capabilities. Produce brassboard low-power and lightweight laser detector for bench-level testing.

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology
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(U) **A. Mission Description Continued**

(U) FY 2001 ($ in Thousands) Continued
(U) $18,290 Total

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0305160F, Defense Meteorological Satellite Program.
(U) PE 0601102F, Defense Research Sciences.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0603410F, Space Systems Environmental Interactions Technology.
(U) PE 0305111F, Weather Systems.
(U) PE 0603707F, Weather Systems Advanced Development.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology / PROJECT: 621011

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621011 Rocket Propulsion Technology	33,594	41,600	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

The technologies developed in this project are boost and orbit transfer, satellite maneuvering, and tactical and ballistic missile rocket propulsion. This project develops technologies and provides technology options for rocket propulsion advanced demonstrations, components, or subsystems. Technologies of interest are those which will improve reliability, operability, survivability, affordability, environmental compatibility, and performance of future space and missile launch sub-systems while reducing material, manufacturing, and support costs. Technology will be developed to reduce the weight and cost of components using new materials, improved designs, and improved manufacturing techniques. All efforts in this project are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) initiative; a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus rocket propulsion technology on national needs.

(U) FY 1999 ($ in Thousands)

(U)	$5,338	Continued to develop propellants with high-energy density for increased payload capability and lower cost space launch systems.
(U)	$3,146	Continued developing advanced combustion technology for improved performance and reliability of engines used in heavy lift vehicles.
(U)	$3,975	Developed advanced material technology for lightweight components and material property enhancement to decrease cost per pound to orbit particularly for reusable systems.
(U)	$10,858	Continued to develop propulsion component technology for reliable, safe, and low-cost boost and orbit transfer systems. Developed solid and hybrid rocket propulsion technologies for upperstage and air launched missiles; both of the latter are part of international agreements.
(U)	$7,000	Continued to develop technologies for long-term sustainment of strategic systems that also apply to the development of the next generation booster.
(U)	$3,277	Developed solar electric and solar thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer appropriate for large communication satellites and satellite constellations.
(U)	$33,594	Total

(U) FY 2000 ($ in Thousands)

(U)	$4,940	Continue to develop high-energy density and non-toxic propellants for increased payload capability. Continue to develop promising propellants to transition into future high-performance boost and orbit transfer propulsion systems. Optimize source for producing most favorable high-energy density additives and develop techniques to accurately measure concentrations of these additives to achieve cryogenic propellants that will maximize future propulsion system performance. Continue preparation for demonstrations and transitioning additives into system-ready applications. Continue to characterize, study/evaluate injector performance with application to combustor chamber/injector compatibility to

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology
	PROJECT: 621011

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

(U) FY 2000 ($ in Thousands) Continued

prevent damage to test and operational combustion.

(U) $2,801 Develop advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engines used in heavy lift space vehicles. These efforts will be accomplished by full-scale single element cold flow injector testing in windowed pressure vessels, using laser diagnostics, and will characterize injector performance and reliability at high pressures and the development of a subscale hot fire experiment apparatus. The result of these efforts will be a flexible, low-cost subscale screening of candidate injector designs while preserving chamber lifetime and reliability requirements and goals, thereby reducing the cost by 2X of injector development to industry and government.

(U) $3,539 Continue to develop advanced material technology for lightweight components and material property enhancements for use in launch and space systems. Complete development of low-cost, high temperature, non-erosive, lightweight, coated carbon-carbon ceramic and hybrid polymer components for use in solid rocket space launch and missile motors. Develop processes required to apply the materials to liquid-propellant rocket production for dramatic weight reductions and transition design and processing techniques for high-strength, low-weight engine and motor components (metal and non-metal).

(U) $14,175 Continue to develop propulsion component technology for reliable, safe, and low-cost boost and orbit transfer systems. Continue developing and demonstrating advanced materials for rocket engine components and continue to develop turbomachinery, combustion devices, and propellant management devices for solid and liquid rockets. Begin development of high temperature oxygen rich turbine materials for applications to oxidizer rich turbomachinery. Begin application of advanced Aluminum Metal Matrix Composite Materials to rocket turbomachinery housings and rocket structural hardware. Complete testing of a high-performance, low-cost cryogenic upper stage combustion chamber for an expander cycle application. Complete the testing of a high performance hydrostatically supported liquid hydrogen. Continue characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions. Continue to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Initiate development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Verify performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continue to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles.

(U) $3,845 Continue developing solar electric propulsion technologies for stationkeeping, repositioning, and orbit transfer appropriate for large communication satellites and satellite constellations. Continue Hall thruster development to higher powers to meet Air Force need for Low Earth Orbit/Geosynchronous Orbit orbit transfers using electric propulsion. Complete development of propulsion for Air Force small satellites (~100 kg). Continue development of propulsion systems for micro-satellites (<25 kg) needed for advanced Air Force imaging missions. Continue the design and test of solar thrusters and concentrators for future orbit transfer systems and satellite propulsion systems with longer life.

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 621011

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,300	Continue the development of analytical tools for prediction of propellant life. Complete development of tools to increase the capability to determine the age life of strategic systems and other solid rocket motors.
(U)	$2,000	Continue development of Post Boost Control Systems for sustainment of current Intercontinental Ballistic Missile (ICBM) fleet. Continue development of compatible case/liner, insulator, and case systems for higher combustion temperature propellants. Complete design and begin fabrication of solid rocket motor test hardware. Fabricate and test gas generator with non-refractory materials capable of withstanding high heat loads. Develop technologies that are readily available over the life of strategic systems, which may also be potentially advantageous to the development of the next generation strategic systems..
(U)	$1,200	Continue development of missile propulsion technology for sustainment of current ICBM fleet. Complete design solid rocket motor test hardware.
(U)	$2,800	Continue the development of propulsion technologies for the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program. Complete the design efforts to minimize weight while significantly improving heat transfer capability of a high pressure thrust chamber assembly.
(U)	$2,300	Continue development of tactical missile propulsion systems. Complete fabrication of hybrid tactical oxider system for integration into test hardware. The fuel system will be developed in coordination with Japan.
(U)	$1,700	Continue the development of advanced upperstage and orbit transfer propulsion. Complete the design and fabrication of advanced solar thermal propulsion test hardware. Integrate propulsion components with system level components in preparation for space flight.
(U)	$41,600	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Efforts transferred to PE 0602203F, Project 624847.
(U)	$0	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activites:

(U) PE 0602111N, Anti-Air/Anti-Surface Warfare Technology.

(U) PE 0602303A, Missile Technology.

(U) PE 0603302F, Space and Missile Launch Technology.

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	PROJECT: 621011

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

(U) PE 0603311F, Ballistic Missile Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 623326

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
623326 Lasers and Imaging Technology	15,614	19,039	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts required for Air Force missions. Technologies researched include advanced, short-wavelength laser devices for application as illuminators and imaging sources as well as advanced optical imagers for target identification and assessment. Laser technologies will be studied for their utility in aimpoint selection, target maintenance, and damage assessment. Additionally, high power solid state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, techniques for laser target vulnerability assessments, and nonlinear optical processes and techniques are developed.

(U) FY 1999 ($ in Thousands)

(U)	$1,025	Developed generic, high energy laser technologies for applications such as illuminators and use in wavelength-specific military missions.
(U)	$3,040	Developed long-range optical technologies for increased resolution, characterization, and data fusion to support missions such as space object identification and ground target identification from space.
(U)	$1,486	Investigated and developed advanced laser transceiver systems, and advanced data collection and processing algorithms for light detection and ranging (LIDAR) remote sensing of atmospheric properties, chemical agents, and target effluents.
(U)	$2,854	Developed laser source and target coupling technology for next-generation high-payoff applications such as damage/destroy countermeasures against infrared imaging seekers.
(U)	$588	Investigated and developed nonlinear optics (NLO) technologies to support imaging and beam projection technologies.
(U)	$3,471	Developed high power solid state lasers/arrays at alternate wavelengths for applications such as forward looking infrared (FLIR) systems and infrared (IR) missile jamming, chemical agent detection, illuminators, efficient semiconductor laser array pumping modules, and disrupt/jam countermeasures against near-term threats.
(U)	$3,150	Developed spatially coherent lasers for tactical/unmanned air vehicle and space applications such as designation/illumination and remote sensing which require higher power sources.
(U)	$15,614	Total

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

(U) FY 2000 ($ in Thousands)

(U)	$1,892	Develop long-range optical technologies for increased resolution characterization and data fusion applications. Lightweight deployable mirrors that are the critical basis for these applications will be demonstrated at the one-meter class size in the laboratory with holographic correction integrated into the test system. Issues associated with deployment schemes for the membrane mirrors will also be addressed.
(U)	$645	Continue development of nonlinear optics technologies to support imaging and beam projection applications such as relay mirrors. Nonlinear optics allows non-mechanical beam cleanup and mirror corrections with greatly decreased complexity. Laboratory efforts will concentrate on component development to obtain increased efficiency and resolution for scaling to large and higher power devices. Small scale tests and demonstrations of relay mirror components will be performed.
(U)	$3,633	Develop high power chemical and all-gas phase iodine laser technologies for applications such as directed energy weapons and illuminators. Demonstrate high energy, frequency conversion of chemical oxygen iodine laser (COIL) for potential airborne laser illuminator applications. Complete parallel technology efforts for the repetitively pulsed COIL illuminator. Evaluate these results and assess the potential of this technology for an alternate, scalable airborne laser illuminator. Improve efficiency and reduce weight of COIL devices for airborne laser missions. Develop with proof of principle experiments advanced COIL technologies which include iodine atom production with electric discharges and iodine atom production through chemical reactions. Evaluate, theoretically and experimentally, advanced ejector nozzle concepts which improve the pressure recovery potential of COIL devices. Demonstrate a 100-watt subsonic all-gas phase chemical iodine laser.
(U)	$4,229	Develop laser source, beam control, and target coupling technologies to counter current and next generation air-to-air and surface-to-air missile threats to aircraft platforms. Develop compact, reliable, high-power, solid state laser technologies at mid-infrared wavelengths. Investigate new laser materials needed to reduce the size and weight (currently 40 pounds, one cubic foot) of solid state laser based infrared counter measure demonstrator. Develop a mid-infrared laser with the beam brightness needed for platforms with high infrared signatures. Investigate novel materials effects associated with plasma/spark and ultra-fast lasers for countering focal plane array seekers. Investigate propagation, beam control, and imaging technologies related to ultra-fast lasers.
(U)	$6,640	Develop low-cost, scalable, high power solid state laser architectures by integrating doped fiber lasers with diode-laser pump sources for directed energy applications such as unmanned aerial vehicle designators/imagers and next generation weapons applications such as space-based lasers and airborne lasers. Develop promising fiber laser technologies exhibiting attributes that will enable applications that require laser mobility such as low-cost, high efficiency (approaching 25%), compactness (10 milliwatts per cubic centimeter), and scalability. Develop integration technologies necessary for demonstration of power at 100s of Watts.
(U)	$800	Develop relay mirror concepts and pursue development of large optics and their optical compensation for large mirror space-based applications.
(U)	$1,200	Develop advanced laser remote optical sensing technology to support advanced standoff detection requirements for measurement and signature intelligence (MASINT), bomb damage assessment, target characterization, weapons of mass destruction, and theater intelligence, surveillance,

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

(U) FY 2000 ($ in Thousands) Continued

and reconnaissance. Complete Phase I experiments for frequency agile heterodyne receiver development. Establish transmitter/receiver requirements for unmanned aerial vehicle applications.

(U) $19,039 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Program transferred to PE 0602605, Project 624866.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603319F, Airborne Laser Demonstrator.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)								DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology							PROJECT: 624846

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624846 Spacecraft Payload Technologies	0	0	8,395	11,785	10,499	9,866	13,918	Continuing	TBD

(U) **A. Mission Description**

This project develops advanced technologies for spacecraft payload operations. The project focuses on three primary areas: (1) development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; (2) research and improvement of advanced space data generation and exploitation technologies, including infrared, Fourier Transform hyperspectral imaging, and satellite antenna subsystem technologies; and (3) creation of high fidelity space simulation models to support space-based surveillance and space asset protection research and development for the warfighter.

(U) FY 1999 ($ in Thousands)

(U) $0 Previously accomplished in Project 628809.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Previously accomplished in Project 628809.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $2,872 Develop advanced space infrared technologies, hardened focal plane detector arrays, and quantum well infrared photodetectors (QWIPs) to enable acquisition, tracking, and discrimination of hot targets, as well as 'cold body' targets such as decoys, satellites, and midcourse warheads. Design low temperature multicolor and low background infrared detectors and QWIPs, higher temperature infrared detectors, and higher performance radiation hardened detectors. Continue development of two-, three-, and multi-color detectors, and tunable and broadband gratings. Develop longer wavelength infrared detectors, mid-wavelength infrared detectors for higher temperature operation, and infrared detectors with optimal background-limited performance for stressing, low photon noise, space backgrounds.

(U) $812 Develop hyperspectral imaging data exploitation methodologies for military remote sensing applications with the Fourier Transform HyperSpectral Imager (FTHSI). The FTHSI payload will demonstrate the capability of providing the warfighter data concerning terrain categorization, feature extraction, geological formation mapping, and trafficability within an area observed from space. Complete analysis of the hyperspectral imaging data received from the FTHSI payload. Complete assembly of data images for target identification and image evaluation for commercial and military purposes.

(U) $3,878 Continue to develop technologies for space-based payload components such as low power, high performance, radiation hardened electronic devices, micro-electro-mechanical system (MEMS) devices, and advanced electronics packaging for next generation high performance space

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

(U) FY 2001 ($ in Thousands) Continued

electronics. Goals are decreased feature size, improved scalability, decreased size/weight /power, and radiation hardness. Continue characterizing microelectronic materials and internal structures and apply results to improve fabrication processes. Design next-generation low-power, quantum-sized devices such as high-speed, radiation-hardened, low-power alternatives for space applications. Fabricate improved radiation-hardened nonvolatile memories, processors, sensors, and analog devices. Fabricate ultra-high density, low-power MEMS device for evaluation in space environment. Fabricate smaller, lighter, lower power electronics packaging.

(U) $833 Continue to develop modeling, simulation, and analysis (MS&A) tools for space-based surveillance systems, optical/infrared imaging space systems, large deployable space optics, and distributed satellite architecture payloads. MS&A tools provide data and validate research and development systems engineering level technology trade off decisions for space-based missions/campaign level assessments and for intelligent satellite system testbeds. Integrate simulation architecture models using visual programming codes and commercial-off-the-shelf software to enhance fidelity of satellite constellation-level modeling. Interconnect satellite toolkit, spacecraft simulation toolkit, and weather and space simulation software into one framework. Demonstrate multi-satellite constellations and distributed satellite cluster models in simulation testbed.

(U) $8,395 Total

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

Not Applicable.

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

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology	PROJECT: 625797

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
625797	Advanced Weapons and Survivability Technology	14,730	18,530	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

High power microwave (HPM) and other unconventional weapon concepts using innovative technologies are explored in this project. Technologies that support a wide range of Air Force missions such as suppression of enemy air defenses, command and control warfare, and vehicle self-protection are developed. This project provides for vulnerability assessments of representative U.S. strategic and tactical systems to directed energy weapons, directed energy weapon technology assessment for specific Air Force missions, and directed energy weapon lethality assessments against foreign targets. In addition to directed energy weapon threats, this project conducts assessments of specific space environmental (natural and man-made) effects on space systems and develops hardening technologies and methodologies.

(U) FY 1999 ($ in Thousands)

(U) $6,048 Developed generic advanced weapon technologies that support multiple Air Force applications such as command and control warfare and suppression of enemy air defenses.

(U) $3,979 Assessed effects/lethality of directed energy weapon technologies against representative air and ground military systems.

(U) $1,397 Developed HPM technologies that will support applications such as command and control warfare.

(U) $1,583 Developed HPM technologies that will support applications such as suppression of enemy air defenses.

(U) $1,723 Assessed the vulnerability of various space assets to threats such as solar radiation, space debris, and directed energy weapons.

(U) $14,730 Total

(U) FY 2000 ($ in Thousands)

(U) $1,498 Investigate technologies for developing innovative HPM sources to support multiple Air Force applications such as command and control warfare and suppression of enemy air defenses. Conduct field test for single shot HPM device. Design, build, and test candidate repetitive device. Obtain experimental data to improve anchoring of existing computer models.

(U) $1,977 Assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. Investigate susceptibility of current fighter technologies and provide results to developers. Complete lethality assessment studies on selected military relevant targets. Continue to identify HPM protection requirements on large and small aircraft.

(U) $1,800 Develop wideband HPM technologies that will support command and control warfare applications. Research methods to enhance HPM source technology such as power throughput for solid state switches and high repetition rates for high pressure gas switches. Extend the current capabilities of electromagnetic modeling and simulation codes to better predict the electromagnetic environment induced in more complex geometric structures.

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,646	Develop narrowband high power microwave (HPM) technologies that will support suppression of enemy air defenses. Develop models of HPM effects for military electronic targets of interest. Validate and verify the models through measurement and computer simulation. Assess predictability of models. Determine those HPM effects parameters enhanced through repetitively pulsing. Design and develop component technologies - prime power, pulsed power, sources, and antennas - for repetitively pulsed systems.
(U)	$5,561	Investigate HPM technologies that will support offensive and defensive advanced airborne tactical applications made possible based on increased power available on future aircraft. Establish the technical feasibility of the concepts that are emerging from the Directed Energy Applications in Tactical Aircraft Combat (DE ATAC) study by gathering the appropriate HPM effects data and investigating the feasibility of the source technology specification set for each concept. Investigate a wide range of technology alternatives and lethality parameters and use this data in a trade off study to select the most promising concepts that optimizes performance, cost, and schedule.
(U)	$571	Investigate Active Denial Technology applications for Agile Combat Support. Develop high specific power, millimeter-wave sources using computer simulation and experiments.
(U)	$1,977	Assess the vulnerability of six U.S., NATO, and foreign satellites to the effects of directed energy weapons, primarily high energy lasers and HPMs. Previous assessments will be updated, as required, based on new intelligence information. Other directed energy effects will be included as appropriate.
(U)	$2,500	Evaluate radio frequency threats to U.S. infrastructure.
(U)	$18,530	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Program transferred to PE 0602605, Project 624867.
(U)	$0	Total

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

Not Applicable.

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

(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.

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(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602601F Space Technology / PROJECT: 628809

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
628809 Spacecraft Vehicle Technologies	33,881	45,256	31,002	31,064	33,603	36,604	37,749	Continuing	TBD

(U) **A. Mission Description**

This project focuses on seven major space and missile technology areas: spacecraft platforms (e.g., structures, controls, power, and thermal management); space-based payload (e.g., survivable electronics); satellite control (e.g., software for autonomous distributed satellite formation flying, signal processing, and control); modeling and simulation of space-based systems; satellite protection technologies (e.g., space environment effects, debris prediction, and threat warning/attack reporting); microsatellite technologies; and integrated experiments of advanced technologies for transition to planned systems (e.g., payload/platform/launch vehicle merging).

(U) FY 1999 ($ in Thousands)

(U) $3,862 Developed technologies for space platform subsystems such as cryocoolers, space vehicle thermal management, compact, high efficiency solar power cells, lightweight batteries, and innovative power generation and storage concepts.

(U) $3,796 Developed technologies for space platform structures such as spacecraft structural controls for vibration suppression, multifunctional structures, and lightweight composite satellite and launch vehicle structures.

(U) $3,199 Developed technologies for space-based payload subsystems such as advanced infrared sensors, advanced hardened focal plane detector arrays, and antenna architectures for a space-based radar Air Moving Target Indication (AMTI) capability.

(U) $4,023 Developed technologies for space-based payload components such as low power, high performance, radiation hardened electronic devices, micro-electro-mechanical systems (MEMS) devices, and advanced electronics packaging.

(U) $1,862 Developed technologies and software for autonomous distributed satellite formation flying, signal processing, and control. Developed modeling and simulation applications for space-based surveillance systems.

(U) $1,160 Completed space environmental effects migration and space debris prediction satellite protection technology development efforts. Delivered mission operations and orbit control software, and orbit and orbital debris analyses for use in operations planning and operation of satellite flight demonstrations.

(U) $8,891 Developed ground and small satellite integration technologies for deployable large aperture optical arrays and spaceborne platforms with advanced bus components and standardized interfaces for testing and demonstrating revolutionary high payoff mission hardware and mission-enabling technologies for space and near-space experiments. Launched the MightySat I vehicle and demonstrated operation of the integrated platform and stand-alone experimental payloads.

(U) $3,203 Developed microsatellite (10-100kg) technologies and integrated microsatellite technology concepts for collaborative microsatellite constellations to support applications such as near-earth object inspection.

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology
	PROJECT 628809

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

(U) FY 1999 ($ in Thousands) Continued

(U)	$3,885	Conducted Phase III of the Terabit fiber optic technology program.
(U)	$33,881	Total

(U) FY 2000 ($ in Thousands)

(U)	$5,780	Develop technologies for advanced space platform subsystems such as cryocoolers, space vehicle thermal management, compact, high efficiency solar power cells, lightweight batteries, and innovative power generation and storage concepts. Advanced space platform subsystems will have more available power, longer operational lifetimes and increased operational range, and will be lighter and more affordable than current subsystems. Start development of 35% efficient solar cells and polymer batteries. Continue development of thin film solar cells, lithium-ion batteries, and thermal to electric conversion cells. Continue development of non-electrochemical energy storage techniques.
(U)	$7,166	Develop technologies for advanced space platform structures such as spacecraft structural controls for vibration suppression, multifunctional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Whole spacecraft and launch vibration suppression will enable precision pointing and sensing systems. Multifunctional and composite structures, with a higher level of integration and standardized interfaces will be reusable, lighter, and more affordable. Deployable large aperture optical arrays will enable continuous space-based battlefield surveillance. Design vibration suppression systems for primary and secondary payloads. Continue development of design and integration techniques for multifunctional structures and integration of multi-chip modules into spacecraft bus. Develop and fabricate component subsystems for deployable large aperture optical arrays.
(U)	$4,367	Develop technologies for space-based payload components such as low power, high performance, radiation hardened electronic devices, micro-electro-mechanical system (MEMS) devices, and advanced electronics packaging for next generation high performance space electronics. Goals are decreased feature size, improved scalability, decreased size/weight/power, and radiation hardness. Characterize microelectronic materials and internal structures to improve fabrication processes. Characterize next-generation low-power, quantum-sized devices for possible space application. Design devices such as improved radiation-hardened nonvolatile memories, processors, sensors, and analog devices. Design ultra-high density, low-power MEMS device for evaluation in space environment. Design smaller, lighter, lower power electronics packaging.
(U)	$1,807	Develop modeling, simulation, and analysis (MS&A) tools for space-based surveillance systems, optical/infrared imaging space systems, large deployable space optics, and distributed satellite architecture payloads. MS&A tools provide data and validate research and development systems engineering level technology trade off decisions for space-based missions/campaign level assessments and for intelligent satellite system testbeds. Integrate simulation architecture models using visual programming codes and commercial-off-the-shelf software to enhance fidelity of satellite constellation-level modeling.
(U)	$3,232	Develop key satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize acquired intentional and unintentional ground-based radio frequency and laser signals. Satellite threat warning technologies enable the warfighter to increase

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology
	PROJECT 628809

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

(U) FY 2000 ($ in Thousands) Continued

knowledge of possible hostile acts directed at mission critical satellites and aid in satellite anomaly resolution. Characterize technologies to determine whether hostile acts or the space environment are affecting critical warfighter mission satellites, discriminating between environmental/radiation effects, radio frequency interference, and laser signals. Develop methodology for determining signal information necessary for source evaluation and nature.

(U) $6,420 Develop ground support and small satellite integration technologies for spaceborne platforms with advanced bus components and standardized interfaces for testing and demonstrating revolutionary high payoff mission hardware and mission-enabling technologies for space and near-space experiments. The small experimental satellites provide an affordable, adaptable space platform as an orbiting 'lab-bench' to test high payoff, high risk mission hardware and reduce risk of further development by demonstrating proof-of-concept. Launch the MightySat II.1 vehicle and demonstrate operation of the integrated platform and stand-alone experimental payloads.

(U) $7,110 Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. This new class of small, highly capable satellites can reduce life cycle costs by as much as 90 percent and enables new space missions and architectures such as reconfigurable, multi-mission microsatellite formations for sparse aperture sensing, precise geolocation, secure communications, near-earth object inspection, and remote satellite servicing. Complete development of first microsatellite in the series to test autonomous microsatellite operations. Design microsatellite for a three unit constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing

(U) $4,440 Develop hyperspectral imaging technologies for space-borne assets to provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Develop Warfighter-1 target detection and terrain classification algorithms and perform on-orbit evaluation of the hyperspectral sensor and ground operations. Complete integration and testing of data processing and exploitation algorithms for the Fourier Transform Hyperspectral Imaging sensor and validate results with baseline data. Develop an advanced hyperspectral processing and data exploitation center for developing and validating hyperspectral imaging algorithms.

(U) $4,934 Continue the terabit technology program, focusing on increasing the channel capability and improving the bit error rate. Extend the range of the wireless 28GHz link.

(U) $45,256 Total

(U) FY 2001 ($ in Thousands)

(U) $4,875 Continue to develop technologies for advanced space platform subsystems such as cryocoolers, space vehicle thermal management, compact, high efficiency solar power cells, lightweight batteries, and innovative power generation and storage concepts. Advanced space platform subsystems will have more available power, longer operational lifetimes and increased operational range, and be lighter and more affordable than current subsystems. Improve accuracy of cryocooler modeling tools, and identify mechanisms that limit operational life and degrade cryocooler

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	PROJECT 628809

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

(U) FY 2001 ($ in Thousands) Continued

subsystem performance. Continue development of 35% efficient solar cells, thin film solar cells, thermal to electric conversion, and lithium ion and polymer batteries.

(U) $6,176 Continue to develop technologies for advanced space platform structures such as spacecraft structural controls for vibration suppression, multifunctional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Whole spacecraft and launch vibration suppression will enable precision pointing and sensing systems. Multifunctional and composite structures, with a higher level of integration and standardized interfaces will be reusable, lighter, and more affordable. Deployable large aperture optical arrays will enable continuous space-based battlefield surveillance. Develop and complete vibration suppression algorithms. Continue development of multifunctional structures and complete integration techniques. Integrate and ground test component subsystems of deployable large aperture optical arrays to identify performance of deployable optics.

(U) $2,346 Continue to develop ground support and small satellite integration technologies for spaceborne platforms with advanced bus components and standardized interfaces for testing and demonstrating revolutionary high payoff mission hardware and mission-enabling technologies for space and near space experiments. The small experimental satellites provide an affordable adaptable space platform as an orbiting 'lab-bench' to test high payoff, high risk mission hardware and reduce risk of further development by demonstrating proof-of-concept. Conduct MightySat II.1 mission operations and analyze platform and stand-alone experiment operations.

(U) $17,605 Continue to develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. This new class of small, highly capable satellites can reduce life cycle costs by as much as 90 percent and enables new space missions and architectures such as reconfigurable, multi-mission microsatellite formations for sparse aperture sensing, precise geolocation, secure communications, near-earth object inspection, and remote satellite servicing. Fabricate and test prototype microsatellite, and begin fabrication of a three flight unit constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing.

(U) $31,002 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602102F, Materials.

(U) PE 0603302F, Space and Missile Rocket Propulsion.

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

(U) PE 0603311F, Ballistic Missile Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603410F, Space Systems Environmental Interactions.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602602F Conventional Munitions

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	39,106	37,892	45,223	45,350	47,597	48,985	50,450	Continuing	TBD
622068	Advanced Guidance Technology	15,706	12,454	0	0	0	0	0	Continuing	TBD
622502	Ordnance Technology	23,400	25,438	45,223	45,350	47,597	48,985	50,450	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: Beginning in FY 2001, Project 622068 is combined with Project 622502.

(U) **A. Mission Description**

This program investigates, develops and establishes the technical feasibility and military utility of advanced ordnance and guidance technologies for conventional air-launched munitions to defeat mobile surface targets, high value fixed surface targets, and airborne targets. The program includes development of: (1) conventional ordnance technologies including warheads, fuzes, explosives, munition integration, and conventional weapon lethality and vulnerability assessments; and (2) advanced guidance technologies including seekers, navigation and control, target detection and identification algorithms, and simulation assessments for affordable precision conventional weapons. Payoffs from this technology investment are more affordable and effective conventional weapons that can be used against the full target spectrum in normal and adverse weather and battlefield conditions while reducing collateral damage.

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	40,386	42,205	46,840	
(U)	Appropriated Value	41,529	38,205		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1,143	-61		
	b. Small Business Innovative Research	-658			
	c. Omnibus or Other Above Threshold Reprogram		-126		

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

	FY 1999	FY 2000	FY 2001	Total Cost
d. Below Threshold Reprogram	-403			
e. Rescissions	-219	-126		
f. Other				TBD
(U) Adjustments to Budget Years Since FY 2000 PBR			-1,617	
(U) Current Budget Submit/FY 2001 PBR	39,106	37,892	45,223	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602602F Conventional Munitions		PROJECT: 622068

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622068 Advanced Guidance Technology	15,706	12,454	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project investigates, develops, and evaluates conventional munition advanced guidance technologies to establish technical feasibility and military utility. This project includes development of advanced guidance including terminal seekers, navigation and control, target detection and identification algorithms, and guidance and control simulations. Project payoffs include: adverse weather and 'launch and leave' precision guidance capability; increased number of kills per sortie; increased pilot and aerospace vehicle survivability; improved weapon reliability; more affordable weapons; reduced collateral damage; and increased effectiveness of conventional weapons.

(U) FY 1999 ($ in Thousands)

(U) $3,888 Investigated and developed advanced component technology for low-cost, precision, adverse weather autonomous seekers that will allow increased standoff launch ranges, reduced pilot workload, and improved aerospace vehicle survivability.

(U) $8,133 Investigated and developed advanced navigation and control technologies for current and future munitions that will decrease pilot workload and increase survivability.

(U) $1,780 Investigated and developed advanced optical and digital processors and advanced target detection/classification/identification algorithms for autonomous seekers that will provide the basis for smart autonomous weapons that will decrease pilot workload and increase survivability.

(U) $1,905 Investigated and developed detailed six degree of freedom and hardware-in-the-loop simulations and models for the analysis of guided munitions and their components to enable requirement studies, design iteration/evaluation, and experiment risk reduction. These advanced simulations will shorten development time, reduce development cost, and provide more effective munitions that will reduce cost per kill.

(U) $15,706 Total

(U) FY 2000 ($ in Thousands)

(U) $4,067 Investigate and develop advanced component technology for low-cost, precision, adverse weather autonomous seekers that will allow increased standoff launch ranges, reduced pilot workload, and improved aerospace vehicle survivability.

(U) $4,611 Investigate and develop advanced navigation and control technologies for current and future munitions that will decrease pilot workload and increase survivability.

(U) $2,076 Investigate and develop advanced optical and digital processors and advanced target detection/classification/identification algorithms for autonomous seekers that will provide the basis for smart autonomous weapons that will decrease pilot workload and increase survivability.

(U) $1,700 Investigate and develop detailed six degree of freedom and hardware-in-the-loop simulations and models for the analysis of guided munitions

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

(U) FY 2000 ($ in Thousands) Continued

and their components to enable requirement studies, design iteration/evaluation, and experiment risk reduction. These advanced simulations will shorten development time, reduce development cost, and provide more effective munitions that will reduce cost per kill.

(U) $12,454 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 622502.

(U) $0 Total

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

Not Applicable.

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

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602602F Conventional Munitions

PROJECT: 622502

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
622502 Ordnance Technology	23,400	25,438	45,223	45,350	47,597	48,985	50,450	Continuing	TBD

(U) A. Mission Description

This project investigates, develops, and evaluates conventional munition technologies to establish technical feasibility and military utility. Included in this project are technologies for advanced conventional weapon dispensers, submunitions, safe and arm devices, fuzes, explosives, conventional warheads, and weapon airframe and carriage technology. It also assesses the lethality and effectiveness of current and planned conventional weapons technology programs and assesses target vulnerability. This project also includes development of advanced conventional munition guidance including terminal seekers, navigation and control, target detection and identification algorithms, and guidance/control simulations. The payoffs include: improved storage capability and transportation safety of fully assembled weapons; improved non-nuclear warhead and fuze effectiveness; improved submunition dispensing; low-cost airframe/subsystem components and structures; reduced aerospace vehicle/weapons drag and radar signature; accurate long-range navigation and control, affordable precision terminal seekers; and advanced digital simulation capabilities.

(U) FY 1999 ($ in Thousands)

(U)	$6,512	Investigated and developed high fidelity analytical tools including computational mechanics model for calculating weapons effects and assessing lethality and vulnerability. Quantified and characterized the coupling of destructive energy into the target, and the means to translate that information into advanced analytical methods for predicting weapon effectiveness. These tools will reduce development time and cost while providing more effective munitions to the Air Force.
(U)	$2,238	Investigated and developed new affordable explosives that provide higher performance and lower sensitivity for development of advanced munitions that will provide more effective munitions to the Air Force and reduce cost per kill.
(U)	$3,332	Investigated and developed fuze, and safe and arm technology for advanced munitions that will reduce cost and provide increased weapons supportability, safety, and performance for the Air Force.
(U)	$4,695	Investigated and developed advanced control and carriage technologies for integrated ordnance packages with enhanced lethality for current and future air launched weapons that will provide increased accuracy, lethality, and loadout while improving aircrew survivability and decreasing pilot workload.
(U)	$6,623	Investigated and developed advanced warhead development technologies and advanced kill mechanisms to enhance munitions lethality that will allow reduced sortie rates and lower cost per kill.
(U)	$23,400	Total

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602602F Conventional Munitions — PROJECT: 622502

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

(U) FY 2000 ($ in Thousands)

(U)	$6,625	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.
(U)	$2,452	Investigate and develop more affordable explosives that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. This technology will allow the Air Force and Navy to develop safer, less expensive explosive fills for inventory and future weapons.
(U)	$5,761	Investigate and develop advanced fuze and safe/arm technologies for air-delivered munitions to enhance lethality through precise selection of burst height either at, above, or below the surface. These technologies will increase weapon safety and tactical performance while simultaneously decreasing procurement costs and system supportability requirements.
(U)	$4,603	Investigate and develop advanced air-delivered munition control and carriage technologies for integrated ordnance packages in order to enhance weapon lethality. These technologies will contribute to increased weapon loadout on strike aircraft and increased sortie effectiveness.
(U)	$5,997	Investigate and develop advanced warhead kill mechanisms to enhance air-delivered munition lethality. These advanced kill mechanisms allow a smaller warhead to have the effectiveness of a larger one, thereby enabling the development of smaller munitions with corresponding increases in strike aircraft loadout and sortie effectiveness.
(U)	$25,438	Total

(U) FY 2001 ($ in Thousands)

(U)	$6,736	Investigate and develop high fidelity analytical tools such as computational mechanics models for predicting weapons effects and assessing target vulnerability which will reduce warhead development time and cost, thereby providing more effective munitions to the Air Force. Investigate demilitarization concepts for the 1000-pound unitary general purpose bomb. Develop a high level model, including models of geological structures, of the processes involved in predicting penetrator performance. Investigate innovative kill mechanisms for defeating Weapons of Mass Destruction (WMD). Transition selected high fidelity analytical tools to weapon designers in DoD and industry.
(U)	$3,316	Investigate and develop more efficient affordable explosives that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. This technology will enable the Air Force and Navy to develop safer, less expensive explosive fills for inventory and future weapons. Complete warhead testing and evaluation of the reformulated MNX-221 explosive to verify improved density and reduced ignition sensitivity. Continue development of a new class of energetic materials based on nano-scale and microscale particles, with initial emphasis on improving handling safety. Initiate development of innovative explosives technologies that allow concentration of the explosive effects on the target, thereby reducing potential collateral damage.
(U)	$5,343	Investigate and develop advanced fuze, including safe and arm, technologies for air-delivered munitions to enhance lethality through precise selection of burst height either at, above, or below the surface to increase weapon safety and tactical performance while simultaneously

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions	PROJECT 622502

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

(U) FY 2001 ($ in Thousands) Continued

decreasing procurement costs and system supportability requirements. Investigate MicroElectro Mechanical System (MEMS) technology concepts for safe and arm components and fuze accelerometers. Develop a low threshold energy shock hardened detector for multi-event hard target fuze capable of 4000 feet/second impacts. Initiate testing of the multi-event hard target fuze.

(U) $5,317 Investigate and develop advanced air-delivered munition control and carriage technologies for integrated ordnance packages in order to enhance weapon lethality. These technologies will contribute to increased weapon loadout on strike aircraft and increased sortie effectiveness. Design, fabricate, and test submunitions for survivability during high mach number dispense. Begin ground testing of technologies that will enable the development of a fast reaction weapon to engage and destroy time-critical targets. Investigate emerging military and commercial communication architectures to determine if they can be utilized to improve munitions planning, performance, and deployment.

(U) $7,491 Investigate and develop advanced warhead kill mechanisms to enhance air-delivered munition lethality and enable the development of smaller munitions, with effectiveness similar to current inventory weapons, which would result in a corresponding increase in strike aircraft loadout and sortie effectiveness. Perform subscale and full-scale experiments of several candidate payload technologies to determine their effectiveness to neutralize, deny, or destroy specially formulated chemical/biological targets. Continue testing and characterizing the effectiveness of tantalum warheads against targets which simulate the full spectrum of ground mobile threats. Complete in-house research on the effects of explosives on chemical/biological containers to determine residual collateral damage effects to areas surrounding the target area. Complete research on explosive compressor generators as novel non-lethal kill mechanisms.

(U) $5,020 Investigate and develop advanced component technologies for lower cost, enhanced precision, adverse weather, and autonomous seekers for air-delivered munitions that will enable the development of next generation seekers that will increase a weapon's kill probability, reduce pilot work load, and enhance sortie effectiveness. Design and fabricate the subsystems for a gimbaless laser radar with total electronic scanning. Develop and validate advanced algorithms that identify mobile targets using their unique external components, such as guns or antenna.

(U) $6,447 Investigate and develop advanced navigation and control technologies for air-delivered munitions that will allow a more efficient flight path to the target, increase standoff ranges, enhancing strike aircraft effectiveness and survivability. Includes investigation of guidance/control technologies deemed 'revolutionary' that may provide significantly enhanced capability to locate and engage a moving or partially hidden target. Develop a low-cost multisensor navigation sensor using MicroElectro Mechanical System (MEMS) technology that can meet tactical grade performance in a low-cost package. Fabricate brassboard components and begin integration of the brassboard intended for field testing. Integrate brassboard components of advanced Global Positioning System to begin laboratory bench tests.

(U) $2,992 Investigate and develop advanced optical and digital processors and target detection/classification/identification algorithms for improved seeker performance to allow greater air-delivered weapon autonomy that will further deny an enemy's ability to hide or camouflage a target while decreasing the pilot's workload. Complete the phenomenology studies required to validate the performance enhancements to be realized with a

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602602F Conventional Munitions — PROJECT: 622502

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

(U) FY 2001 ($ in Thousands) Continued

dual-mode millimeter wave and infrared seeker. Develop the analytical tools required to enhance the development, test, and analysis of advanced seekers and target detection and identification processors. Investigate optical processing and components technologies that increase sensor field of view, tracking rates, and target resolution.

(U) $2,561 Investigate and develop detailed six degree of freedom and hardware-in-the-loop simulations and models to analyze guided munitions or their components to enable requirements studies, design iteration/evaluation, and experiment risk reduction that will shorten development time, reduce development cost, and provide more effective munitions. Develop tactical scene generation capability to produce reuseable government-owned acquisition and targeting software algorithms for guided munition seekers. Complete the analysis of air-to-surface terminal fuzing. Develop in-house personal computer-based simulations for analysis of advanced weapon concepts.

(U) $45,223 Total

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

Not Applicable.

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

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	0	0	32,337	32,017	36,279	36,236	36,544	Continuing	TBD
624866	Lasers & Imaging Technology	0	0	16,018	14,953	18,847	19,207	19,098	Continuing	TBD
624867	Advanced Weapons & Survivability Technology	0	0	16,319	17,064	17,432	17,029	17,446	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: Starting in FY 2001, the two projects in this PE were moved in toto from PE 0602601F.

(U) **A. Mission Description**

This is the Applied Research program for directed energy technologies for the Air Force Research Laboratory. In lasers, this PE examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts required for Air Force missions. Technologies researched include high power solid-state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, techniques for laser target vulnerability assessments, and nonlinear optics processes and techniques. In advanced weapons, this PE examines high power microwave and other unconventional weapon concepts using innovative technologies such as compact toroids. This also provides for vulnerability assessments of representative U.S. strategic and tactical systems to directed energy weapons, directed energy weapon technology assessment for specific Air Force missions, and directed energy weapon lethality assessments against foreign targets.

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	0	0	0	
(U)	Appropriated Value	0	0		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research				

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY

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

	FY 1999	FY 2000	FY 2001	Total Cost
c. Omnibus or Other Above Threshold Reprogram				
d. Below Threshold Reprogram				
e. Rescissions				
f. Other				
(U) Adjustments to Budget Years Since FY 2000 PBR			32,337	
(U) Current Budget Submit/FY 2001 PBR	0	0	32,337	TBD

(U) Significant Program Changes:
Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)			DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY		PROJECT: 624866

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624866 Lasers & Imaging Technology	0	0	16,018	14,953	18,847	19,207	19,098	Continuing	TBD

(U) **A. Mission Description**

This project examines the technical feasibility of moderate to high power lasers, associated optical components, and long-range optical imaging concepts required for Air Force missions. High power solid state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, laser target vulnerability assessment techniques, and nonlinear optical processes and techniques are developed. Advanced, short-wavelength laser devices for application as illuminators and imaging sources as well as advanced optical imagers for target identification and assessment are developed. Laser technologies are studied for their utility in aimpoint selection, target maintenance, and damage assessment.

(U) FY 1999 ($ in Thousands)

(U) $0 This work was performed in PE 0602601F/Project 623326. The funding was $15.614 million.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 This work is performed in PE 0602601F/Project 623326. The funding is $19.039 million.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $1,925 Develop long-range optical technologies for increased resolution, characterization, and data fusion applications. Lightweight membrane mirrors issues for scaling to very large size (~ 10-meter mirrors) will be explored. Issues associated with producing the mirror close to final curvature will be addressed and demonstrated on 0.5 meter class mirror with holographic correction.

(U) $645 Develop and field test nonlinear optics technologies to support beam projection and imaging applications associated with large aperture lightweight optics. The nonlinear optics components that provide optical compensation for beam projection and imaging technology will be scaled up in size and integrated into laboratory/field tests and demonstrations. Additional improvements and techniques to extend the wavelength regime and reduce the number of such components will be pursued.

(U) $2,951 Develop high power chemical and all gas iodine laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications. Perform engineering validation of advanced chemical oxygen iodine laser nozzle concepts which include iodine atom production techniques and integrated ejector nozzle concepts. Demonstrate a one-kilowatt all gas phase supersonic iodine laser. Perform validation testing of advanced nozzle concepts for potential application to airborne lasers.

(U) $3,521 Develop laser source, beam control, and target coupling technologies to counter current and next generation air-to-air and surface-to-air missile

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT 624866

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

(U) FY 2001 ($ in Thousands) Continued

threats to aircraft platforms. Develop an electrically pumped mid-infrared solid state laser operating at room temperature, eliminating the optical pump source and cryogenic cooler for mid-infrared lasers. Investigate novel materials effects associated with plasma/spark and ultra-fast lasers for countering focal plane array seekers. Obtain a high fidelity surrogate seeker for laboratory testing of effects. Develop a moderate power ultra-fast laser source for investigations of novel atmospheric propagation characteristics.

(U) $6,976 Develop low-cost, scalable, high power solid state laser architectures by integrating doped fiber lasers with diode-laser pump sources for directed energy applications such as unmanned aerial vehicle designators/imagers and next generation weapons applications such as space-based lasers and airborne lasers. Develop promising fiber laser technologies exhibiting attributes that will enable applications that require laser mobility such as low-cost, high efficiency (approaching 30%), compactness (30 milliwatts per cubic centimeter), and scalability. Develop integration technologies necessary for demonstration of power at one kilowatt.

(U) $16,018 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603319F, Airborne Laser Demonstrator.

(U) PE 0603444F, Maui Space Surveillance System.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

PROJECT: 624867

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624867 Advanced Weapons & Survivability Technology	0	0	16,319	17,064	17,432	17,029	17,446	Continuing	TBD

(U) **A. Mission Description**

High power microwave (HPM) and other unconventional weapon concepts using innovative technologies are explored in this project. Technologies that support a wide range of Air Force missions such as suppression of enemy air defenses, command and control warfare, and vehicle self-protection are developed. This project provides for vulnerability assessments of representative U.S. strategic and tactical systems to directed energy weapons, directed energy weapon technology assessment for specific Air Force missions, and directed energy weapon lethality assessments against foreign targets. In addition to directed energy weapon threats, this project conducts assessments of specific space environmental (natural and man-made) effects on space systems and develops hardening technologies and methodologies.

(U) FY 1999 ($ in Thousands)

(U) $0 This work was performed in PE 0602601F/Project 625797. The funding was $14.730 million.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 This work is performed in PE 0602601F/Project 625797. The funding is $18.632 million.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $3,074 Investigate technologies for developing multi-pulsed HPM components to support multiple Air Force applications as recommended by Phase II Directed Energy Applications in Tactical Airborne Combat (DE ATAC) Study. Investigate better modeling techniques in order to incorporate HPM technologies into warfighting/war gaming activities.

(U) $1,868 Assess effects/lethality of directed energy weapon technologies against representative air and ground military systems. Formulate susceptibility criteria for DE ATAC Phase II concepts. Conduct susceptibility tests on representative command and control warfare targets.

(U) $2,000 Develop wideband HPM technologies that will support command and control warfare applications. Research advanced antenna designs driven by command and control warfare concept studies. Continue to improve the electrical efficiency of HPM sources in order to achieve greater range or smaller packaging. Validate computer codes' ability to predict the electromagnetic coupling to command and control target equipment within complex structures. Begin development of codes to predict probability of effect on target equipment based on coupling to the target.

(U) $2,899 Develop narrowband HPM technologies that will support suppression of enemy air defenses. Expand range of predictability of HPM effects models for military electronic targets of interest. Validate predictability of models. Complete development of component technologies - prime power, pulsed power, sources, and antennas - for repetitively pulsed systems.

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY — PROJECT: 624867

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$3,716	Investigate high power microwave (HPM) technologies that will support offensive and defensive advanced airborne tactical applications made possible based on increased power available on future aircraft. Design optimal sources for the most promising concepts identified by the trade off study. Perform HPM effects experiments upon targets of interest to determine effectual lethality of each concept.
(U)	$1,956	Continue to assess the vulnerability of U.S., NATO, and foreign satellites to the effects of directed energy weapons, primarily high energy lasers and high power microwaves. Previous assessments will be updated, as required, based on new intelligence information. Other directed energy effects will be included as appropriate.
(U)	$806	Continue investigation of best means for Active Denial Technologies to support Agile Combat Support applications. Continue development of millimeter-wave sources for Active Denial Technology - conduct experiments including beam transport and power extraction. Investigate HPM source enhancement technologies using computer simulations.
(U)	$16,319	Total

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

Not Applicable.

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

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	75,208	52,085	78,749	63,166	71,652	73,735	75,878	Continuing	TBD
624506	Surveillance Technology	11,137	5,116	0	0	0	0	0	Continuing	TBD
624519	Communications Technology	18,503	11,792	22,520	15,484	14,950	15,512	16,861	Continuing	TBD
624594	Information Technology	13,967	14,811	24,167	24,687	25,019	25,438	25,785	Continuing	TBD
624600	Electromagnetic Technology	12,878	6,992	10,593	7,272	6,966	7,118	7,210	Continuing	TBD
625581	Command and Control (C2) Technology	18,723	13,374	21,469	15,723	24,717	25,667	26,022	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, the efforts performed in Project 624506, Surveillance Technology, will be preformed in Project 624594, Information Technology, and in PE 0602204F, Project 627622. In FY 2001, portions of work previously performed in PE 0602204F, Project 626096, Project 622003, and Project 627622 move to this PE, Project 624594, Information Technology, Project 625881, Command and Control Technology, and Project 624519, Communication Technology, respectively. This realignment aligns projects with the Air Force Research Laboratory organizational structure.

(U) **A. Mission Description**

This program develops the technology base 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' to the Command and Control (C2) warrior. Current developments include: improving effectiveness and survivability through assured, secure communications; improving processing and presentation of information for real-time battle management; improving the timeliness and quality of data acquisition for decision making; and the technologies, tools, and techniques to protect the critical C3 infrastructure. The program addresses four technology areas: communications; information; electromagnetic; and command and control.

Note: In FY 2000, Congress added $7.0 million for Electromagnetic Technology, $0.8 million for Distributed Agent-based C2 Planning, $0.6 million for Common Battle Space Algorithms/Processing, $0.6 million for Intelligent Networks for Global Information Assurance, $0.4 million for Computer Forensics, and $0.4 million for Real-time Knowledge-based Sensor-to-Shooter Decision Making.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	71,661	46,448	52,283	
(U)	Appropriated Value	72,175	52,148		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-514	-18		
	b. Small Business Innovative Research	-847			
	c. Omnibus or Other Above Threshold Reprogram		-45		
	d. Below Threshold Reprogram	4,814			
	e. Rescissions	-420			
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			26,466	
(U)	Current Budget Submit/FY 2001 PBR	75,208	52,085	78,749	TBD

(U) Significant Program Changes:

In FY 2001, funds were added to Project 624519 to increase emphasis on assured communications, to Project 624594 to increase emphasis on information technology research, to Project 624600 to increase the emphasis on electromagnetic technology research, and to Project 625581 to increase emphasis on critical infrastructure protection.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications / PROJECT: 624506

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624506 Surveillance Technology	11,137	5,116	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

The Air Force requires advanced surveillance and fusion technologies to improve the performance and reduce the cost of Air Force surveillance systems. Major Applied Research areas of interest include: low-observable surveillance; passive surveillance; information fusion; and advanced processing technologies. Technologies being developed include: advanced passive bistatic radar; spatial coordinate and time processing techniques; sensor and data fusion; and advanced signal processors.

(U) FY 1999 ($ in Thousands)

(U) $1,462 Developed and demonstrated sensor performance analysis and software for synthetic aperture radar and moving target indicator from airborne and space-based platforms in hostile (jamming) scenarios.

(U) $2,775 Developed technologies and concepts for passive surveillance with emphasis on electronic support measures and airborne wideband bistatics for unmanned aerial vehicle platform applications.

(U) $3,900 Developed, tested, and demonstrated improved real-time multispectral and multisensor fusion techniques for enhanced air and space situational awareness. Implemented measures of merit for advanced distributed fusion system evaluation.

(U) $3,000 Designed architecture for an affordable, scaleable, teraflop information processor and augmented it to support rapid fusion processing.

(U) $11,137 Total

(U) FY 2000 ($ in Thousands)

(U) $1,589 Demonstrate and assess operational algorithms for processing massive global databases, to produce improved real-time multispectral and multisensor data fusion, delivering an enhanced air and space situational picture.

(U) $1,581 Develop multisensor fusion algorithms in a fully distributed environment. Complete development and demonstrate fusion quality measures validating enhanced performance.

(U) $1,946 Develop embedded, affordable, scalable, teraflop processing technologies for real-time information fusion and exploitation. Complete design and implementation technologies for fully programmable, scaleable, affordable teraflop processors for real-time fusion and processing.

(U) $5,116 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 624594.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications
	PROJECT 624506

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0603726F,Aerospace Information Technology Systems Integration.
(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.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications / PROJECT: 624519

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624519 Communications Technology	18,503	11,792	22,520	15,484	14,950	15,512	16,861	Continuing	TBD

(U) **A. Mission Description**

The Air Force requires technologies that enable assured, worldwide communications, and enable an agile Aerospace Expeditionary Force by providing the communication technologies which will allow reachback communications for distributed collaborative command and control (C2). The rapid build-up of U.S. presence abroad, via rapid application of air power, requires assured connectivity providing reliable, responsive, affordable transfer of information using all available communications media. This program provides the technologies for: multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques such as spread spectrum and adaptive null steering; lightweight and phased array antennas; and modular, programmable, low-cost radios. It includes technologies for advanced processors and devices, advanced network protocols, intelligent communications management and control, advanced algorithms, and enabling processing techniques.

(U) FY 1999 ($ in Thousands)

(U) $3,414 Developed critical communications technologies (for imagery and video) employing programmable devices, processing technologies, and monolithic microwave integrated circuits to provide global connectivity to aerospace forces in the ultra-high frequency (UHF) and super-high frequency (SHF) spectrums. Analyze weight, cost, and drag for unmanned aerial vehicle (UAV) applications.

(U) $4,676 Developed assurance of service and universal transaction service technologies for improved security, survivability, timeliness, and reconstruction of communications networks.

(U) $4,639 Developed advanced communications signal processors, an advanced Smart Network protocol, advanced algorithms, and enabling processing technologies essential for survivable radio communications.

(U) $5,774 Developed Defensive Information Warfare (DIW) tools and technologies (i.e., pathology and forensics to detect and countermeasure break-ins) to ensure information protection and security of sensitive and encrypted Air Force information systems.

(U) $18,503 Total

(U) FY 2000 ($ in Thousands)

(U) $4,300 Develop assured and survivable information and networking technologies enabling the capability for worldwide command, control and communication operations for Expeditionary Aerospace Forces. Develop assurance of services and universal transaction services technologies for improved security, survivability, and timeliness in a global, seamless, distributed communications network employing wireless and wired links.

(U) $5,053 Develop critical communications and signal processing technologies to provide adaptive, covert, anti-jam, and assured global battlespace

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BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications / PROJECT: 624519

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

(U) FY 2000 ($ in Thousands) Continued

connectivity to aerospace forces and greatly reduce equipment footprint. Continue millimeter component development and the Smart Network Radio program.

(U) $2,439 Develop Defensive Information Warfare tools and technologies to ensure information protection and security of sensitive and encrypted Air Force communication and information systems. Develop net visualization tools and attack indicators. Develop automated capability for computer forensics analysis.

(U) $11,792 Total

(U) FY 2001 ($ in Thousands)

(U) $7,400 Develop assured and survivable information and networking technologies enabling the capability for worldwide command, control and communication operations for Expeditionary Aerospace Forces. Develop information systems and networking technologies for globally distributed information systems. Continue to develop technologies to provide managed, seamless global information exchange for Air Force, in a joint/coalition environment. Develop technologies to improve quality of service, robustness, security, and survivability of mission-critical information.

(U) $7,484 Develop critical assured communications and signal processing technologies to provide adaptive, covert, anti-jam, and assured global battlespace connectivity to aerospace forces and greatly reduce equipment footprint. Continue to develop and apply critical multiband and wideband wireless communications technologies for assured communications in Joint and Coalition environments.

(U) $7,636 Develop Defensive Information Warfare tools and technologies to ensure information protection and security of sensitive and encrypted Air Force communication and information systems. Continue to develop net visualization tools and attack indicators. Continue to develop automated capability for computer forensics analysis. Develop preemptive indicators, damage assessment, and recovery techniques.

(U) $22,520 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603726F, Aerospace Information Technology System Integration.

(U) PE 0603789F, C3I Advanced Development.

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications
	PROJECT 624519

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications / PROJECT: 624594

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624594 Information Technology	13,967	14,811	24,167	24,687	25,019	25,438	25,785	Continuing	TBD

(U) **A. Mission Description**

The Air Force requires technologies which improve and automate capabilities to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. This project improves Global Awareness at all levels, enabling warfighters to understand relevant military situations on a consistent basis, with the timeliness and precision needed to accomplish their missions. Global Awareness is achieved by exploiting information provided by the Air Force and other government agencies. The information is fused to support Dynamic Planning and Execution via the Global Information Exchange distribution system. Knowledge, information, and data are archived in the Global Information Base for continued use and historical analysis. The information technologies required to achieve this capability are developed under this project in an affordable manner, and include appropriate access mechanisms for our coalition partners.

(U) FY 1999 ($ in Thousands)

(U) $3,067 Developed information exploitation capabilities for imagery and electromagnetic signals. Developed technology to transition the capability to tag targets in space and sort large volumes of communications in direct support of information superiority for global engagement.

(U) $4,800 Developed information warehousing and protein storage and retrieval technologies to provide timely warfighter access to a complete multimedia, multidimensional suite of Command, Control, Communications, Computers, and Intelligence information.

(U) $3,100 Developed technologies for real-time and stored data fusion to support target identification, dynamic planning, and weapons engagement.

(U) $3,000 Developed advanced technologies and approaches for the acquisition, analysis, and timely dissemination of intelligence information.

(U) $13,967 Total

(U) FY 2000 ($ in Thousands)

(U) $4,551 Develop information exploitation technologies for imagery and electronic signals to increase global awareness. Automate multisensor and multimedia technologies to automatically detect and track targets using radiated signals across the entire spectrum for precision location and identification.

(U) $5,100 Develop and evaluate innovative multisensor collaborative fusion technologies in a fully distributed aerospace environment. Develop innovative multisensor collaboration system to fuse events in time and space, to locate and identify objects, and to project future behavior for spaceborne systems in a fully distributed fusion environment.

(U) $5,160 Develop global information base technologies for global, theater, and local situation awareness providing timely and accurate input to dynamic planning and execution operations. Develop information extraction technology to retrieve data from text and automatically put into structured formats enabling the warfighter to process large volumes of text faster and more effectively.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications
	PROJECT 624594

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$14,811	Total

(U) FY 2001 ($ in Thousands)

(U)	$4,800	Develop information exploitation technologies for imagery and electronic signals to increase global awareness. Continue to develop multisensor, multimedia analytical techniques to automatically detect and track the presence and location of objects (target, non-targets both civilian and military) and extract changes in the information. Investigate advanced information dissemination techniques for seamless integration into the global information base via the global grid.
(U)	$7,640	Develop and evaluate innovative multisensor collaborative fusion technologies in a fully distributed aerospace environment. Develop and evaluate collaborative multisensor technologies for near-real-time cueing and retasking of sensors for dynamic fusion of information, addressing surface, airborne, and spaceborne systems in a fully distributed environment.
(U)	$5,081	Develop global information base technologies to achieve situational awareness at all command levels for the dynamic planning and execution process. Develop and investigate technology concepts that employ multiple levels of abstraction to rapidly extract information from globally distributed databases, to provide timely and accurate information to dynamic planning and execution operations. Continue to develop information extraction technology to retrieve data from text and automatically insert into structured formats, enabling the warfighter to process large volumes of text faster and more effectively.
(U)	$2,674	Develop embedded, affordable, scalable, teraflop processing technologies for real-time information fusion and exploitation. Develop and evaluate technology for real-time information fusion and exploitation for Expeditionary Aerospace Force situational awareness that is 100 times more affordable than current embedded and radiation hardenable high performance processing systems.
(U)	$1,812	Develop information technologies that significantly reduce the develop cost of complex electronic systems. Complete the development of a requirements modeling representation concisely capturing the engineering requirements for computer-aided simulation, verification, and analysis. Complete the research for making digital hardware models more reusable. Develop an interface between digital hardware models and battlespace models, enabling more of a system to be verified by simulation.
(U)	$2,160	Develop modeling and simulation technologies to support next generation distributed collaborative environments. Evaluate, exploit and develop techniques to expand the capability while reducing the complexity of existing high-resolution models and simulations for the National Air and Space Warfare Model. Develop simulation techniques to provide accurate, real-time decision support for the next generation distributed collaborative environments.
(U)	$24,167	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications
	PROJECT: 624594

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0603726F, Aerospace Information Technology System Development.
(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.

(U) **E. Schedule Profile**
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

PROJECT: 624600

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624600 Electromagnetic Technology	12,878	6,992	10,593	7,272	6,966	7,118	7,210	Continuing	TBD

(U) **A. Mission Description**

This project conducts research in electromagnetics and photonics technologies for application to Intelligence, Surveillance, and Reconnaissance (ISR) Systems. Future surveillance, communications, and imagery/information processing systems will require improved technology for the generation, control, processing, and radiation of electromagnetic and optical energy to reduce system cost, improve system sensitivity, and increase processing rates. Promising technologies for improving ISR systems are electromagnetic propagation and scattering (from targets and clutter) and antennas. This project develops technology and control techniques for large phased array antennas, infrared focal plane array technology, and characterizes phenomena for low-observable surveillance.

(U) FY 1999 ($ in Thousands)

(U) $4,384 Demonstrated digital beam nulling techniques and new computer codes for advanced surveillance and communications systems applications.

(U) $1,177 Developed advanced electromagnetic materials and components capable of higher processing speeds for sensing and communications applications.

(U) $5,500 Developed photonic sub-systems and components for control and processing of both data and radio frequency signals.

(U) $1,817 Developed advanced concepts for electromagnetic apertures.

(U) $12,878 Total

(U) FY 2000 ($ in Thousands)

(U) $2,000 Design and develop electromagnetic technologies for advanced surveillance and reconnaissance systems applications. Develop and evaluate algorithms for a digital beam-formed multibeam antenna.

(U) $2,000 Design and develop antenna concepts for aerospace surveillance and reconnaissance applications. Develop and evaluate advanced concepts for large, lightweight arrays. Develop and evaluate a three-dimensional optically excited antenna array.

(U) $2,992 Design and develop electro-optical technology to enable passive or active targeting of difficult targets. Investigate ways of mitigating atmospheric phenomenology effects on extended range aerospace sensors. Develop turbulence compensation techniques for precision targeting, target signatures and phenomenology models, and selected multifunction sensor target characteristics. Design and develop infrared focal plane array technology.

(U) $6,992 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications
	PROJECT: 624600

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

(U) FY 2001 ($ in Thousands)

(U)	$3,421	Design and develop electromagnetic technologies for advanced surveillance and reconnaissance systems applications. Continue to develop and evaluate algorithms for a digital beam-formed multibeam antenna.
(U)	$3,200	Design and develop antenna concepts for aerospace surveillance and reconnaissance applications. Continue to develop and evaluate advanced concepts for large, lightweight arrays. Continue to develop and evaluate a three-dimensional optically excited antenna array.
(U)	$3,972	Design and develop electro-optical technology to enable passive or active targeting of difficult targets. Investigate ways of mitigating atmospheric phenomenology effects on extended range aerospace sensors. Continue to develop turbulence compensation techniques for precision targeting, target signatures and phenomenology models, and selected multifunction sensor target characteristics. Continue to design and develop infrared focal plane array technology.
(U)	$10,593	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603203F, Advanced Aerospace Sensors.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)								DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research			PE NUMBER AND TITLE: 0602702F Command Control and Communications					PROJECT: 625581

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
625581 Command and Control (C2) Technology	18,723	13,374	21,469	15,723	24,717	25,667	26,022	Continuing	TBD

(U) **A. Mission Description**

The Air Force requires Command and Control (C2) technologies which provide the next generation of weapon systems with improved processing and presentation of information for real-time battle management. Technologies being developed in this project will increase capability and quality, while reducing the cost of C2 systems and infrastructure. Work in this project focuses on developing advanced C2 systems capable of providing vast improvements in military decision making. The project develops technology for distributed systems, data bases, and fault tolerance mechanisms; and knowledge-based technologies and systems. It also develops the technologies, tools, and techniques required to ensure protection of critical Command, Control, Communications, and Intelligence infrastructure.

(U) FY 1999 ($ in Thousands)

(U) $6,500 Developed intelligent information technologies including preplan-to-react planning technology for noncontinuous planning and tools and techniques for collaborative intelligent systems.

(U) $6,123 Developed architecture-centered technology that provides easier-to-design and easier-to-maintain software for increased capability, quality, and reliability with reduced support cost.

(U) $6,100 Developed distributed computing and database technology including collaborative workspaces shared across a distributed computing environment and optical storage multimedia database management systems.

(U) $18,723 Total

(U) FY 2000 ($ in Thousands)

(U) $6,616 Develop the next generation of planning and assessment technologies and tools enabling aerospace commanders to determine and create the desired operational effects at the right place at the right time. Develop intelligent information technologies including planning technology for coalition C2. Develop high performance knowledge base technology for coordination and cooperative use of aerospace C2 resources.

(U) $1,448 Investigate and develop technologies for the rapid development and application of next generation knowledge bases for C2 aerospace systems. Complete development of architecture-centered technology and modeling and analysis of evolvable software for increased capability, quality, and reliability of software-intensive systems. Develop techniques for knowledge base theory slicing, merging, and conflict resolution.

(U) $5,310 Investigate, analyze, and develop intelligent information management and user interface systems that tailor visualization strategies, information, access, and assurance mechanisms based on C2 application parameters.

(U) $13,374 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications
	PROJECT 625581

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

(U) FY 2001 ($ in Thousands)

(U)	$6,233	Develop the next generation of planning and assessment technologies and tools enabling aerospace commanders to determine and create the desired operational effects at the right place at the right time. Develop technologies to dynamically assess the battlespace, determine measures to create the desired effects, and provide near-real-time command of forces to execute those measures. Develop technologies to provide alternative courses of action and feasibility assessment in uncertain environments.
(U)	$1,963	Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace command and control (C2) systems. Develop tools and techniques needed by an Expeditionary Aerospace Force for building very large comprehensive knowledge bases by rapidly formulating and creating new knowledge, along with capabilities to re-use, augment, and repair existing knowledge bases. Continue the development of techniques for knowledge base theory slicing and merging, conflict resolution, and context management. Investigate new techniques to allow users to enter, validate, and manipulate knowledge using natural language, sketching, and templating approaches.
(U)	$6,294	Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by Aerospace Expeditionary Forces. Develop and evaluate advanced display and human-computer interface technologies for current and next generation C2 systems.
(U)	$1,979	Develop tools and techniques to promote assured performance and affordability of complex air and space platforms. Continue to develop new techniques for rapidly incorporating new functions into scaleable, open architecture systems. Develop dynamically reconfigurable aerospace systems using field programmable gate arrays. Develop concepts and preliminary designs for the next generation C2 global information systems which will allow the seamless insertion of highly autonomous unmanned airborne and spaceborne platforms for deployment against time-critical targets.
(U)	$5,000	Develop the technologies, tools, and techniques required to ensure protection of critical command, control, and communications infrastructure. Develop the technologies which will allow a robust implementation of an overarching, integrated capability for protection of the global C3 infrastructure. Develop protection techniques with emphasis on integrity of information and availability of networks required for distributed, collaborative C2 systems.
(U)	$21,469	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602702F Command Control and Communications
	PROJECT: 625581

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

(U) Related Activities:

(U) PE 060361F, C3 Applications

(U) PE 0303401F, Communications-Computer Systems (C-CS) Security RDT&E

(U) PE 0603726F, Aerospace Information Technology Systems Integration

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology / PROJECT: 624770

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
624770	Dual Use Science and Technology (S&T)	9,451	9,879	10,144	10,358	10,581	10,804	11,030	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program allows the Air Force to leverage industry investments in advanced technologies that are mutually advantageous to both the Air Force and industry. One of the program's objectives is to establish a tool for the Air Force to stimulate the development of dual-use technologies that will provide greater access to commercial technologies, and will result in affordable defense systems that maintain battlefield superiority. A key component of the program is the cost sharing requirement from both industry and the Air Force, which affirms commitment to the development effort. Specific projects are determined through annual competitive solicitation(s). A second objective is to use FY 1997 Defense Authorization Act Section 804, Other Transactions Authority, as part of the Dual Use S&T program to educate the Air Force S&T workforce in non-traditional or commercial contracting practices. Technology development areas considered include advanced materials and manufacturing, affordable sensors, advanced propulsion, power and fuel efficiency, information and communications systems, and weapons systems sustainment.

(U) FY 1999 ($ in Thousands)

(U) $3,325 Developed air vehicle technologies that extend the life and improve the performance of both Air Force and commercial fixed wing air vehicles. Areas of research included improving flight control, lightweight structures, common electronics, and vehicle subsystems.

(U) $3,200 Developed information technologies that improve the capability of both aerospace command and control, and commercial communications and awareness. Areas of research included intelligent information systems, communication systems, information fusion, and collaborative environment development.

(U) $2,926 Developed space technologies that will reduce the cost and improve the capability of both Air Force and commercial space vehicles and launch systems. Areas of research included improved space vehicle survivability, space vehicle control, and space-based sensing.

(U) $9,451 Total

(U) FY 2000 ($ in Thousands)

(U) $4,100 Develop air vehicle technologies that extend the life and improve the performance, effectiveness, and reliability of both Air Force and commercial fixed wing air vehicles. Technology areas include improving flight control, lightweight structures, common electronics, and vehicle subsystems. Specific projects include developing ceramic matrix composites for engine exhaust sections, developing and commercializing high power diodes capable of high temperature operation, and developing low-cost, revolutionary alloy steels.

(U) $4,279 Develop information and sensor technologies that improve the capability of aerospace command and control, information dominance, and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology
PROJECT: 624770	

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

(U) FY 2000 ($ in Thousands) Continued

battlefield management, as well as enhance commercial communications and awareness. Technology areas include intelligent information systems, communication systems, information fusion, and collaborative environment development. Specific projects include development of low-cost Continuous Transverse Stub array antennas, and smart imaging sensors for application to military operations and civilian navigation.

(U) $1,500 Develop space technologies that will reduce the cost and improve the capability of both Air Force and commercial space vehicles and launch systems. Technology areas include improved space vehicle survivability, space vehicle control, and space-based sensing. Specific projects include development of flight-ready thermal protection systems for military and commercial space vehicles, development of novel batteries for space applications, and development and commercialization of design software for space components.

(U) $9,879 Total

(U) FY 2001 ($ in Thousands)

(U) $2,800 Develop advance materials and manufacturing technologies that will reduce the cost and improve the capability of both Air Force and commercial air and space vehicles and launch systems. Technology areas considered include: growth processes for wide bandgap semiconductor materials, such as Silicon Carbide (SiC), Gallium Nitride (GaN) and related materials; superior ceramic matrix composites (CMCs); advanced metal matrix composites (MMCs) and intermetallics materials for durable, maintainable vehicles; composite material structures based upon low-cost preforming, infusion, and curing; and inflatable membrane solar concentrators for high powered (>100kW) military and commercial satellites.

(U) $2,600 Develop affordable advanced sensors technology that can be applied to both commercial and military space and airborne systems to provide a complete and timely picture of the battlespace, enable a timely precision response, and enhance the warfighter's survivability, as well as enhance commercial telecommunications, imaging, and surveying. Technology areas considered include: antennas that are conformal in shape, cost-effective to manufacture, operate over a very wide frequency bandwidth, and are polarization diverse; laser radar (LADAR) to provide precise and timely topographical maps for both commercial and military purposes; innovative focal plane arrays (FPAs) for LADAR; and navigation aids, including inertial navigation components and satellite-based global positioning.

(U) $1,744 Develop advanced propulsion, power, and fuel efficiency technologies that improve the performance, increase life, and reduce emissions of airbreathing and rocket propulsion systems. Technology areas considered include: advanced gas turbine combustion; cost-effective, long life, turbine blades; mitigation of particulate formation in airbreathing and rocket propulsion systems; advanced common core compressors; lightweight rocket nozzles; enhanced fuel-air mixing and jet penetration techniques; and smart engine health monitoring techniques.

(U) $1,500 Develop information and communications systems technologies that enhance human-vehicle interactions, improve the capability of aerospace command and control, advance information dominance and battlefield management, as well as enhance commercial communications and awareness. Technology areas considered include: automation of logistics and equipment failure reporting; information recovery; intelligent

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology / PROJECT: 624770

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

(U) FY 2001 ($ in Thousands) Continued

information systems; information fusion; intelligent image correlators; smart data processing; and web-based virtual consortiums for modeling and simulation research/application.

(U) $1,500 Develop weapon systems sustainment technologies that extend the life and improve the performance, effectiveness, and reliability of both Air Force and commercial air and space vehicles. Technology areas considered include: computational methods for assembling and validating system maintenance instructions; on-board aircraft generation and liquefaction of oxygen and nitrogen; structural integration of subsystems to reduce weight and cost; design tools; and cost-effective techniques for monitoring system health.

(U) $10,144 Total

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

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	9,961	17,927	17,841	
(U)	Appropriated Value	10,000	10,000		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-39	-1		
	b. Small Business Innovative Research	-336			
	c. Omnibus or Other Above Threshold Reprogram		-54		
	d. Below Threshold Reprogram	-121			
	e. Rescissions	-53	-66		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-7,697	
(U)	Current Budget Submit/FY 2001 PBR	9,451	9,879	10,144	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to a re-evaluation of priorities within the Science and Technology (S&T) Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 02 - Applied Research	PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology
PROJECT: 624770	

(U) **D. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(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 0602601F, Space Technology.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602605F, Directed Energy Technology.
(U) PE 0602702F, Command Control and Communications.
(U) PE 0602805N, Dual Use Science and Technology (S&T).
(U) PE 0602805A, Dual Use Science and Technology (S&T).
(U) This project is coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **E. Acquisition Strategy**
Not Applicable.

(U) **F. Schedule Profile**
(U) Not applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603106F Logistics Systems Technology

PROJECT: 632745

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632745	Logistics Performance and Support Technology (S&T)	9,478	10,651	13,895	11,367	11,729	12,814	9,740	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates cost-effective technologies to improve the design, performance, security, and support of current and future weapon systems, including their support equipment. This effort also develops technology to incorporate human operator, maintenance, and support considerations into the weapon systems design process and to make engineering, product support, and maintenance data electronically available throughout weapon systems' life cycles. The program provides more realistic logistics planning and combat capability assessment tools, and provides technologies to reduce deployment airlift and footprint requirements, acoustic sensor and processing technologies to locate and identify threats, and two-way communication technologies for command and control. This program improves logistics information command and control and asset visibility, provides critical logistics risk reduction technology, and helps control total weapon systems' life cycle costs.

(U) FY 1999 ($ in Thousands)

(U) $2,123 Developed, demonstrated, and transitioned technologies to enable/streamline aircraft maintenance processes by continuing development of electronic technical data, algorithms, and software to enhance aircraft battle damage assessment capability. Completed field test with trained aircraft damage assessors.

(U) $4,373 Developed and demonstrated tools and technologies to maximize efficiency and effectiveness of Air Force operational deployments by continuing to develop technologies for next generation, multi-function, modular support equipment that is highly reliable, reconfigurable, and easily deployable. Continued to develop and field test technologies to enhance rapid contingency planning, deployments, and operations. Began development of technology to provide wing commanders/senior logisticians with advanced information and management capabilities.

(U) $1,381 Developed and demonstrated analytical tools by defining artificial intelligence requirements to improve efficiency of Air Force depot maintenance operations and logistics information systems.

(U) $457 Investigated technologies to demonstrate the feasibility of downloading aircraft status information anytime during a flight (Passive Aircraft Status System).

(U) $1,144 Developed and demonstrated integrative architecture capable of exchanging data with Common Object Request Broker Architecture (COBRA) and High-Level Architectecture (HLA) federations to support future development of realistic human behavior models for large-scale synthetic battlespace exercises and improved interfaces to airlift command and control systems.

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603106F Logistics Systems Technology / PROJECT: 632745

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

(U) FY 1999 ($ in Thousands) Continued

(U) $9,478 Total

(U) FY 2000 ($ in Thousands)

(U) $756 Develop and demonstrate technologies to enhance and streamline aircraft maintenance processes to improve the Air Force's ability to meet Air Expeditionary Force (AEF) requirements by providing faster and more accurate methods of diagnosing and predicting component failures. Begin development of a diagnostics capability to provide technicians with more effective tools for isolating faults on the software intensive, reconfigurable systems found on modern aircraft and advanced aircraft systems currently in development. Based on field test results, advance and transition technology to support the assessment of battle damaged aircraft.

(U) $3,846 Develop and demonstrate intelligent software agents and realistic human behavior models. These computer agents and models will add realism and fidelity to large-scale synthetic environments and war games, and improve the user interaction with information systems. Define technology requirements for intelligent software agents that automate the setting-up and running of synthetic exercises to reduce the costs of running these simulations. Define technology requirements for computer agents that improve the human interface effectiveness for airlift command and control systems.

(U) $6,049 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 the emerging AEF concepts. Continue to develop technology to provide wing commanders and senior logisticians with advanced information and management capabilities, including rapid access to real-time resources status information, proactive problem identification, decision support, and process tracking. Continue design and development of an integrated, easily deployable, waste management system to process all types of waste materials produced during deployed operations. Demonstrate agile/lean deployment capability, reduced airlift requirements, and reduced on-site footprint using highly reliable, modular, multi-function support equipment for flightline maintenance.

(U) $10,651 Total

(U) FY 2001 ($ in Thousands)

(U) $1,967 Develop and demonstrate technologies to enhance and streamline aircraft maintenance processes to improve the Air Force's ability to meet AEF requirements by providing faster and more accurate methods of diagnosing and predicting component failures. Continue development of diagnostics capability to provide technicians with more effective tools for isolating faults on the software intensive, reconfigurable systems found on modern aircraft and advanced aircraft systems currently in development.

(U) $4,945 Develop and demonstrate intelligent software agents and realistic human behavior models. These computer agents and models will add realism and fidelity to large-scale synthetic environments and war games, and improve the user interaction with logistics information systems. Develop

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603106F Logistics Systems Technology / PROJECT: 632745

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

(U) FY 2001 ($ in Thousands) Continued

intelligent software agents that automatically translate and execute air tasking order inputs for synthetic exercises and war games. Develop software agents that enhance the users' ability to monitor and respond to asymmetric events during mobility and airlift operations.

(U) $4,805 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 the emerging Air Expeditionary Force (AEF) concepts. Continue to develop technology to provide wing commanders and senior logisticians with advanced information and management capabilities, including rapid access to real-time resources status information, proactive problem identification, decision support, and process tracking. Continue to develop an integrated, easily deployable, waste management system to process all types of waste materials produced during deployed operations.

(U) $2,178 Develop and demonstrate logistics technologies for improved system supportability, deployability, and mobility. These technologies will greatly improve the flexibility and deployability of the flightline maintenance equipment, improve the airlift/mobility operations of the AEF and ensure that weapon systems are more reliable and maintainable. Transition specifications for the next generation of powered support equipment for more agile/lean flightline maintenance. Transition specifications and technology for next generation ground refueling systems to support Air Force Special Operations Command.

(U) $13,895 Total

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

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

	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget (FY 2000 PBR)	9,069	10,786	14,015	TBD
(U) Appropriated Value	9,177	10,786		
(U) Adjustments to Appropriated Value				
a. Congressional/General Reductions	-108	-6		
b. Small Business Innovative Research	-248			
c. Omnibus or Other Above Threshold Reprogram		-58		
d. Below Threshold Reprogram	710			
e. Rescissions	-53	-71		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603106F Logistics Systems Technology
	PROJECT: 632745

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

	FY 1999	FY 2000	FY 2001	Total Cost
f. Other				TBD
(U) Adjustments to Budget Years Since FY 2000 PBR			-120	
(U) Current Budget Submit/FY 2001 PBR	9,478	10,651	13,895	TBD

(U) Significant Program Changes:
Not Applicable.

(U) **D. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0207219F, Advanced Tactical Fighter.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603721N, Integrated Diagnostic System.
(U) PE 0604708F, Generic Integrated Maintenance Diagnostics Systems.
(U) PE 0604740F, Computer Resource Management Technology.
(U) PE 0605801A, Pollution Prevention Research and Development.
(U) PE 0708011F, Manufacturing Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **E. Acquisition Strategy**
Not Applicable.

(U) **F. Schedule Profile**
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	31,726	33,978	21,678	20,778	22,398	23,279	24,456	Continuing	TBD
632100	Laser Hardened Materials	9,949	11,107	10,730	11,094	11,842	12,079	12,319	Continuing	TBD
633153	Non-Destructive Inspection Development	4,079	4,300	2,218	3,637	3,474	3,814	4,154	Continuing	TBD
633946	Materials Transition	17,698	18,571	8,730	6,047	7,082	7,386	7,983	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2004, Air Base Technology efforts currently funded in PE 0603205F will transfer into this PE in Project 633946.

(U) **A. Mission Description**

This program demonstrates materials technology options for transition into Air Force weapon systems. The non-destructive inspection/evaluation (NDI/E) techniques for fighter, bomber, and transport aircraft are critical to the logistics centers as well as the operational fleet as the planned service lives of these systems increase and new materials are introduced. This program provides critical data for prospective users to make engineering decisions on both structural and non-structural materials for air and space. Reducing risk in materials technology improves the affordability, supportability, reliability, survivability, and operational performance of current and future warfighting systems. Also developing materials technologies for the broadband laser protection of aircrews and sensors from a variety of threats is a high priority of the Air Force. Note: In FY 2000, Congress added $4.0 million for advanced low-observable coatings and $4.5 million for composite space launch payload dispensers which partially explains the perceived decrease in FY 2001.

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	32,900	25,890	25,702	
(U)	Appropriated Value	33,006	34,390		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-106	-1		
	b. Small Business Innovative Research	-977			
	c. Omnibus or Other Above Threshold Reprogram		-187		
	d. Below Threshold Reprogram	-19			
	e. Rescissions	-178	-224		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-4,024	
(U)	Current Budget Submit/FY 2001 PBR	31,726	33,978	21,678	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget reflect reduced emphasis on implementation of Integrated Product Process Development (IPPD) and vehicle health monitoring technology.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems — PROJECT: 632100

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632100 Laser Hardened Materials	9,949	11,107	10,730	11,094	11,842	12,079	12,319	Continuing	TBD

(U) **A. Mission Description**

Develops enabling materials and concepts for protecting Air Force assets such as aircrews, munitions, and aerospace sensors against laser and high power microwave (HPM) directed energy threats. Concepts are demonstrated to provide hardening options for transition to Air Force systems. The goal is to ensure mission capability before, during, and after threat exposure. The world laser market is rapidly expanding with easy export to any nation. Survivability solutions must account for a variety of lasers facing a mission. Current protection schemes are activated by intensity or color and are only capable of countering a specific portion of the laser threat. To harden systems against all potential lasers a combination of approaches is required.

(U) FY 1999 ($ in Thousands)

(U) $1,463 Developed and demonstrated advanced materials technologies that enhance laser hardening of Air Force aircraft and spacecraft structures to ensure safety, survivability, and operability in a laser threat environment.

(U) $4,270 Developed and demonstrated advanced materials technologies that enhance laser hardening for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a laser threat environment.

(U) $4,216 Developed and demonstrated advanced materials technologies that enhance laser hardening for sensors, avionics, and components to increase survivability and mission effectiveness of electronic systems.

(U) $9,949 Total

(U) FY 2000 ($ in Thousands)

(U) $1,666 Develop and demonstrate advanced materials technologies that enhance laser hardening of Air Force spacecraft sensors to ensure safety, survivability, and operability in a laser threat environment. Evaluate hybrid optical limiters and establish specific performance improvement goals for the protection of staring focal plane arrays (FPAs). Optimize Rugate fixed-wavelength filters and optical switches for mid-wave infrared (MWIR) space systems. Evaluate hardening solutions for critical space sensor designs and environments.

(U) $5,554 Develop and demonstrate advanced materials technologies that enhance laser hardening for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a laser threat environment. Design and develop fixed filters for panoramic night vision goggles (PNVG). Fabricate and test wrap-around tristimulus spectacles (eye-glasses). Design and develop prescription capable flexible filter for eye protection. Demonstrate prescription-capable, eye-centered Rugates on lenses with dyed plastic substrates. Transition eye centered Rugate spectacles for preliminary human factors study.

(U) $3,887 Develop and demonstrate advanced materials technologies that enhance laser hardening for sensors, avionics, and components to increase

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems
	PROJECT 632100

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

(U) FY 2000 ($ in Thousands) Continued

survivability and mission effectiveness of air vehicles systems. Integrate laser hardening modules into operational electro-optical systems. Perform flight test demonstrations of hardened sensor for Air Force Special Operational Command. Characterize and transition enhanced sensor modules for Air Force targeting systems. Initiate development of hardening architecture for low light level television (LLLTV) systems.

(U) $11,107 Total

(U) FY 2001 ($ in Thousands)

(U) $1,609 Develop and demonstrate advanced materials technologies that enhance laser hardening of Air Force spacecraft sensors to ensure safety, survivability, and operability in a laser threat environment. Fabricate and characterize hybrid optical limiters for the protection of staring focal plane arrays (FPAs). Fabricate Rugate fixed-wavelength filters and optical switches for mid-wave infrared (MWIR) space systems. Develop hardening solutions for critical space sensor designs and environments based on successful approaches employed in tactical sensors.

(U) $5,365 Develop and demonstrate advanced materials technologies that enhance laser hardening for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a laser threat environment. Develop fixed filters and invisible laser eye protection visor for panoramic night vision goggles (PNVG). Evaluate tunable filter PNVG protection technology. Validate wrap-around tristimulus spectacles (eye-glasses). Develop prescription capable flexible filter for eye protection. Transition prescription-capable, eye-centered Rugates on lenses with dyed plastic substrates.

(U) $3,756 Develop and demonstrate advanced materials technologies that enhance laser hardening for sensors, avionics, and components to increase survivability and mission effectiveness of air vehicles systems. Fabricate high performance Rugate filters for hardened LLLTV systems. Initiate development of specific hardening techniques for specific munitions. Develop specific hardening techniques for MWIR and long-wave infrared (LWIR) staring forward looking infrared (FLIR) systems.

(U) $10,730 Total

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

Not Applicable.

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

(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 0604706F, Life Support System

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems
	PROJECT 632100

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

(U) Coordinated through the Tri-Service Laser Hardening Materials and Structures Working Group and the Joint Service Agile Laser Eye Protection Program.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems / PROJECT: 633153

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633153	Non-Destructive Inspection Development	4,079	4,300	2,218	3,637	3,474	3,814	4,154	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates advanced Non-Destructive Inspection/Evaluation (NDI/E) technologies to monitor performance integrity and to detect failure causing conditions in weapon systems components and materials. NDI/E capabilities greatly influence and/or limit many designs, manufacturing, and maintenance practices. Reduction in the number of fighter wings and the need for rapid sortie generation demand an ability to perform real-time NDI/E faster than current capability. This project provides technology to satisfy critical Air Force requirements to extend lifetimes of current systems through increased reliability and cost-effectiveness at field and depot maintenance levels, as well as assuring manufacturing quality, integrity, and safety requirements.

(U) FY 1999 ($ in Thousands)

(U) $2,750 Developed advanced technologies for improved capabilities in materials corrosion and fatigue monitoring and testing of aging aircraft to reduce operation and maintenance costs and to guarantee full operability and safety of the aircraft fleet.

(U) $554 Developed advanced inspection technologies supporting low-observable (LO) and space systems to enhance affordability and ensure full performance and survivability of LO systems and rapid turnaround of space systems.

(U) $775 Developed advanced technologies for improved NDI/E capabilities in materials and process testing, monitoring, inspection, and maintenance to reduce cost and increase reliability of advanced materials.

(U) $4,079 Total

(U) FY 2000 ($ in Thousands)

(U) $1,541 Develop and demonstrate advanced technologies for improved capabilities in materials corrosion and fatigue monitoring and testing of aging aircraft to reduce operation and maintenance costs and to guarantee full operability and safety of the aircraft fleet. Demonstrate enhanced laser generated ultrasonics (LGU) for corrosion detection that use an alternate source of laser pulses to generate ultrasound and are efficiently transmitted through fiber optics, thus enabling laser based ultrasonics (LBU) sensors for remote access inspection. Demonstrate a high-resolution digital radioscopy technique to evaluate and characterize cracks as an alternative to current X-ray film-based systems which eliminates the need for hazardous material usage and enables electronic storage, transmission, and analysis of images.

(U) $2,144 Develop and demonstrate advanced inspection technologies supporting LO and space systems to enhance affordability and ensure full performance and survivability and rapid turnaround of space systems. Validate a signature assessment tool for fighter aircraft and initiate development of an advanced multispectral LO nondestructive evaluation (NDE) tool for assessing radio frequency (RF) signature (zone vs. whole aircraft) that is real-time, small, lightweight, portable, user friendly and covers multiple frequency bands. Select multiple NDE methods to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems
	PROJECT 633153

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

(U) FY 2000 ($ in Thousands) Continued

detect changes in key material properties necessary for ten-year service life estimate prediction of solid rocket motors. This technology provides improved capabilities to monitor vehicle health and enables anticipatory condition-based maintenance actions on aerospace vehicles.

(U) $615 Develop and demonstrate advanced technologies for improved capabilities to assess high cycle fatigue (HCF) and engine life prediction practices to extend the total 'safe' life of turbine engine disks. Establish nondestructive evaluation (NDE) benchmarks and design an automated inspection capability to inspect engine rotary components for planned life extension of engine rotors. Establish a baseline capability to retain digital NDE records for extended periods and enable enhanced analysis of the aging aircraft fleet.

(U) $4,300 Total

(U) FY 2001 ($ in Thousands)

(U) $696 Develop and demonstrate advanced technologies for improved capabilities in materials corrosion and fatigue monitoring and testing of aging aircraft to reduce operation and maintenance costs and to guarantee full operability and safety of the aircraft fleet. Transition to industry enhanced laser generated ultrasonics (LGU) for corrosion detection that use an alternate source of laser pulses to generate ultrasound and are efficiently transmitted through fiber optics thus enabling laser based ultrasonics (LBU) sensors for remote access inspection. Transition a high-resolution digital radioscopy technique to evaluate and characterize cracks as an alternative to current X-ray film-based systems which eliminates the need for hazardous material usage and enables electronic storage, transmission, and analysis of images.

(U) $870 Develop and demonstrate advanced inspection technologies supporting low-observable systems to enhance affordability and ensure full performance and survivability. Transition a low-observable material assessment tool for fighter aircraft. Develop an advanced multispectral low-observable NDE tool for assessing radio frequency (RF) signature (zone vs. whole aircraft) that is real-time, small, lightweight, portable, user friendly, and covers multiple frequency bands. Initiate an advanced hand-held directional reflectometer (HHDR) for field level infrared (IR) signature NDE.

(U) $552 Develop and demonstrate advanced technologies for improved capabilities to assess high cycle fatigue (HCF) and engine life prediction practices to extend the total 'safe' life of turbine engine disks. Evaluate NDE benchmarks and develop an automated inspection capability to inspect engine rotary components for planned life extension of engine rotors. Develop a method to retain digital NDE records for extended periods and enable enhanced analysis of the aging aircraft fleet.

(U) $100 Develop and demonstrate advanced technologies for improved capabilities to monitor vehicle health and enable anticipatory condition-based maintenance actions on aerospace vehicles. Investigate interfaces to material behavior prediction tools. Establish a NDE baseline capability method to detect changes in key material properties necessary for ten-year service life estimate prediction of solid rocket motors.

(U) $2,218 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603112F Advanced Materials for Weapon Systems	633153

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602102F, Materials.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems PROJECT 633946

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633946 Materials Transition	17,698	18,571	8,730	6,047	7,082	7,386	7,983	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates a materials technology base to achieve its acceptance by designers by reducing the time to scale-up new defense-related materials and material processes. The goal is to reduce risk, improve confidence, and reduce cost of the incorporation of new materials into weapons, airframes, engines, and space applications. Advanced materials and related processes that have matured beyond applied research are characterized and critical data are collected to reduce the risk of demonstrating these technologies in Air Force applications. Critical evaluations of materials in the proposed design environment are performed. This design and scale-up data provides confidence to transition new materials for upgrading current systems and integrate into future Air Force systems as well as providing the initial incentive for their industrial development. Also develops technologies (i.e., utilities and shelters) that improve airmobile systems performance and reduce airlift requirements in support of Air Expeditionary Force (AEF) operations.

(U) FY 1999 ($ in Thousands)

(U) $14,252 Developed technologies and databases to facilitate timely transition of advanced structures, propulsion, and subsystems materials to warfighters, industry, and academia.

(U) $3,009 Developed technologies and databases to facilitate timely transition of advanced materials for high power radars, space-based sensors, and infrared countermeasures to warfighters, industry, and academia.

(U) $437 Developed technologies and databases to facilitate timely transition of advanced materials for improved systems support and operational support to warfighters, industry, and academia.

(U) $17,698 Total

(U) FY 2000 ($ in Thousands)

(U) $5,277 Develop and demonstrate advanced materials technologies for air vehicles and subsystems to enhance lift, propulsion, low-observable performance, and affordability of manned and unmanned air vehicles. Develop advanced aircraft brake materials with improved braking capacity, increased life, and better environmental stability. Develop large integrated composite structures for aircraft with reduced part count and assembly costs. Develop advanced non-linear optical (NLO) materials for aircraft infrared countermeasure (IRCM) against far-infrared laser sources.

(U) $7,050 Develop and demonstrate advanced materials technologies for space vehicles and subsystems to provide enhanced surveillance and sensing capabilities and improved access to space. Initiate development of robust, high performance and producible infrared (IR) focal plane array (FPA) materials. Develop materials and materials processing technologies to improve spacecraft component designs, performance, and reliability.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems
	PROJECT 633946

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$975	Develop and demonstrate advanced materials technologies to enhance the sustainability of Air Force air and space systems by lowering operations and maintenance costs and ensuring full operability and safety of systems and personnel. Develop and verify an accelerated environmental effects test to determine in-service performance degradation of aircraft coating systems and initiate development of large aperture Aluminum Oxynitride (ALON) window material with high optical quality, durability, and strength. Demonstrate the utilization of residual stress measurements in the fatigue life management of turbine engine disks.
(U)	$2,367	Provide affordability education and training through the application of Integrated Product and Process Development (IPPD) tenets and cost modeling to the Air Force Science and Technology (S&T) environment. Training is focused on Air Force S&T scientists and engineers, including executives, middle managers, and all advanced development program managers. Enhance IPPD and cost modeling course material, including web-based methods and tools.
(U)	$2,902	Develop technologies (i.e., utilities and shelters) that improve airmobile systems performance and reduce airlift requirements in support of Air Expeditionary Force (AEF) operations. Emphasize two areas of AEF operations: deployed base systems and physical force protection. Demonstrate small air-inflatable shelters that reduce deployment weight by 50% and require 30% less set-up time. Fabricate advanced cycle technologies for mobile heat pumps that reduce weight and volume by 30%. Develop a small-footprint fuel cell reformer capable of converting logistics fuels into hydrogen for fuel cell power generation. Develop structural retrofit and evaluate deployable blast protection reinforcement systems for buildings to reduce blast debris hazards.
(U)	$18,571	Total

(U) FY 2001 ($ in Thousands)

(U)	$1,461	Develop and demonstrate advanced materials technologies for air vehicles and subsystems to enhance lift, propulsion, low-observable performance, and affordability of manned and unmanned air vehicles. Fabricate advanced aircraft brake materials with improved braking capacity, increased life, and better environmental stability. Fabricate large integrated composite structures for aircraft with reduced part count and assembly costs. Validate advanced non-linear optical (NLO) materials for aircraft infrared countermeasure (IRCM) against far-infrared laser sources.
(U)	$2,145	Develop and demonstrate advanced materials technologies for space vehicles and subsystems to provide enhanced surveillance and sensing capabilities and improved access to space. Develop improved material processes with increased yields for robust, high performance and producible infrared (IR) focal plane array (FPA) materials. Demonstrate materials and materials processing technologies to improve spacecraft component designs, performance, and reliability. Initiate effort to develop the key data needed for reduced risk and increased confidence in organic matrix composite materials.
(U)	$1,884	Develop and demonstrate advanced materials technologies to enhance the sustainability of Air Force air and space systems by lowering

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems
	PROJECT 633946

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

(U) FY 2001 ($ in Thousands) Continued

operations and maintenance costs and ensuring full operability and safety of systems and personnel. Validate an accelerated environmental effects test to determine in-service performance degradation of aircraft coating systems. Fabricate a large aperture Aluminum Oxynitride (ALON) window material with high optical quality, durability, and strength. Transition the utilization of quantitative residual stress measurements in the fatigue life management of turbine engine disks.

(U) $450 Provide affordability education and training through the application of Integrated Product and Process Development (IPPD) tenets and cost modeling to the Air Force Science and Technology (S&T) environment. Training is focused on Air Force S&T scientists and engineers, including executives, middle managers, and all advanced development program managers. Initiate education and training of organic IPPD and cost modeling experts in each Air Force S&T Technical Directorate.

(U) $2,790 Develop technologies (i.e., utilities and shelters) that improve airmobile systems performance and reduce airlift requirements in support of Air Expeditionary Force (AEF) operations. Emphasize two areas of the AEF operations: deployed base systems and physical force protection. Develop scaled air-inflatable frames for large shelters. Demonstrate advanced cycle technologies for mobile heat pumps that reduce weight and volume by 30%. Fabricate a small-footprint fuel cell reformer capable of converting logistics fuels into hydrogen for fuel cell power generation. Fabricate structural retrofits and develop deployable blast protection reinforcement systems for buildings to reduce blast debris hazards.

(U) $8,730 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0603211F, Aerospace Structures

(U) PE 0603202F, Aerospace Propulsion Subsystem Integration

(U) PE 0603203F, Advanced Aerospace Sensors.

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 633946

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603202F Aerospace Propulsion Subsystems Integration
	PROJECT: 63668A

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63668A	Aircraft Propulsion Subsystem Integration	25,150	19,586	34,440	32,161	32,353	27,080	23,423	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates gas turbine propulsion system technologies applicable to a broad range of aircraft. The Aircraft Propulsion Subsystem Integration (APSI) program includes demonstrator engines such as the Joint Technology Demonstrator Engine (JTDE) for manned systems and the Joint Expendable Turbine Engine Concept (JETEC) for uninhabited air vehicle and cruise missile applications. These demonstrator engines apply the core technology developed under the Advanced Turbine Engine Gas Generator (ATEGG) program coupled with affordable and durable system component technology such as low pressure fans and low pressure turbines (LPT), engine controls, and nozzles developed as part of APSI. This program also focuses on system integration aspects of inlets, nozzles, engine/airframe compatibility, and low-observable technologies. APSI will provide aircraft with potential for longer range and higher cruise speed 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. The APSI program supports the demonstration of performance, cost, and durability goals of the Integrated High Performance Turbine Engine Technology (IHPTET) program. IHPTET is a three phase, totally integrated DOD, Defense Advanced Research Projects Agency (DARPA), National Aeronautics and Space Administration (NASA), and industry initiative focused on doubling turbine engine propulsion capabilities while reducing cost of ownership. The IHPTET program structure provides continuous technology transition for military turbine engine upgrades and derivatives and has the added benefit of enhancing the U.S. turbine engine industry's international competitiveness.

(U) FY 1999 ($ in Thousands)

(U) $3,404 Designed, fabricated, and demonstrated controls technology for turbofan/turbojet engines for improved performance and reduced maintenance of current and future Air Force aircraft.

(U) $8,320 Designed, fabricated, and demonstrated durability and integration technology for turbofan/turbojet engines for improved supportability and affordability of current and future Air Force aircraft.

(U) $9,279 Designed, fabricated, and tested technology demonstration engines for improved performance and fuel consumption of turbofan/turbojet engines for fighters, aircraft, bombers, and transports.

(U) $4,147 Designed, fabricated, and tested technology demonstration engines for improved performance, durability, and affordability of engines for missile and uninhabited air vehicle applications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603202F Aerospace Propulsion Subsystems Integration
	PROJECT 63668A

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

(U) FY 1999 ($ in Thousands) Continued

(U) $25,150 Total

(U) FY 2000 ($ in Thousands)

(U) $4,350 Design, fabricate, and demonstrate durability and integration technologies for turbofan/turbojet engines for improved supportability and affordability of current and future Air Force aircraft. Initiate engine testing in support of the national High Cycle Fatigue (HCF) program including fan blade damage tolerance, frangible bearings, prognostics and health management, and F119 explosive blade out concept demonstration.

(U) $11,625 Design, fabricate, and test advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Complete advanced engine designs for fixed inlet guide vanes and Moderate Aspect Ratio (MAR) rotor, Integrally Bladed Rotor (IBR) repair, fan rim damper, HCF mistuning technologies, vaneless counterrotating high/low pressure turbine (LPT), probabilistic rotor system design, gamma titanium aluminide LPT coverplate, sprayform cast hardware, and Ceramic Matrix Composite (CMC) technologies. Initiate advanced engine designs for HCF robust front frame, two-stage forward swept fan, tiled LPT blade, uncooled CMC LPT blade, and model-based control with diagnostics. All of these technology innovations are applicable to a significant part of the Air Force engine inventory along with future engines including JSF F-119 and F-120 designs.

(U) $3,611 Design, fabricate, and test advanced component technologies for improved performance, durability, and affordability of engines for missile and uninhabited air vehicle applications. Complete engine testing of shrouded forward swept fan, low-cost ceramic hot section, low-cost rapid prototyping and high-speed machining, hybrid ceramic bearings, and high temperature transpiration cooled combustor. Initiate design of Organic Matrix Composite (OMC) fan, high stage loading splittered fan, uncooled ceramic high/low pressure turbine, and slinger combustor

(U) $19,586 Total

(U) FY 2001 ($ in Thousands)

(U) $5,363 Design, fabricate, and demonstrate durability and integration technologies for turbofan/turbojet engines for improved supportability and affordability of current and future Air Force aircraft. Complete engine testng in support of the National HCF program including fan blade damage tolerance, frangible bearings, prognostics and health management, and F119 explosive blade out concept demonstration

(U) $22,319 Design, fabricate, and test advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Fabricate and full-engine test fixed inlet guide vanes and MAR rotor, IBR repair, fan rim damper, HCF mistuning technologies, vaneless counterrotating high/low pressure turbine, probabilistic rotor system design, gamma titanium aluminide LPT coverplate, sprayform cast hardware, and CMC technologies. Continue advanced engine designs for HCF robust front frame, two-stage forward

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603202F Aerospace Propulsion Subsystems Integration
	PROJECT 63668A

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

(U) FY 2001 ($ in Thousands) Continued

swept fan, tiled LPT blade, uncooled CMC LPT blade, and model-based control with diagnostics. All of these technology innovations are applicable to a significant part of the Air Force engine inventory along with future engines including JSF F-119 and F-120 designs.

(U) $4,731 Design, fabricate, and test advanced component technologies for improved performance, durability, and affordability of engines for missile and uninhabited air vehicle applications. Continue design of OMC fan, high stage loading splittered fan, uncooled ceramic high/low pressure turbine, and slinger combustor.

(U) $2,027 Design, develop, and test integrated propulsion designs to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency (DARPA) missile demonstration. Fabricate and test flight type scramjet engine. Document engine performance and structural durability.

(U) $34,440 Total

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	27,722	29,825	31,022	
(U)	Appropriated Value	27,814	19,825		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-92	-2		
	b. Small Business Innovative Research	-880			
	c. Omnibus or Other Above Threshold Reprogram		-108		
	d. Below Threshold Reprogram	-1,551			
	e. Rescissions	-141	-129		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			3,418	
(U)	Current Budget Submit/FY 2001 PBR	25,150	19,586	34,440	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603202F Aerospace Propulsion Subsystems Integration
	PROJECT 63668A

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

(U) Significant Program Changes:
Increased funding in FY 2001 reflects increased emphasis on turbine engine propulsion.

(U) **D. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0603112F, Advanced Materials for Weapon Systems
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0602122N, Aircraft Technology
(U) PE 0603217N, Air Systems Advanced Technology Demonstration.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **E. Acquisition Strategy**
Not Applicable.

(U) **F. Schedule Profile**
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	26,260	37,948	28,311	29,714	26,107	25,269	27,389	Continuing	TBD
63665A	Advanced Aerospace Sensors Technology	12,681	12,615	14,601	16,013	11,765	10,572	12,384	Continuing	TBD
6369CK	Advanced Electronics	1,461	811	0	0	0	0	0	Continuing	TBD
6369DF	Target Attack and Recognition Technology	12,118	24,522	13,710	13,701	14,342	14,697	15,005	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, work performed under Project 6369CK and in PE 0603726F, Project 632863 moves to Project 63665A.

(U) **A. Mission Description**

This program develops technology to enable continued sensors superiority from space and aerial platforms. It develops and demonstrates the means to find, fix, target, track, and engage air and ground targets anytime, anywhere, and in any weather. Specifically, this program develops aerospace radio frequency (i.e., radar) and electro-optical sensors for detecting, locating, and targeting airborne, fixed, and time-critical mobile ground targets (whether those targets are obscured by natural or man-made means) while providing the capability to adapt to changes in target signatures and background environments. It also develops technology to enable combat aircraft to defeat increasingly sophisticated active and passive countermeasures, destroy a wide variety of targets with precision under a myriad of environmental conditions, and reliably perform complex missions with less logistics support in a world of proliferating threats. These advanced sensor capabilities will provide for flexible, multi-function/multi-mission combat aircraft that can: safely penetrate threat areas; destroy multiple ground targets per pass; accurately detect and identify targets beyond-visual-range within a complex mix of look-alike friendly, neutral, and enemy aircraft; win aerial engagements; and return to fight again. Note: In FY 2000, Congress added $2.3 million for Airborne Ground Radar Imaging and $9.0 million for the Integrated Demonstrations and Applications Laboratory.

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	28,534	29,405	32,330	
(U)	Appropriated Value	28,642	38,405		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-108	-2		
	b. Small Business Innovative Research	-780			
	c. Omnibus or Other Above Threshold Reprogram		-208		
	d. Below Threshold Reprogram	-1,347			
	e. Rescissions	-147	-247		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-4,019	
(U)	Current Budget Submit/FY 2001 PBR	26,260	37,948	28,311	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) program.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

PROJECT: 63665A

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63665A Advanced Aerospace Sensors Technology	12,681	12,615	14,601	16,013	11,765	10,572	12,384	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates aerospace sensor technologies for manned and unmanned platforms, including electro-optical (EO) sensors, radar sensors, components and algorithms, and electronic counter-countermeasures (ECCM) for radars. This project will provide aerospace platforms with the capability to precisely detect and target both airborne (conventional and low radar cross section) and ground-based, high-value, time-critical targets. Work includes developing both complete sensor capabilities as well as advanced component technologies. Desired warfighting capabilities include the ability to detect and target in difficult background conditions, especially the ability to counter improvements in camouflage, concealment, and deception techniques.

(U) FY 1999 ($ in Thousands)

(U)	$4,321	Developed integrated EO sensor technologies to detect, locate, and identify targets at ranges longer than currently achievable, whether the targets are camouflaged, low-observable, or employing other means of deception. Fabricated an EO sensor that operates in day or night across multiple bands.
(U)	$1,482	Developed and demonstrated radar electronic counter-countermeasure techniques to negate air intercept and synthetic aperture radar electronic countermeasures. Assessed use of neural nets to identify and remove jamming waveforms.
(U)	$2,743	Developed processing techniques to negate clutter and electromagnetic interference for uninterrupted sensor performance and increased detection and targeting performance against sophisticated and low radar cross section targets. Conducted laboratory and rooftop demonstrations of advanced mitigation techniques for severe interference and jamming environments.
(U)	$3,253	Developed the radio frequency (RF) sensor and algorithm technology required to detect, identify, and target high-value, time-critical targets obscured by foliage or concealed through deception, including ground testing real-time image formation/interference mitigation for foliage penetrating synthetic aperture radars.
(U)	$882	Developed critical components required to lower life cycle cost of current and future radar systems. Flight tested an affordable antenna suitable for unmanned vehicles.
(U)	$12,681	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors
	PROJECT 63665A

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

(U) FY 2000 ($ in Thousands)

(U)	$1,679	Develop integrated electro-optical (EO) sensor technologies to search, detect, locate, and identify targets at ranges longer than currently achievable, whether the targets are camouflaged, low-observable, or employing other means of deception. Complete fabrication and initiate flight test of an EO sensor that operates in day or night across multiple bands.
(U)	$2,236	Develop EO sensor technologies to detect and locate deep hide targets from high altitudes. Collect infrared sensor model validation data. Create hyperspectral imaging/fusion algorithms.
(U)	$2,183	Develop radar signal processing techniques to mitigate clutter and interference and improve detection and tracking of difficult targets. Develop adaptive processing for fighter detection of low-observable targets, demonstrating improved radar performance via enhanced antenna implementation. Develop integrated processing methods for improved ground target detection and tracking.
(U)	$3,398	Develop radio frequency (RF) sensor and algorithm technology required to detect, identify, and target high-value, time-critical targets obscured by foliage or obscured by deceptive techniques. Flight test image formation processing and automatic target detection.
(U)	$1,555	Develop technology to lower life cycle costs of radar systems. Laboratory test low-cost digital receivers and sensor components. Evaluate space-based apertures using micro-electro-mechanical phase shifters. Demonstrate a millimeter wave array for high-altitude unmanned aerial vehicles
(U)	$1,564	Develop technology for non-cooperative target identification. Build high resolution algorithms. Validate models. Flight test sensor hardware. Evaluate laser vibration as a solution to target identification.
(U)	$12,615	Total

(U) FY 2001 ($ in Thousands)

(U)	$1,915	Develop integrated EO sensor technology to search, detect, locate and identify air and ground targets at ranges longer than currently achievable, whether the targets are camouflaged, low-observable, or employing other means of deception. Optimize sensor design and perform utility assessments for affordable integrated targeting capability.
(U)	$3,320	Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace intelligence, surveillance, and reconnaissance applications. Complete critical signature data collection experiments to determine performance parameters for day/night hyperspectral sensors. Fabricate a hyperspectral imaging sensor for high altitude reconnaissance aircraft.
(U)	$1,908	Develop advanced radar signal processing techniques to mitigate clutter and jamming interference and improve detection and tracking of difficult targets. Demonstrate ability to detect slow moving airborne and ground targets from an airborne platform.
(U)	$2,470	Develop and demonstrate the radio frequency sensor and algorithm technology required to detect, identify, and target high-value, time-critical targets obscured by foliage or concealed through deceptive techniques. Perform flight test demonstration of foliage penetration radio frequency (RF) sensor and real-time image formation algorithms.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors / PROJECT: 63665A

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$874	Develop technology to lower life cycle costs of radar systems. Develop low-cost, lightweight antennas using micro-electro-mechanical phase shifters for aerospace surveillance and strike radar applications.
(U)	$2,180	Develop advanced electro-optical sensor technology for non-cooperative target identification. Flight test eye-safe sensor. Perform necessary modifications prior to sensor transition.
(U)	$825	Develop advanced multi-function sensor component technologies for radar, electronic warfare, navigation, and communications applications. Demonstrate and evaluate affordable, high performance RF circuits and packaging technologies for use in phased array transmit/receive modules on manned and unmanned platforms. (In FY 2000, this work was performed in Project 6369CK)
(U)	$1,109	Develop advanced RF photonic signal control and distribution technologies for phased array apertures. Demonstrate and evaluate photonic beamforming. Design and fabricate true-time-delay photonic technology for phased array antennas used in intelligence, surveillance, and reconnaissance applications. (In FY 2000, this effort was conducted under PE 0603726F, Project 632863.)
(U)	$14,601	Total

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

Not Applicable.

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

(U) Related Activities:

PE 0602204F, Aerospace Sensors.
PE 0603205F, Flight Vehicle Technology.
PE 0603707F, Weather Systems Advanced Development.
PE 0602111N, Weapons Technology.
PE 0602232N, Space and Electronic Warfare (SEW) Technology.
PE 0604249F, LANTIRN Night Precision Attack.
PE 0603270F, Electronic Combat Technology.

A memorandum of agreement has been established between the Air Force Research Laboratory and the Defense Advanced Research Projects Agency (DARPA) to jointly develop the technology required to detect high-value, time-critical targets in a variety of environments including deception, camouflage, concealment, and deep hide.

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT 63665A

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors — PROJECT: 6369CK

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
6369CK Advanced Electronics	1,461	811	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates military specific microwave, microelectronic, and photonic devices, tools, and components to improve performance, reliability, and affordability of aerospace radar, communications, and electronic counter-countermeasure systems for both retrofit and new system applications. Results provide the warfighter with improved sensor capabilities in terms of increased situational awareness, higher accuracy detection and tracking of targets and threats at longer ranges, and more precise weapon employment. This project develops electronics technologies unavailable from commercial sources and includes development of: aerospace radar monolithic solid state transmit/receive modules; high-speed analog-to-digital converters; photonic processing techniques; high reliability electronics power distribution; microwave and microelectronics packaging and interconnect techniques; and radio frequency (RF) photonic distribution subsystems.

(U) FY 1999 ($ in Thousands)

(U)	$1,461	Developed advanced multi-function sensor electronics, including integrated analog/digital applications, to increase reliability, improve performance and jam resistance, and decrease cost, weight, and volume in aerospace sensors. Developed very high-speed digital assemblies. Fabricated and tested high performance RF/digital multichip assemblies. Completed preliminary designs for miniature, all-digital microwave receiver components.
(U)	$1,461	Total

(U) FY 2000 ($ in Thousands)

(U)	$456	Develop advanced multi-function sensor electronics. Develop affordable, high performance radio frequency circuits and packaging technologies for use in phased array transmit/receive modules on manned and unmanned platforms.
(U)	$355	Perform application trade studies for space-based photonics RF signal distribution, including photonic beamforming for Global Positioning System (GPS) applications.
(U)	$811	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort transferred to Project 63665A.
(U)	$0	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603203F Advanced Aerospace Sensors	6369CK

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

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603270F, Electronic Combat Technology.

(U) PE 0603739E, Electronic Manufacturing Technology.

(U) PE 0603706E, Microwave/Millimeter Wave Integrated Circuits.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors — PROJECT: 6369DF

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
6369DF Target Attack and Recognition Technology	12,118	24,522	13,710	13,701	14,342	14,697	15,005	Continuing	TBD

(U) **A. Mission Description**

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) FY 1999 ($ in Thousands)

(U) $1,932 Developed and demonstrated advanced air-to-air detection, tracking, identification, and engagement technologies. Investigated advanced sensors suites. Analyzed ground test data for target identification through combined radar modes.

(U) $5,290 Developed advanced situation awareness technologies to increase air-to-ground engagement lethality and survivability. Demonstrated multisource fusion of electronic intelligence with synthetic aperture radar (SAR). Flight demonstrated real-time rerouting of a low-observable platform using real-time information-in-the-cockpit technology. Developed and flight tested fusion of forward looking infrared and SAR data on an interdiction fighter.

(U) $4,896 Develop and demonstrate innovative air-to-ground automatic target recognition (ATR) and identification technologies to increase the ability to detect, identify, and target hostile ground forces. Developed and integrated an ATR/fusion algorithm testbed. Downselected and integrated an optimal algorithm for the longer timelines of reconnaissance radars. Performed detailed analysis of air-to-ground ATR algorithms using enhanced radar with third-generation forward looking infrared and multispectral automatic target recognition (ATR). Demonstrated the identification of friendly and hostile ground forces.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE
		February 2000
BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603203F Advanced Aerospace Sensors	6369DF

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

(U) FY 1999 ($ in Thousands) Continued

(U) $12,118 Total

(U) FY 2000 ($ in Thousands)

(U) $2,661 Develop advanced situation awareness technologies for rapid detection, location, and prosecution of time-critical targets. Demonstrate ground station fusion of synthetic aperture radar and signals intelligence. Develop on-board/off-board data and image fusion algorithms.

(U) $2,909 Develop and demonstrate real-time information-in-the-cockpit technologies. Flight demonstrate and simulate real-time route replanning and retargeting for stealth strike platforms. Develop real-time retargeting algorithms for special operation forces.

(U) $1,539 Develop and evaluate radar ATR algorithms for tracking moving ground targets. Evaluate radar algorithms for tracking moving ground target. Reduce transition risk by planning affordable upgrades to strike and reconnaissance platforms.

(U) $1,176 Develop target recognition concepts using hyperspectral imaging and other candidate sensor inputs to determine requirements for ATR and target/background phenomenology efforts. Build algorithms using hyperspectral imaging data.

(U) $2,966 Test and integrate Defense Advanced Research Projects Agency multi-sensor ATR fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, and reconnaissance functions.

(U) $2,041 Develop advanced tactical targeting technology in conjunction with Defense Advanced Research Projects Agency for suppression of enemy air defenses. Conduct hardware-in-the-loop testing against threat radio frequency signals.

(U) $2,262 Develop air-to-ground radar imaging technology for all-weather detection and identification of ground targets.

(U) $8,968 Develop integrated demonstrations and applications laboratory testbed for maturing aerospace sensor technologies through hardware-in-the-loop simulation. Create the capability to generate high fidelity emissions that simulate real battlespace threat systems, allowing warfighters to affordably evaluate sensor technologies under realistic combat conditions.

(U) $24,522 Total

(U) FY 2001 ($ in Thousands)

(U) $2,113 Develop advanced situation awareness technologies for rapid detection, location, and prosecution of time-critical targets. Demonstrate algorithms for multisensor fusion of on- and off-board data and images.

(U) $2,857 Develop and demonstrate technologies for real-time information in- and out-of-the-cockpit for improved situational awareness. Complete route replanning simulations. Continue to develop real-time retargeting algorithms for special operation forces applications.

(U) $1,820 Develop and evaluate radar automatic target recognition (ATR) algorithms for tracking and identifying moving and stationary ground targets. Conduct risk reduction activities to improve affordability and smooth transition of technology via planned sensor upgrades to strike and reconnaissance platforms.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors / PROJECT: 6369DF

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$1,146	Develop target recognition concepts using hyperspectral imaging data and other candidate sensor inputs to determine requirements for ATR and target/background phenomenology efforts. Evaluate algorithms using hyperspectral imaging data.
(U)	$2,600	Continue testing and integrating Defense Advanced Research Projects Agency (DARPA) multi-sensor automatic target recognition fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, and reconnaissance missions.
(U)	$3,174	Develop advanced tactical targeting technology in conjunction with DARPA for suppression of enemy air defenses. Optimize targeting algorithms and techniques. Modify brassboard units that triangulate threat emitter position and provide targeting for precision guided munitions.
(U)	$13,710	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0603253F, Advanced Sensor Integration.
(U) PE 0603762E, Sensor and Guidance 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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	6,369	5,960	2,445	500	436	0	0	Continuing	TBD
632978	Flight Vehicle Technologies	4,682	4,599	1,796	266	268	0	0	Continuing	TBD
634398	Air Base Technology	1,687	1,361	649	234	168	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: This program element (PE) will be eliminated in FY 2004 and the ongoing technical programs in Project 632978 will be transferred to PE 0603245F, Flight Vehicle Technology Integration, Project 632568, Flight Vehicle Technology Integration and the ongoing programs in 634398 will transferred to 0603112F, Advanced Materials for Weapon Systems, Project 633946, Materials Transition.

(U) **A. Mission Description**

This program develops and demonstrates advanced aerospace vehicle subsystems, aerodynamic/flight controls, and vehicle-pilot interface technologies for improved aerospace vehicle performance, decreased vulnerability, and reduced logistics support. This program also demonstrates technologies for fixed and bare base assets, including airfield pavements, energy systems, air base survivability, air base recovery, protective systems, fire protection, and crash rescue.

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	7,007	5,992	4,258	
(U)	Appropriated Value	7,035	5,992		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-28			
	b. Small Business Innovative Research	-212			
	c. Omnibus or Other Above Threshold Reprogram		-32		
	d. Below Threshold Reprogram	-391			

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603205F Flight Vehicle Technology

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

		FY 1999	FY 2000	FY 2001	Total Cost
	e. Rescissions	-35			
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-1,813	
(U)	Current Budget Submit/FY 2001 PBR	6,369	5,960	2,445	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603205F Flight Vehicle Technology PROJECT 632978

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632978 Flight Vehicle Technologies	4,682	4,599	1,796	266	268	0	0	Continuing	TBD

(U) **A. Mission Description**

This program develops and demonstrates advanced manned and unmanned aerospace flight controls, and vehicle-pilot interface technologies for improved aerospace vehicle performance, decreased vulnerability, and reduced logistics support.

(U) FY 1999 ($ in Thousands)

(U) $1,929 Developed technologies for automatic in-flight replanning for the cockpit to reduce pilot workload. These benefits will be seen in future aerospace vehicle designs and technologies.

(U) $973 Developed algorithms for multiple ship integrated control strategies to enable the safe and effective cooperative employment of manned and unmanned strike aerospace vehicles for air combat operations.

(U) $1,780 Developed advanced integrated aerospace vehicle subsystems to provide increased performance and decreased vulnerability while decreasing both cost and logistic supportability requirements. Fabricated flight critical stabilator actuator to demonstrate operational and military utility.

(U) $4,682 Total

(U) FY 2000 ($ in Thousands)

(U) $2,184 Develop technologies for automatic in-flight replanning for the cockpit to reduce pilot workload. Begin testing autonomous unmanned combat air vehicles systems for automatic in-flight replanning.

(U) $854 Develop algorithms for multiple ship integrated control strategies to enable the safe and effective cooperative employment of manned and unmanned strike aerospace vehicles for air combat operations. Begin integrated control system testing of advanced flight control algorithms.

(U) $1,561 Develop advanced integrated aerospace vehicle subsystems to provide increased performance and decreased vulnerability while decreasing both cost and logistic supportability requirements. Start ground demonstration of a nacelle ballistic fire suppression concept. Continue flight critical stabilator actuator test to demonstrate operational military and utility.

(U) $4,599 Total

(U) FY 2001 ($ in Thousands)

(U) $208 Continue development of aerospace vehicle air-to-air collision avoidance technologies to increase tactics flexibility and increase aerospace vehicle survivability. Continue development of air collision avoidance technologies previously developed and simulated for a limited number of manned aircraft and Unmanned Air Vehicles (UAVs) to larger flights of UAVs. Initiate integration of the auto air collision avoidance algorithms into vehicle management systems architecture and validate in a laboratory environment.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603205F Flight Vehicle Technology
PROJECT 632978	

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$533	Demonstrate optical control technologies to integrate power and control systems to significantly decrease system volume and weight and to eliminate electromagnetic interference problems in air vehicle control systems. Conduct physical system ground demonstration of optical control technologies.
(U)	$1,055	Develop advanced concepts for engine nacelle ballistic impact fire suppression to increase survivability, while decreasing both cost and logistics support requirements. Complete ground demonstration of nacelle ballistic fire suppression concepts.
(U)	$1,796	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602201F, Aerospace Flight Dynamics

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

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology / PROJECT: 634398

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634398 Air Base Technology	1,687	1,361	649	234	168	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops 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.

(U) FY 1999 ($ in Thousands)

(U) $601 Developed aircraft and air base fire fighting and power generation technologies including clean, environmentally safe fire fighting agents, equipment, personnel protective clothing, fire risk assessment techniques, and fire fighter training systems.

(U) $929 Developed technologies, utilities, and shelters that improve air base operations. These technologies include completion of the acoustic cycle heat pump that reduces airlift requirements in support of Air Expeditionary Force (AEF) operations rapid deployment.

(U) $157 Constructed an air transportable shelter advanced development model for field testing to support AEF operations rapid deployment.

(U) $1,687 Total

(U) FY 2000 ($ in Thousands)

(U) $621 Develop aircraft and air base fire fighting and power generation technologies to improve fire fighting rescue. Test fire fighting agents and equipment. Develop protective clothing, fire risk assessment technologies, and fire fighting training systems.

(U) $360 Develop technologies, utilities, and shelters that improve air base operations. These technologies include completion of the acoustic cycle heat pump that reduces airlift requirements in support of AEF operations rapid deployment.

(U) $380 Construct an air transportable shelter advanced development model for field testing to support AEF operations. Begin laboratory tesing of advanced lightweight shelter components.

(U) $1,361 Total

(U) FY 2001 ($ in Thousands)

(U) $278 Develop aircraft and air base fire fighting and power generation technologies to improve fire fighting rescue. Test safe fire fighting agents. Contoinue development of protective fire fighting clothing and fire risk assessment technologies. Evaluate new fire fighting training concepts.

(U) $181 Develop technologies, utilities, and shelters that improve air base operations. Complete the acoustic cycle heat pump technology demonstration that reduces airlift requirements in support of AEF operations rapid deployment.

(U) $190 Construct an air transportable shelter advanced development model for field testing to support AEF operations rapid deployment.

(U) $649 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology / PROJECT: 634398

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics
(U) PE 0603307F, Air Base Operability Advanced Technology Development.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603211F Aerospace Structures

PROJECT: 63486U

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63486U	Advanced Aerospace Structures	11,640	16,638	12,961	11,918	15,094	18,908	17,071	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates affordable aerospace vehicle structures by utilizing innovative metallic and composite structures technologies to reduce the cost of airframe ownership. Innovative structural concepts integrate these two types of materials with design and monitoring techniques to develop and demonstrate solutions and repairs for corrosion fatigue, multi-site damage fatigue, and other damage to which aging aircraft are susceptible. The goal of this program is to develop technologies to restore structural integrity, extend life, and improve survivability of the current fleet and future fleet of manned and unmanned aerospace vehicles. The results are less maintenance intensive, more durable, and more dependable structures for current and future aerospace systems. This yields lower cost of ownership (by delaying acquisition and by reducing support and maintenance costs), restored and improved sortie rates (due to durability, damage or threat tolerance, and design for supportability), and reduced observability (both radar cross section and infrared). Note: In FY 2000, Congress added $3.0 million for polymeric foam technology.

(U) FY 1999 ($ in Thousands)

(U) $5,688 Improved durability and performance, affordability, and longevity of existing aging aircraft and future aerospace vehicle structures operating in extreme thermal and acoustic environments to decrease vulnerability and increase longevity of aerospace vehicles with the fabrication of an integrated aft fuselage and nozzle section.

(U) $5,491 Developed advanced structural concepts and design methods for future and existing air vehicles, such as the fabrication of a full-scale structural component for demonstration or flexible wing demo that twists to control flight.

(U) $461 Developed and applied new analysis methods and design criteria to advanced composite structures for reduction in life cycle costs of current and future aerospace vehicles by maximizing the use of composite structures.

(U) $11,640 Total

(U) FY 2000 ($ in Thousands)

(U) $7,420 Improve durability and performance, affordability, and longevity of existing aging aircraft and future aerospace vehicle structures operating in extreme thermal and acoustic environments. Continue to fabricate an integrated aft fuselage and nozzle section.

(U) $8,733 Develop advanced structural concepts and design methods for future and existing aerospace vehicles to enhance durability and longevity of existing aircraft and future aerospace vehicle structures. Design a full-scale structural component for demonstration or flexible wing demo that twists to control flight. Evaluate polymeric foam technology for a wide variety of secondary structures (i.e., leading and trailing edges, flaps,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603211F Aerospace Structures
	PROJECT 63486U

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

(U) FY 2000 ($ in Thousands) Continued

doors, spoiler, etc.).

(U) $485 Develop and apply new analysis methods and design criteria to advanced composite structures for reduction in life cycle costs of current and future aerospace vehicles by maximizing the use of composite structures.

(U) $16,638 Total

(U) FY 2001 ($ in Thousands)

(U) $5,168 Continue improvement in durability and affordability of existing aging aircraft and future aerospace vehicle structures for reduced operations and support costs and extend usable structural lives. Develop advanced methods for predicting structural strength and life remaining due to effects of fatigue, corrosion, and damage. Develop and validate low-cost advanced methods to restore original structural integrity, reduce repair cost, reduce inspection cost, and increase aircraft availability.

(U) $1,003 Develop advanced design concepts and methods to suppress aero-acoustic noise and vibration in advanced aircraft weapons bays to expand weapons employment envelope and reduce fatigue related failures. Investigate concepts to reduce life cycle cost of aircraft by reducing/eliminating fatigue in weapons bay area. Evaluate aerodynamic airflow control devices to improve weapons system performance by expanding aircraft store (fuel tanks, weapons, space, etc.) and aircraft release envelope.

(U) $1,069 Develop advanced structural concepts and design methods for future aerospace vehicles for enhanced affordability and higher performance. Demonstrate, through flight test, the increased control authority of an active aeroelastic wing and, thereby, transition of technology to reduce airframe cost and weight for future air vehicles.

(U) $1,400 Demonstrate new analysis methods and design criteria for advanced composite structures to reduce life cycle costs of current and future aerospace vehicles by maximizing the use of composite structures. Continue to develop design concepts and structural criteria to implement lower cost manufacturing processes and materials in future airframes. Verify the structural integrity of affordable bonded unitized composite structure.

(U) $4,321 Reduce susceptibility and increase survivability of existing and planned aircraft through demonstration of lightweight and low-cost electromagnetic infrared signature suppression capability. Apply new structural design specifications that allow smaller and damage tolerant inlet and exhaust engine ducts. Design a full-scale structurally integrated airframe and turbine engine inlet and begin ground component testing.

(U) $12,961 Total

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603211F Aerospace Structures / PROJECT: 63486U

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	12,411	13,749	15,182	
(U)	Appropriated Value	12,494	16,749		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-83			
	b. Small Business Innovative Research	-364			
	c. Omnibus or Other Above Threshold Reprogram		-91		
	d. Below Threshold Reprogram	-342			
	e. Rescissions	-65	-20		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-2,221	
(U)	Current Budget Submit/FY 2001 PBR	11,640	16,638	12,961	TBD

(U) Significant Program Changes:
Changes to this program since the previous President's Budget are due to reductions to the acoustic bay weapons program.

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

(U) Related Activities:
(U) PE 0603245F, Flight Vehicle Technology Integration.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) E. Acquisition Strategy

Not Applicable.

(U) F. Schedule Profile

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	33,579	38,723	41,964	40,254	41,845	37,527	34,546	Continuing	TBD
632480	Aerospace Fuels and Atmospheric Propulsion	1,904	2,198	2,075	2,984	3,164	3,228	3,292	Continuing	TBD
633035	Aerospace Power Technology	3,167	3,520	2,423	2,632	4,224	4,309	4,394	Continuing	TBD
63681B	Advanced Turbine Engine Gas Generator	28,508	33,005	37,466	34,638	34,457	29,990	26,860	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates affordable turbine engine high pressure core components, advanced airbreathing engine concepts, high heat sink and thermally stable fuels, and power technology for air, space, and weapon power applications. Anticipated technology advances include turbine engine improvements providing a 33% reduction in aircraft takeoff gross weight for tactical fighter aircraft and a 100% increase in aircraft range/loiter; ducted rocket improvements that increase missile average and terminal velocity by 50% and range by 100% for enhanced lethality; higher temperature fuels for propulsion and thermal management; and electric power system components projected to provide a two-to-five-fold improvement in aircraft reliability and maintainability, a 20% reduction in power system weight, and enhaced vulnerablity and survivability. Note: In FY 2000, Congress added $0.4 million for aircraft and weapons power.

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	36,867	38,778	39,061	
(U)	Appropriated Value	36,984	39,178		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-117	-2		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology

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

		FY 1999	FY 2000	FY 2001	Total Cost
	b. Small Business Innovative Research	-1,195			
	c. Omnibus or Other Above Threshold Reprogram		-212		
	d. Below Threshold Reprogram	-1,905			
	e. Rescissions	-188	-241		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			2,903	
(U)	Current Budget Submit/FY 2001 PBR	33,579	38,723	41,964	TBD

(U) Significant Program Changes:

Increased funding in FY 2001 reflects increased emphasis on turbine engine propulsion.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology PROJECT 632480

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632480 Aerospace Fuels and Atmospheric Propulsion	1,904	2,198	2,075	2,984	3,164	3,228	3,292	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates new thermally stable, high heat sink, controlled chemically reacting fuels and advanced fuel system components that minimize cost, reduce maintenance, and improve performance of aerospace systems. Emphasis is on demonstrating the effects/benefits of JP-8+225 and JP-900 on advanced high temperature fuel system designs and components on upgraded and advanced systems.

(U) FY 1999 ($ in Thousands)

(U) $1,304 Demonstrated thermally stable JP-8+100 high heat sink fuel that reduces fuel system maintenance on current aircraft and provides greater cooling capacity (performance) for upgraded and future aircraft and missiles.

(U) $203 Demonstrated effectiveness of thermally stable JP-8+100 for reduced maintenance in a variety of aircraft.

(U) $300 Demonstrated advanced fuel system designs and high temperature components that permit utilization of the increased cooling capacity of JP-8+100 and high heat sink fuels.

(U) $97 Developed and demonstrated critical high-speed propulsion components/structures for manned and unmanned applications which will provide technology at lower risk for future missile systems where time-to-target is critical and for next generation reconnaissance/strike vehicles and airbreathing boosters.

(U) $1,904 Total

(U) FY 2000 ($ in Thousands)

(U) $888 Demonstrate thermally stable JP-8+100 high heat sink fuel that reduces fuel system maintenance on current aircraft and provides greater cooling capacity (performance) for upgraded and future aircraft and missiles. Determine the effects/benefits of thermally stable JP-8+100 and JP-8+225 fuel for several current and advanced fighter configurations.

(U) $725 Demonstrate effectiveness of thermally stable JP-8+100 for reduced maintenance in a variety of aircraft. Fabricate a subscale fuel system simulator for testing thermally stable JP-8+225 and other high heat sink fuels that reduce fuel system maintenance for the current inventory and future propulsion configurations.

(U) $410 Demonstrate advanced fuel system designs and high temperature components that permit utilization of the increased cooling capacity of JP-8+100 and high heat sink fuels. Design and fabricate heat exchanger for indirect cooling concept for advanced, high temperature engine designs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT 632480

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$175	Demonstrate a direct fuel/air heat exchanger for cooled cooling air systems. Compare performance and benefits of the direct fuel/air heat exchanger to the indirect system.
(U)	$2,198	Total

(U) FY 2001 ($ in Thousands)

(U)	$855	Demonstrate thermally stable JP-8+100 high heat sink fuel that reduces fuel system maintenance on current aircraft and provides greater cooling capacity (performance) for upgraded and future aircraft and missiles. Demonstrate, in a subscale fuel system simulator, the effects/benefits of thermally stable JP-8+225 and other high heat sink fuels that reduce fuel system maintenance for advanced fighter configurations.
(U)	$810	Demonstrate effectiveness of thermally stable JP-8+100 for reduced maintenance in a variety of aircraft. Fabricate a subscale integrated fuel/air heat exchanger-combustor in a cooled cooling air configuration, using fuel/air heat exchanger technology designed and fabricated in FY 2000.
(U)	$410	Demonstrate low-cost fuel-additive approaches to control particulate emissions from gas turbine engines. Demonstrate concepts for improving ignition and combustion in advanced engines.
(U)	$2,075	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology PROJECT 633035

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633035 Aerospace Power Technology	3,167	3,520	2,423	2,632	4,224	4,309	4,394	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates aircraft and ground power systems including engine starters, auxiliary power units, and electrical power generation and distribution systems to enhance system reliability, survivability, and vulnerability, reduce weight, and lower life cycle costs for (manned and unmanned) aircraft and spacecraft while enabling high power density sources for directed energy weaponry.

(U) FY 1999 ($ in Thousands)

(U) $431 Designed, fabricated, and tested an electrical distribution system which ensures fault tolerant architecture, improving aircraft reliability and survivability.

(U) $931 Developed an aircraft electrical power generation and distribution system for test validation and flight demonstration which will ensure fault tolerant architecture and will improve aircraft reliability and survivability.

(U) $1,805 Designed, fabricated, and tested a demonstrator aircraft on-board Integrated Power Unit (IPU) which is critical for aircraft engine starting, auxiliary power, and emergency power.

(U) $3,167 Total

(U) FY 2000 ($ in Thousands)

(U) $740 Design, fabricate, and test a demonstrator aircraft on-board IPU which is critical for aircraft engine starting, auxiliary power, and emergency power. The demonstrator will integrate the switched reluctance starter generator with magnetic bearings and the turbomachine to demonstrate IPU feasibility, weight savings, and reliablilty improvements over conventional Auxiliary Power Unit/Emergency Power Unit (APU/EPU) approaches.

(U) $90 Perform IPU aircraft integration analysis to determine mission available power for Directed Energy Weapon (DEW) applications.

(U) $2,690 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. Develop IPU prognostics health management and power electronics for increased reliability, decreased maintenance, and 2X increase in power density which is enabling for advanced fighter aircraft and Uninhabited Combat Aerial Vehicles (UCAV).

(U) $3,520 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology
	PROJECT 633035

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

(U) FY 2001 ($ in Thousands)

(U)	$596	Design, fabricate, and test an electrical distribution system which ensures fault tolerant architecture, improving aircraft reliability and survivability. Complete test of the demonstrator aircraft on-board Integrated Power Unit (IPU). The demonstrator will integrate the switched reluctance starter generator with magnetic bearings and the turbomachine to demonstrate IPU feasibility, weight savings, and reliablilty improvements over conventional Auxiliary Power Unit/Emergency Power Unit (APU/EPU) approaches.
(U)	$100	Design, fabricate, and test for emergency power capabilities of an IPU.
(U)	$1,727	Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. Test IPU prognostics health management and power electronics for increased reliability, decreased maintenance, and 2X increase in power density which is enabling for advanced fighter aircraft and Uninhabited Combat Aerial Vehicles (UCAV).
(U)	$2,423	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602201F, Aerospace Flight Dynamics.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology PROJECT 63681B

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63681B Advanced Turbine Engine Gas Generator	28,508	33,005	37,466	34,638	34,457	29,990	26,860	Continuing	TBD

(U) **A. Mission Description**

This project develops turbine engine gas generator technology to meet the requirements of current and future aircraft propulsion systems. The objective is to provide the continued evolution of technologies into an advanced gas generator in which the performance, cost, durability, repairability, and maintainability aspects can be assessed in a real engine environment. The gas generator, or core, is the basic building block of the engine and it consists of a compressor, a combustor, and a high pressure turbine. Experimental core engine testing enhances early, low-risk transition of key engine technologies into engineering development where they can be applied to derivative and/or new systems. These technologies are applicable to a wide range of military and commercial systems including aircraft, missiles, land combat vehicles, and ships. The Advanced Turbine Engine Gas Generator project supports the Integrated High Performance Turbine Engine Technology (IHPTET) program. IHPTET is a three phase, totally integrated DoD, Defense Advanced Research Projects Agency (DARPA), National Aeronautics and Space Administration (NASA), and industry program focused on doubling turbine engine propulsion capabilities while reducing cost of ownership. The IHPTET program structure provides continuous technology transition for military turbine engine upgrades and derivatives and has the added benefit of enhancing the U.S. turbine engine industry's international competitiveness and demonstrates affordable turbine engine high pressure core components.

(U) FY 1999 ($ in Thousands)

(U)	$23,485	Designed, fabricated, and performance tested technology demonstration core engines to provide improved performance and fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports.
(U)	$982	Designed, fabricated, and durability tested technology demonstration core engines to provide increased durability and affordability for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports.
(U)	$4,041	Designed, fabricated, and tested technology demonstration core engines to provide improved performance and fuel consumption for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, theater transports, and large uninhabited air vehicles.
(U)	$28,508	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology
	PROJECT 63681B

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

(U) FY 2000 ($ in Thousands)

(U)	$26,940	Design, fabricate, and performance test technology demonstration core engines to provide improved performance and fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports. Initiate advanced core engine testing for integrally bladed rotor repair, impingement film floatwall combustor, advanced thermal barrier coating, supercooled high pressure turbine castability, and mistunning technologies. Design advanced hardware for core engine testing of load decoupler fan frame; ceramic matrix composite combustor liner; ceramic bearing; and advanced turbine vane, blade, and disk aterials. All of these technology innovations are appicable to a significant part of the Air Force engine inventory along with future engines including JSF F-119 and F-120 designs.
(U)	$2,006	Design, fabricate, and durability test technology demonstration core engines to provide increased durability and affordability for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports. Fabricate hardware for core engine testing in support of the national high cycle fatigue program, compressor rotor ring damper, compressor rotor damping coating, and advanced non-intrusive stress measurement system.
(U)	$4,059	Design, fabricate, and test technology demonstration core engines to provide improved performance and fuel consumption for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, theater transports, and large uninhabited air vehicles. Conduct core engine testing of splittered compressor rotor, rich quench lean combustor, counter rotating turbines, ceramic turbine vanes, and hybrid ceramic bearings. Design hardware for core engine testing of forward swept splittered compressor rotor, high temperature rise combustor, counter rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings.
(U)	$33,005	Total

(U) FY 2001 ($ in Thousands)

(U)	$28,707	Design, fabricate, and performance test technology demonstration core engines to provide improved performance and fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports. Complete core engine testing for integrally bladed rotor repair, impingement film floatwall combustor, advanced thermal barrier coating, supercooled high pressure turbine castability, and mistunning technologies. Design and fabricate long lead hardware for core engine testing of load decoupler fan frame, ceramic matrix composite combustor liner, ceramic bearing, and advanced turbine vane, blade and disk materials. All of these technology innovations are appicable to a significant part of the Air Force engine inventory along with future engines including JSF F-119 and F-120 designs.
(U)	$2,073	Design, fabricate, and durability test technology demonstration core engines to provide increased durability and affordability for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports. Conduct core engine testing of national high cycle fatigue program, compressor rotor ring damper, compressor rotor damping coating, and advanced non-intrusive stress measurement system.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology
	PROJECT 63681B

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$4,440	Design, fabricate, and test technology demonstration core engines to provide improved performance and fuel consumption for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, theater transports, and large uninhabited air vehicles. Conduct core engine testing of splittered compressor rotor, rich quench lean combustor, counter rotating turbines, ceramic turbine vanes and hybrid ceramic bearings. Fabricate hardware for core engine testing of forward swept splittered compressor rotor, high temperature rise combustor, counter rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings.
(U)	$2,246	Design, develop, and test structures and propulsion designs to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency (DARPA) missile demonstration. Complete fabrication and testing of flight type scramjet combustor and inlet.
(U)	$37,466	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0603202F, Aircraft Propulsion Subsystem Integration.
(U) PE 0602122N, Aircraft Technology.
(U) PE 0603210N, Aircraft 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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603227F Personnel Training and Simulation Technology / PROJECT: 632743

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632743	Advanced Training/Force Management	6,145	6,250	6,491	7,633	8,569	5,773	5,886	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates technologies that will result in improved warfighter readiness. Develops, demonstrates, and evaluates technologies for Distributed Mission Training (DMT) including realistic, effective, and affordable synthetic combat environments, technologies for long distance networking to enhance joint-service training, visual displays for real-time and post-mission debrief, and instructional strategies to support warfighter training in a joint synthetic battlespace. Provides a technology testbed for examining warfighter skills, cognitive functions, and behaviors contributing to combat readiness. Develops models to support aircrew, space, and information operations, performance measurement systems for air, space and information warfare, and tools for mission planning, rehearsal, execution, and force protection in a distributed mission environment. Develops and demonstrates technologies necessary to provide realistic training for night time warfighting. Develops and demonstrates computer-based intelligent tutoring technology for representative tasks in high technology jobs, and software to enable Air Force training developers to rapidly and affordably build intelligent computer assisted training systems which continually interact with students for effective individualized training. Develops and demonstrates information management technology for the warfighter at the unit level. Work concentrates on aircrew, space, and information dominance domains. Note: In FY 2000, Congress added $1.5 million for Behavioral Science Research under AFRL (Air Force Research Laboratory).

(U) FY 1999 ($ in Thousands)

(U) $1,154 Developed, demonstrated, and evaluated technologies to create DMT capabilities including electronic combat environment tools to represent threat systems and to allow for a more accurate representation of the battlespace in the DMT environment. Incorporated Semi-Automated Forces (SAF) and Synthetic Theater of War (STOW) to give a more realistic representation of the combat environment and developed a certified dynamic threat system which incorporates representative real-world threat systems.

(U) $920 Began development of simulator visual technologies including a high-resolution laser projection system for more accurately portraying friendly and threat airborne systems.

(U) $1,990 Developed and demonstrated technologies to enable and enhance Night Vision Goggle (NVG) training and rehearsal for aircrews by developing simulation requirements for physics-based, low-cost, deployable real-time simulation of NVG imagery to support mission training and provided technical support to Air Force and DoD for NVG design, acquisition, flight test, lighting compatibility, mishap investigations, and training syllabus development. Designed and delivered low-cost, NVG compatible interim lighting kits for aircraft deployed to support Kosovo

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	PROJECT 632743

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

(U) FY 1999 ($ in Thousands) Continued

operations.

(U) $2,081 Developed, demonstrated, and evaluated computer-based training technologies and evaluated knowledge representation and student modeling technologies. Evaluated adaptive instruction authored by targeted end users. Incorporated interconnection technology including high level architecture requirements into the virtual and constructive training systems, and advances in display, networking, and computing technology into brief/debrief stations to support squadron-level briefing room and training capability.

(U) $6,145 Total

(U) FY 2000 ($ in Thousands)

(U) $2,921 Develop, demonstrate, and evaluate technologies to create Distributed Mission Training (DMT) capabilities including physics-based modeling for constructive simulations and knowledge representation for courseware development. Technologies will more accurately represent real-world systems and representation technologies including a virtual threat cockpit to allow for human-in-the-loop training scenarios. Develop real-time intelligence fusion into the DMT battlespace environment to simulate real-time intelligence updates and develop technologies to include weapons controller interfaces and wing command and control system to incorporate live ground segments. Begin development of a multi-level security system so different simulators at different geographic locations with different levels of security authorization can participate in joint exercises without security violations.

(U) $958 Demonstrate advances in simulator visual system technologies through the development of high fidelity image generation, display, and database systems. Advanced visual systems will provide operators greater visual definition to identify other aircraft, ground vehicles, roads, and bridges at realistic tactical ranges or to properly assess their aspect angle, increasing mission rehearsal capability for the warfighter. Begin development of a PC-based high resolution real-time image generator. Continue development of an ultra-high resolution laser projector for DMT simulators.

(U) $889 Develop DMT guidelines and technologies for combat support teams. Technologies will enhance readiness of support forces and increase survivability of warfighters. Develop specifications for training development and performance assessment focused on combat support, night vision ground operations, and force protection situational awareness. Conduct technology needs assessment for force protection DMT in Military Operations Other than War (MOOTW).

(U) $1,482 Develop and demonstrate technologies to enable and enhance Night Vision Goggle (NVG) training and rehearsal for aircrews by demonstrating wide area, networked multi-ship, high fidelity NVG combat mission simulations, including a lunar illumination model, as well as dynamic shadowing and illumination effects associated with combat related sources (fires, explosions, flares). This development will enhance night operations combat readiness and flight safety, decreasing the probability of NVG mishaps. Develop perceptual training guidelines for distance

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603227F Personnel Training and Simulation Technology
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(U) **A. Mission Description Continued**

(U) FY 2000 ($ in Thousands) Continued

estimation, scanning techniques, task management techniques, and maintenance of situational awareness and spatial orientation when wearing NVGs. Design interim NVG compatible cockpit lighting systems for selected fighter and bomber aircraft.

(U) $6,250 Total

(U) FY 2001 ($ in Thousands)

(U) $750 Develop and demonstrate integrated techniques for Distributed Mission Training (DMT) for aerospace operations, force protection, and command and control personnel to reduce the learning time for new operators, sustain critical mission competencies, and ensure that deployed personnel have the knowledge and skills to support the mission. Complete first training transfer studies of the impact of DMT on Air Force air-to-air combat flying performance, and demonstrate impact of DMT on washback rates and quality of performance during Flight Lead Upgrade Training. Complete identification and representation of mission essential competencies for aerospace and information operators and force protectors. Develop and field test a common satellite architecture for control training in aerospace operations center, and integrate team performance measurement methods to assess the readiness and mission impact of DMT for combat support teams.

(U) $1,362 Develop advanced distributed learning information systems technologies that will increase mission rehearsal capability for the warfighter by creating the ability to import real-time intelligence data into the DMT environment. Technologies will provide the warfighter with enhanced training tools to make accurate and timely decisions in a real-time environment. Infuse real-time intelligence data under the mandated High Level Architecture (HLA) structure and continue evaluation of a multi-level security system for geographically disbursed man-in-the-loop simulators operating under different security classification levels. Demonstrate and evaluate pilot training results using real-time intelligence information.

(U) $1,852 Demonstrate advances in simulator visual system technologies through the development of high fidelity image generation, display, and database systems. Advanced visual systems will provide operators greater visual definition to identify other aircraft, ground vehicles, roads, and bridges at realistic tactical ranges or to properly assess their aspect angle, increasing mission rehearsal capability for the warfighter. Continue development of PC-based high resolution real-time image generator and development tools. Advance development of an ultra-high resolution laser projector for DMT simulators. Continue development and integration of a less expensive, optical infinity display material for the simulator.

(U) $1,049 Advance DMT capabilities by increasing functional fidelity and realism of the training system through demonstrating and evaluating computer representation technologies. These advances in computer models of enemy threats, terrain, weather, and human behavior increase mission rehearsal capability for the warfighter as they acquire more accurate responses to battlefield stimuli. Develop threat models and environment representations that can be updated with real-time intelligence data. Begin development and demonstration of physics based radar and other

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603227F Personnel Training and Simulation Technology
	PROJECT 632743

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

(U) FY 2001 ($ in Thousands) Continued

sensor models and their interaction with the environment. Develop an HLA compliant simulation architecture optimized for real-time, distributed, scaleable training activities. Develop and test imagery manipulation tools for automatic database generation including automatic materials encoding of source imagery vs. current hand coding.

(U) $1,478 Develop and demonstrate technologies for high fidelity Night Vision Goggle (NVG) simulation to support and increase mission training, preview, and rehearsal capabilities. This will reduce the cost of initial NVG qualification, allow for effective advanced night operation mission pretraining prior to aircraft, and increase combat training realism by adding simulated weather, seasonal, and environmental changes. Evaluate measures of training effectiveness, mission performance and transfer of training from simulator to the aircraft. Conduct field evaluation of night vision goggle training techniques to include distance estimation for helicopter, formation and aerial refueling, and combat maneuvering.

(U) $6,491 Total

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for new system developments that have military utility and address warfighter needs.

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	6,595	4,827	6,538	TBD
(U)	Appropriated Value	6,636	6,327		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-41	-2		
	b. Small Business Innovative Research	-204			
	c. Omnibus or Other Above Threshold Reprogram		-34		
	d. Below Threshold Reprogram	-212			
	e. Rescissions	-34	-41		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-47	
(U)	Current Budget Submit/FY 2001 PBR	6,145	6,250	6,491	TBD

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603227F Personnel Training and Simulation Technology
	PROJECT 632743

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

(U) Significant Program Changes:
Not Applicable.

(U) **D. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0604227F, Distributed Mission Training (DMT).
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **E. Acquisition Strategy**
Not Applicable.

(U) **F. Schedule Profile**
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	28,372	30,953	12,479	13,157	14,901	15,170	17,470	Continuing	TBD
632830	Crewstations, Life Support, and Escape	11,404	20,057	5,841	6,884	8,298	8,435	8,671	Continuing	TBD
633257	Helmet-Mounted Sensory Technologies	16,968	10,896	6,638	6,273	6,603	6,735	8,799	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates technologies to protect and enhance the performance of Air Force personnel in operational environments. Specific projects advance and integrate human factors technologies into crew workstation, command center, life support, and protective equipment designs. Technologies encompass the development and demonstration of escape system flight control and life protection devices for high-speed and low-altitude, adverse-attitude flight regimes to include those derived from the Russian ejection seat (U.S. - Russian cooperation). Life support technology improvements principally focus on protecting aircrew from effects of altitude and G-forces in high performance aircraft and adjusting specifications of existing equipment to accommodate the increasing operational envelope and a more diversified population of aircrew members. Technologies demonstrated will improve the ability to quantify the effects of human performance on mission effectiveness, improvements due to crew system automation, and allow for interaction of critical human performance data and constructive analysis in simulation. Multi-sensory command and control technologies will be demonstrated to reduce data overload and improve information use. Models of human perception, cognitive functions, and goal-oriented decision making will be developed and applied to improve operator performance in high workload environments, facilitate battlespace situational awareness, decrease response time to critical situations, and support coordinated performance in a distributed, collaborative environment. Helmet-mounted trackers and displays will incorporate advanced technology for target detection, identification, sighting, and weapons firing. Improved helmet-mounted night vision device capabilities and laser eye protection capabilities will be incorporated to address the operational limitations of fighting at night and in hazardous laser environments. Note: In FY 2000, Congress added $1.5 million for Panoramic Night Vision Goggles, $3.0 million for High-Brightness Helmet-Mounted Visual Systems Components and Mini-Cathode Ray Tube, and $12.0 million for Ejection Seats, which explains the perceived decrease in FY 2001 and out.

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	29,818	14,841	15,276	TBD
(U)	Appropriated Value	30,053	31,341		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-235	-11		
	b. Small Business Innovative Research	-977			
	c. Omnibus or Other Above Threshold Reprogram		-170		
	d. Below Threshold Reprogram	-310			
	e. Rescissions	-159	-207		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-2,797	
(U)	Current Budget Submit/FY 2001 PBR	28,372	30,953	12,479	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology / PROJECT: 632830

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632830 Crewstations, Life Support, and Escape	11,404	20,057	5,841	6,884	8,298	8,435	8,671	Continuing	TBD

(U) **A. Mission Description**

This project provides technology to improve operator combat performance; develop rigorous, traceable human-centered design tools; protect aircrews from physiological stresses such as high altitude, high G-forces, high temperature, and aerodynamic forces; and reduce aircrew fatalities and major injuries in emergency ejections at high-speed and at low-altitude, adverse-attitude flight conditions, while improving supportability, affordability, and accommodating the full range of the pilot population.

(U) FY 1999 ($ in Thousands)

(U) $1,820 Continued to develop a simulation-based testbed to quantify crew performance requirements, streamline design, and reduce cost/risk of crew system acquisition. Began to develop a human performance model linking crew performance with predicted mission outcome.

(U) $7,820 Developed and demonstrated subsystems to protect the aircrew member during emergency ejections in current and future high performance fighter aircraft, including reducing the science and technology risks associated with adapting the Russian K-36D-3.5A lightweight ejection seat to U.S. aircraft.

(U) $1,764 Completed development and demonstration of advanced hybrid oxygen technologies for aeromedical applications and finalized design of multi-mission oxygen system technology for transport aircraft.

(U) $11,404 Total

(U) FY 2000 ($ in Thousands)

(U) $1,854 Develop and demonstrate human modeling technologies and simulation tools to justify crew performance requirements, reduce the cost and time for system developers to isolate and analyze critical operator tactics in simulated operational exercises, and support clear accountability in design. Begin to integrate simulation software combining a human operator model with a representative weapon system simulation. Demonstrate the ability to quantify crew system requirements for a tactical attack mission by comparing measured man-in-the-loop performance data with model projections.

(U) $1,910 Develop and demonstrate subsystems to protect the aircrew member during emergency ejection in current and future high performance fighter aircraft. Provide improved head and neck protection by demonstrating a modification to both the Air Force and Navy helmet and/or visor that will allow the current inventory HGU-55/P and HGU-85/P helmets to be safely retained up to 600 knots equivalent airspeed (KEAS) and demonstrate the effectiveness of the design in ejection seat tests.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT 632830

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$3,950	Develop and demonstrate subsystems to reduce the science and technology risks associated with adapting the Russian K-36D-3.5A lightweight ejection seat for potential use in future high performance fighter aircraft. Complete redesign of energetics and electronics using U.S. sources and conduct verification tests. Conduct fighter aircraft integration risk reduction study.
(U)	$11,849	Develop a set of common ejection seat characteristics and qualification criteria consistent with joint Air Force/Navy requirements. Initiate a program to lead to the development of fully qualified ejection seats that can compete for installation into fighter aircraft and other current/future aircraft.
(U)	$494	Develop and demonstrate advanced, user-tailored information management and portrayal technologies that enhance battlespace situational awareness for global-level and MAJCOM-level information operation centers to reduce decision-making bottlenecks. Perform task analysis of information operations center and develop measures of performance and effectiveness. Begin to develop visualizations promoting battlespace situational awareness.
(U)	$20,057	Total

(U) FY 2001 ($ in Thousands)

(U)	$1,958	Develop and demonstrate human modeling technologies and simulation tools to justify crew performance requirements, reduce the cost and time for system developers to isolate and analyze critical operator tactics in simulated operational exercises, and support clear accountability in design. Complete development of simulation software and demonstrate integration with human operator models using the High-Level Architecture. Complete a functional specification for using the modeling technology in a simulation-based testbed that supports establishing objective, performance-based crew system requirements.
(U)	$3,133	Develop and demonstrate subsystems to protect the aircrew member during combat and emergency operations in current and future aircraft. Demonstrate life support technologies to address specific deficiencies observed in recent combat operations. Decrease risk of major injuries and fatalities for crewmembers, regardless of gender, ejecting at higher airspeeds while wearing Helmet Mounted Devices (HMD) by developing head, neck, and eye protection for HMD technology during high-speed escape to 700 Knots Equivalent Air Speed.
(U)	$750	Develop and demonstrate advanced, user-tailored information management and portrayal technologies that enhance battlespace situational awareness for global-level and MAJCOM-level information operation centers to reduce decision-making bottlenecks. Continue to develop user-tailored visualizations promoting battlespace situational awareness. Demonstrate the capability for effective, time-critical information exchange operations between MAJCOM Network Operations and Security Centers.
(U)	$5,841	Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology
	PROJECT 632830

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0604703F, Aeromedical/Casualty Care Systems Development.
(U) PE 0604706F, Life Support Systems.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology PROJECT 633257

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633257 Helmet-Mounted Sensory Technologies	16,968	10,896	6,638	6,273	6,603	6,735	8,799	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates advanced helmet-mounted subsystem technologies to improve mission effectiveness and pilot situational awareness during day and night missions in all-weather conditions. Through the development of advanced helmet-mounted tracker and display (HMT/D) technologies, pilots will be able to detect, identify, target, and launch weapons faster and more accurately. This project develops technology for improved aircrew night vision goggles (NVG) to enhance aerial combat capabilities at night. It also develops technologies to protect against lasers and methods to evaluate the biological effects of laser weapons and high-energy laser systems.

(U) FY 1999 ($ in Thousands)

(U) $8,374 Developed and demonstrated HMT/D and subsystem technologies. Demonstrated uncoated visor technologies to reduce life cycle costs of HMT/Ds, initiated design of inertial head tracker, demonstrated high-resolution miniature flat image source to replace CRT, and developed and evaluated improved symbology stabilization algorithm for Joint Helmet Mounted Cueing System (JHMCS).

(U) $3,321 Initiated operational utility evaluation of panoramic night vision goggles (PNVGs) with symbology overlay on fighter aircraft for night time air-to-air and strike missions.

(U) $5,273 Continued to develop and demonstrate laser eye protection (LEP) technologies and susceptibility models, completed flight test of diaelectric stack technology and incorporated real-time atmospheric models into Laser Threat Analysis System to provide more accurate threat and hazard projection. Delivered LEP prototype for airborne laser program, developed reflectivity analysis tool to evaluate high-energy laser hazard, and initiated Laser Range Safety Tool verification and validation.

(U) $16,968 Total

(U) FY 2000 ($ in Thousands)

(U) $5,624 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 launch weapons faster and more accurately. Integrate and demonstrate HMT/D with LEP visors and spectacles. Continue to develop and demonstrate Fighter Data Link symbology on HMT/D, and pre-planned product improvement technologies for JHMCS. Continue to develop and demonstrate a high-luminance, high-resolution, low-voltage Active Matrix Organic Light Emitting Diode image source, color symbology, and an inertial head-mounted tracker.

(U) $3,982 Develop and demonstrate technologies for improved aircrew night vision goggles to increase mission effectiveness and enhance air operations by

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology
	PROJECT 633257

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

(U) FY 2000 ($ in Thousands) Continued

allowing the pilot to perform daytime tactics at night. Continue to develop miniature image sources and smaller format filmless image intensifier tubes, to afford aircrew members a wider field-of-view, improved low-light level resolution, and reduced halo. Continue to evaluate the operational utility of panoramic night vision goggles (PNVGs) with symbology overlay. Demonstrate insertion of imagery into the PNVG in the laboratory.

(U) $1,290 Develop and demonstrate technologies that counter the laser threat, and permit the deployment and use of high-energy laser weapons. Evaluate the biological effects of laser weapons and high-energy laser systems. Complete human factors evaluation of dielectric stack and dye/dielectric stack technologies for laser eye protection against infrared and selected visible laser wavelengths. Develop automated laser eye protection device evaluation system for economically validating reproducibility of manufacturing processes. Continue integration of Laser Threat Analysis System with Air Force mission support system. Initiate development of Laser Range Safety Tool for missile Test Range to support flight test of airborne laser and other high-energy laser systems.

(U) $10,896 Total

(U) FY 2001 ($ in Thousands)

(U) $3,129 Develop and demonstrate advanced helmet-mounted tracker and display (HMT/D) and subsystem technologies to improve mission effectiveness and pilot situational awareness during day and night missions in all-weather conditions. These technologies help pilots to detect, identify, target, and launch weapons faster and more accurately. Develop and demonstrate the utility of color symbology on HMT/D. Integrate and demonstrate a miniature flat display to replace cathode ray tubes in HMT/Ds. Integrate an HMT/D into the air-to-ground strike mission.

(U) $2,183 Develop and demonstrate technologies for improved aircrew night vision goggles to increase mission effectiveness and enhance air operations by allowing the pilot to perform daytime tactics at night. Continue to develop miniature image sources and smaller format filmless image intensifier tubes to provide aircrew members a wider field-of-view, improved low-light level resolution, and reduced halo. Integrate and evaluate laser eye protection technologies with PNVG. Demonstrate imagery insertion on PNVG in flight test.

(U) $1,326 Develop and demonstrate technologies that counter the laser threat, and permit the deployment and use of high-energy laser weapons. Continue to evaluate the biological effects of laser weapons and high-energy laser systems. Initiate human factors evaluation of rugate, and hologram technologies for infrared and visible laser eye protection. Begin integration of Laser Threat Analysis System with Laser Warning Receiver technologies, and incorporate Laser Threat Module into Air Force Mission Support System. Deliver Laser Range Safety Tool to missile test ranges to support flight testing of airborne laser and other high-energy laser systems.

(U) $6,638 Total

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology / PROJECT: 633257

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0602102F, Materials.
(U) PE 0603112F, Advanced Materials for Weapon Systems.
(U) PE 0603319F, Airborne Laser.
(U) PE 0604706F, Life Support Systems.
(U) PE 0604201F, Common Avionics Planning/Development.
(U) PE 0207130F, F-15 Squadrons.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603245F Flight Vehicle Technology Integration
	PROJECT 632568

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632568	Flight Vehicle Technology Integration	7,150	8,289	13,184	13,937	6,960	6,582	11,450	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2004, Flight Vehicle Technology efforts currently conducted in PE 0603205F will transfer into this PE in Project 632568.

(U) **A. Mission Description**

This program 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 to flight demonstrate them in a near-realistic operational environment. Integration and flight test demonstrations reduce the risk and time required to transition technologies into operational aircraft. This program provides proven aerospace vehicle technologies for all-weather, day or night operations, and technologies for improved affordability.

(U) FY 1999 ($ in Thousands)

(U) $2,243 Developed and integrated advanced aeromechanics, propulsion, and flight control technologies, and completed fabrication of next generation exhaust nozzle and airframe structural critical components for increasing combat effectiveness for current and future aerospace vehicle systems.

(U) $965 Completed development and flight-tested control strategies to extend range, ensure safe operation, and allow precision close operations of mixed manned and unmanned aerospace vehicles.

(U) $3,942 Developed flight test units of electric actuator stabilators for reducing weight and manufacturing technologies as they relate to the unmanned aerospace vehicle mission. Integrated and demonstrated advanced subsystem technologies for evaluation of significant improvement in air-to-air combat effectiveness for aerospace vehicles.

(U) $7,150 Total

(U) FY 2000 ($ in Thousands)

(U) $2,430 Develop and integrate advanced aeromechanics, propulsion, and flight control technologies that will increase combat effectiveness for Air Force aircraft systems. Complete fabrication of next generation exhaust nozzle and airframe structural critical components.

(U) $1,919 Develop and flight-test control strategies to extend range, ensure safe operation, and allow precision close operations of mixed manned and unmanned aerospace vehicles. Continue development and flight-test control strategies to extend range, ensure safe operation, and allow precision close operations of mixed manned and unmanned aerospace vehicles. Continue unmanned aerospace vehicle technology development.

(U) $3,940 Develop flight test units of electric actuator stabilators for reducing weight and manufacturing technologies as they relate to the unmanned

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603245F Flight Vehicle Technology Integration
	PROJECT 632568

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

(U) FY 2000 ($ in Thousands) Continued

aerospace vehicle mission. Integrate and demonstrate advanced electric actuator technologies to demonstrate air-to-air combat effectiveness for aerospace vehicles.

(U) $8,289 Total

(U) FY 2001 ($ in Thousands)

(U) $11,011 Develop and demonstrate technologies to support the joint Air Force/Defense Advanced Research Projects Agency unmanned combat air vehicle goals. Demonstrate lightweight/low-cost composite structures, multifunction apertures, compact low-obeservable inlets and exhaust, and advanced materials technologies for affordable low-observables. Demonstrate advanced weapons suspension and release technologies, and the integration of human system interface technologies for advanced manned and unmanned operations.

(U) $1,058 Develop and demonstrate new control techniques to enable safe, highly autonomous mixed-fleet and multi-unmanned air vehicle operations for increased combat effectiveness. Continue unmanned aerospace vehicle development to ensure safe operation, and allow precision close operations of mixed manned and unmanned aerospace vehicles. Develop adaptive flight control algorithms for autonomous operations of mixed fleet air operations.

(U) $1,115 Develop and demonstrate advanced flight control techniques for affordable and reliable autonomous control. Integrate, develop, and test advanced vehicle management technology with advanced system prognostics and autonomous control software to achieve reliability and affordability goals. Complete integrated flight control technology specification for unmanned air vehicles.

(U) $13,184 Total

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

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

	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget (FY 2000 PBR)	7,642	8,335	9,711	
(U) Appropriated Value	7,674	8,335		
(U) Adjustments to Appropriated Value				
a. Congressional/General Reductions	-32	-1		
b. Small Business Innovative Research	-255			
c. Omnibus or Other Above Threshold Reprogram		-45		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603245F Flight Vehicle Technology Integration — PROJECT: 632568

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

		FY 1999	FY 2000	FY 2001	Total Cost
	d. Below Threshold Reprogram	-197			
	e. Rescissions	-40			
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			3,473	
(U)	Current Budget Submit/FY 2001 PBR	7,150	8,289	13,184	TBD

(U) Significant Program Changes:
Air Force funding for the joint Air Force/Defense Advanced Research Projects Agency unmanned combat air vehicle was recently consolidated and part of the funding was placed into this PE.

(U) D. Other Program Funding Summary ($ in Thousands)
(U) Related Activities:
(U) PE 0603106F, Logistics Systems Technology.
(U) PE 0603205F, Flight Vehicle Technology.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0604237F, Variable Stability In-Flight Simulation Test Aircraft.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) E. Acquisition Strategy
Not Applicable.

(U) F. Schedule Profile
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	13,512	9,327	5,350	5,084	5,357	5,178	5,381	Continuing	TBD
632735	Avionics Integration Technology	9,422	5,901	1,992	1,547	751	460	747	Continuing	TBD
63666A	Sensor Fusion & Integration Tech	4,090	3,426	3,358	3,537	4,606	4,718	4,634	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, the following efforts in Project 632735 were moved into PE 0603726F, Project 634850: 1) developing technologies for collecting and integrating on- and off-board sensors over multiple platforms; 2) developing and demonstrating technologies to support maximum use of existing avionics software together with new software in real-time environments; 3) developing and demonstrating advanced architecture concepts to support seamless information flow and fusion for application in space and unmanned aerial vehicles. Also in FY 2001, efforts to develop and evaluate multi-user, medium to high capacity airborne platform information transfer technology transferred from Project 63666A to PE 0603726F, Project 634850.

(U) **A. Mission Description**

This program develops and demonstrates advanced radio frequency sensors and integration techniques for intelligence, surveillance, and reconnaissance functions. Specifically, this program develops and improves: digital receiver components for air moving target indication and advanced unmanned aerial vehicle applications; advanced Global Positioning System receivers and anti-jam techniques for aerospace platforms; aircraft communications, navigation, and identification technologies; technologies for low-probability-of-detection communication between aircraft to improve aircrew situation awareness; and collaborative engineering environments to evaluate methods for integrating on-board and off-board sensor data.

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603253F Advanced Sensor Integration

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	10,462	9,443	11,984	
(U)	Appropriated Value	10,536	9,443		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-74	-3		
	b. Small Business Innovative Research	-233			
	c. Omnibus or Other Above Threshold Reprogram		-51		
	d. Below Threshold Reprogram	3,359			
	e. Rescissions	-76	-62		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-6,634	
(U)	Current Budget Submit/FY 2001 PBR	13,512	9,327	5,350	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget reflect the transfer of work to align projects with the Air Force Research Laboratory organization.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration — PROJECT: 632735

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632735 Avionics Integration Technology	9,422	5,901	1,992	1,547	751	460	747	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates advanced radio frequency (RF) sensors for integrated intelligence, surveillance, and reconnaissance functions on aerospace platforms. These advanced technologies will enable sensors to gather and process information from air- and space-based assets, integrate on-board and off-board sensor data, and perform sensor management functions.

(U) FY 1999 ($ in Thousands)

(U) $5,129 Developed and demonstrated advanced modular, sharable RF sensor processor technologies to provide for avionics cost and weight savings, increased multimission capability, improved reliability, and increased sensor data fusion opportunities. Demonstrated integrated sensor system technology for simultaneously performing radar, electronic warfare, communication, navigation, and identification functions.

(U) $1,694 Developed technologies for collecting and integrating sensor data from various sources in a collaborative engineering environment in order to reduce risks and costs of advanced technology demonstration and to enable faster transition of affordable technology to meet warfighter needs. Developed a collaborative engineering capability and evaluated sensor data in a collaborative environment.

(U) $2,599 Developed and demonstrated technologies to support maximum use of existing avionics software in concert with newly developed software in a real-time avionics environment, thereby providing a cost-effective incremental upgrade capability, including optimizing testing of technology for simultaneous execution of existing 16-bit avionics software with 32-bit application software and develop preliminary architectural framework.

(U) $9,422 Total

(U) FY 2000 ($ in Thousands)

(U) $1,848 Develop and demonstrate advanced modular, sharable RF sensor technologies for aerospace sensor suites performing intelligence, reconnaissance, and surveillance applications. Design a dual-use modular, digital RF receiver. Conduct trade studies for air moving target indication.

(U) $2,463 Develop technologies for collecting and integrating on- and off-board sensors over multiple platforms in a collaborative engineering environment, reducing cost and risk of advanced technology demonstration. Evaluate on-board and off-board sensors and multiple platforms in a collaborative engineering environment. (In FY 2001, this work will transfer to PE 0603726F, Project 634850.)

(U) $425 Develop and demonstrate technologies to support maximum use of existing avionics software together with new software in real-time environments. Transition these technologies to fighter and transport aircraft. (In FY 2001, this work will transfer to PE 0603726F, Project 634850.)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603253F Advanced Sensor Integration
	PROJECT 632735

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$1,165	Develop and demonstrate advanced architecture concepts to support seamless information flow and fusion for application in space and unmanned aerial vehicles (UAVs). Develop UAV architecture concepts applicable to multiple UAV applications. Develop an Assured Space Access Architecture (ASAA) for the space maneuver vehicle as well as the command and control information infrastructure needed for ASAA. (In FY 2001, this work will transfer to PE 0603726F, Project 634850.)
(U)	$5,901	Total

(U) FY 2001 ($ in Thousands)

(U)	$1,992	Develop and demonstrate advanced modular, sharable digital radio frequency (RF) sensor technologies for aerospace sensor suites performing intelligence, reconnaissance, and surveillance applications. Fabricate and test dual-use, modular, digital RF receiver components for multimode radar operation.
(U)	$1,992	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0603204F, Aerospace Sensors.
(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration — PROJECT: 63666A

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63666A Sensor Fusion & Integration Tech	4,090	3,426	3,358	3,537	4,606	4,718	4,634	Continuing	TBD

(U) **A. Mission Description**

Develops and demonstrates advanced reference and information transmission technologies required for precise navigation and targeting and reliable information links for future Air Force information architectures. Specifically, this projects develops the advanced techniques for exploiting and protecting the capabilities of the Global Positioning System (GPS) to provide highly accurate reference data for precision targeting and location of enemy air defense radars. In addition, this project develops high-speed, jam-resistant, low-probability-of-detection information transmission technologies and techniques to improve overall aircrew situation awareness, reduce electromagnetic signatures of navigation and communication systems, and increase aircraft survivability. The focus is on transitioning transceivers, inertial components, navigation system technology into air vehicles. Technologies demonstrated under this project are needed for real-time information in the cockpit, stealth operations, precision targeting and strike, timely bomb damage assessment, force multiplication through multiplatform shared resources, and supportable weapon systems.

(U) FY 1999 ($ in Thousands)

(U) $2,694 Developed enhancements to GPS user equipment and system integration techniques to maximize position accuracy and jam resistance and exploit the benefits of GPS to improve offensive and defensive combat capabilities at reduced costs. Developed optimum anti-jam techniques and techniques for precision attack using improved GPS.

(U) $1,396 Developed multi-user, medium to high capacity, jam-resistant airborne network technology to provide for low probability of detection exchange of time-critical threat, sensor, and other information between aircraft and cooperative assets. Completed evaluation of a common, affordable, open system architecture for unmanned aerial vehicles.

(U) $4,090 Total

(U) FY 2000 ($ in Thousands)

(U) $2,626 Develop reference and receiver technologies to maximize GPS jam resistance, positional accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. This includes integrating and receiver processor technology, direct acquisition techniques, and evaluation of GPS modernization candidate military signals for exploitable vulnerabilities.

(U) $800 Develop and evaluate multi-user, medium to high capacity airborne platform information transfer technology to provide jam-resistant, lower probability of detection exchange of information between aircraft and cooperating space, airborne, and surface communication assets. Fabricate a space-based air traffic communications and positioning brassboard. (In FY 2001, this work will transfer to PE 0603726F, Project 634850.)

(U) $3,426 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603253F Advanced Sensor Integration	63666A

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

(U) FY 2001 ($ in Thousands)

(U)	$3,358	Develop technologies to maximize Global Positioning System (GPS) jam resistance, positional accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Refine GPS receiver processing technology and direct signal acquisition techniques. Continue evaluation of GPS modernization candidate military signals for exploitable vulnerabilities.
(U)	$3,358	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602782A, Command, Control, Communications Technology.
(U) PE 0602232N, Navy C3 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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603270F Electronic Combat Technology

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	25,434	31,947	25,882	26,161	27,363	28,060	28,663	Continuing	TBD
632432	Defensive System Fusion Technology	6,490	11,201	7,257	7,346	8,076	8,238	8,401	Continuing	TBD
63431G	RF Warning & Countermeasures Tech	8,339	8,399	8,284	8,436	8,698	8,871	9,046	Continuing	TBD
63691X	EO/IR Warning & Countermeasures Tech	10,605	12,347	10,341	10,379	10,589	10,951	11,216	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates technologies to support critical Air Force electronic combat (EC) requirements. The focus is on the development of components, subsystems, and technologies that have potential application to satisfy aerospace combat, special operations, and airlift EC requirements and to reduce acquisition and life cycle costs of EC systems. The program develops and demonstrates: radio frequency; infrared; electro-optical; warning; and command, control, and communications countermeasure technologies for aerospace platforms. In addition, the program develops and demonstrates technologies and concepts for signature reduction, advanced electronic warfare transmitters and receivers, and effective power management. Technology demonstrations include flyable brassboards against validated threat simulators. This program ensures the Air Force will maintain demonstrated technology solutions to defeat both current and next generation threats. Note: In FY 2000, Congress added $2.0 million for Closed Loop Infrared Countermeasures and $3.0 million for a multispectral battlespace capability for the Integrated Demonstrations and Applications Laboratory.

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	25,476	27,334	26,775	
(U)	Appropriated Value	25,553	32,334		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-77			
	b. Small Business Innovative Research	-792			
	c. Omnibus or Other Above Threshold Reprogram		-175		
	d. Below Threshold Reprogram	892			
	e. Rescissions	-142	-212		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-893	
(U)	Current Budget Submit/FY 2001 PBR	25,434	31,947	25,882	TBD

(U) Significant Program Changes:
Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603270F Electronic Combat Technology	PROJECT: 632432

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632432 Defensive System Fusion Technology	6,490	11,201	7,257	7,346	8,076	8,238	8,401	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates techniques and technologies for integrating electronic combat (EC) sensors and EC system fusion. It develops the advanced algorithms and assessment techniques needed to evaluate and enable combat aircraft operations in multi-spectral threat and countermeasure environments. It also matures technologies required for command and control (C2) warfare, standoff jamming, and support countermeasures for denial, disruption, and suppression of adversary air defense operations. Included in these are: 1) advanced components and techniques needed to jam enemy radars; 2) advanced standoff jammer technologies; and 3) novel electronic collection methods to inform field commanders of changes in the electronic environment.

(U) FY 1999 ($ in Thousands)

(U) $1,317 Developed low-cost technologies to demonstrate data fusion (e.g., threat, targeting, command and control, etc.) from off-board and on-board sensors to enhance situation awareness in both new and existing aerospace platforms. Optimized code. Completed preliminary design trade offs for candidate techniques and algorithms using commercial technology architectures.

(U) $5,173 Developed and investigated C2 warfare electronic attack (EA) techniques to suppress and counter adversary C2 networks. Designed critical hardware/software components for denying modern digital C2 network links. Prepared to test designs against advanced telemetry links.

(U) $6,490 Total

(U) FY 2000 ($ in Thousands)

(U) $1,867 Develop low-cost technologies to demonstrate data fusion (e.g., threat, targeting, C2, etc.) from off-board and on-board sensors to enhance situation awareness in both new and existing aerospace platforms. Ground demonstrate optimized sensor fusion algorithms in a coalition environment.

(U) $1,473 Develop, as part of an international cooperative effort, the combat information management technologies necessary to provide real-time situation awareness in a joint or coalition theater environment.

(U) $3,487 Develop and investigate C2 warfare EA techniques to suppress and counter adversary C2 networks. Complete a brassboard demonstration model. Conducting laboratory testing against modern digital C2 network links. Conduct EA laboratory testing and threat exploitation.

(U) $1,401 Conduct evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness. Conduct technology survivability trade studies for advanced fighter applications.

(U) $2,973 Develop man- and hardware-in-the-loop multispectral synthetic battlespace evaluation technology. Develop effective high fidelity capability for warfighter to assess new combat platform sensor technology, threat systems, and countermeasures in a virtual battlespace.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603270F Electronic Combat Technology	PROJECT: 632432

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

(U) FY 2000 ($ in Thousands) Continued

(U) $11,201 Total

(U) FY 2001 ($ in Thousands)

(U) $1,923 Develop low-cost technologies to demonstrate data fusion (e.g., threat recognition, targeting, etc.) from off-board and on-board sensors to enhance situational awareness in both new and existing aerospace platforms. As part of an international cooperative Real Time Information into the Cockpit (RTIC) effort, perform design and initial lab integration of optimized sensor fusion algorithms and processor hardware for joint coalition platforms.

(U) $3,432 Develop and investigate offensive counter information warfare technologies to disrupt and/or deny adversarial C2 nodes and networks. Continue threat exploitation. Conduct ground/field testing of brassboard against modern digital C2 network links. Design experimental hardware/software to counter adversarial communication and navigation systems.

(U) $1,427 Conduct evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness. Conduct laboratory evaluations of receiver technology for advanced fighter applications.

(U) $475 Develop affordable threat alert technologies for combat aircraft to increase survivability against advanced, integrated radio frequency air defense systems. Conduct trade study analyses for techniques to defeat future threat radar guided missile systems.

(U) $7,257 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603270F Electronic Combat Technology / PROJECT: 63431G

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63431G RF Warning & Countermeasures Tech	8,339	8,399	8,284	8,436	8,698	8,871	9,046	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates advanced technologies for radio frequency (RF) electronic combat (EC) suites to enhance survivability of aerospace vehicles and to provide crew situation awareness. One major area addressed covers technologies for missile/threat warning, radar frequency 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 novel electronic countermeasures (ECM) techniques as well as advanced ECM technologies such as antennas, power amplifiers, preamplifiers, etc.

(U) FY 1999 ($ in Thousands)

(U) $2,530 Developed low-cost advanced radar and RF emitter warning concepts and techniques. Completed preliminary design for a wideband digital receiver for affordable electronic support measures and radar warning receiver suites. Completed a design for an advanced antenna that improves gain by a factor of ten at half the cost of current designs.

(U) $5,809 Developed aircraft self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems. Developed and demonstrated monopulse angle jamming electronic countermeasures. Developed steerable high-power arrays. Completed design trade offs for affordable improvements to existing ECM suites. Developed multifunction, compact, modular ECM jamming technology.

(U) $8,339 Total

(U) FY 2000 ($ in Thousands)

(U) $1,500 Develop low-cost advanced radar and RF emitter warning concepts and techniques. Fabricate a wideband digital receiver for affordable electronic support measures and radar warning receiver suites.

(U) $3,849 Develop wideband, multimode, multifunction apertures for electronic warfare applications. Fabricate an advanced antenna that improves gain by a factor of ten at half the cost of current designs.

(U) $3,050 Develop aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems. Develop EC techniques to increase space system survivability. Laboratory test a steerable high-power array. Demonstrate advanced monopulse angle jamming techniques.

(U) $8,399 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603270F Electronic Combat Technology / PROJECT: 63431G

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

(U) FY 2001 ($ in Thousands)

(U)	$1,508	Develop affordable radar and radio frequency (RF) emitter warning concepts and techniques. Evaluate a wideband digital receiver for affordable electronic support measures and radar warning receiver suites.
(U)	$3,610	Develop wideband, multimode, multifunction apertures for electronic warfare applications (i.e., threat detection, threat avoidance, suppression of enemy air defenses, surveillance, and reconnaissance). Integrate and chamber test multimode antenna to demonstrate a tenfold improvement in gain while providing a wide field of view and a low radar cross section.
(U)	$3,166	Develop aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems. Conduct laboratory evaluations of electronic combat techniques to increase aerospace system survivability. Complete demonstration of a steerable high-power array. Design and develop a flight-worthy brassboard for monopulse angle jamming integrated electronic countermeasures. Build and demonstrate an advanced electronic protection breadboard.
(U)	$8,284	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0604270F, Electronic Warfare (EW) Development.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603270F Electronic Combat Technology / PROJECT: 63691X

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63691X EO/IR Warning & Countermeasures Tech	10,605	12,347	10,341	10,379	10,589	10,951	11,216	Continuing	TBD

(U) **A. Mission Description**

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 radio frequency (RF) missiles. Countermeasure capability against advanced EO, IR, and laser-guided threats are vital for aerospace platform survival in wartime and peacetime.

(U) FY 1999 ($ in Thousands)

(U) $6,978 Developed on-board, closed-loop, laser-based infrared countermeasure technology and off-board (active decoy) technology to defeat current and future IR missiles in multiple scenarios. Tower tested threat-adaptable, laser-based jamming codes. Designed flight-worthy closed-loop laser infrared countermeasures (IRCM) hardware for flight demonstrations in a C-17 or other large aircraft.

(U) $736 Conducted in-house experiments to analyze current and future IR threat missiles. Developed digital threat models of threat IR missiles. Validated countermeasure techniques for conventional IR missiles. Developed a target simulator for imaging IR seekers.

(U) $1,983 Developed aerospace laser warning and countermeasure technologies necessary to defeat advanced laser acquisition/tracking sensors on threat air defense systems, including detecting and locating both high power (dazzle/damage) and low-power (laser guided ordinance) signals and threat modeling technologies to counter dual-mode missile seekers.

(U) $908 Developed IR missile warning technologies to detect advanced, low signature threat missiles. Developed distributed aperture algorithms and clutter rejection techniques.

(U) $10,605 Total

(U) FY 2000 ($ in Thousands)

(U) $7,636 Develop on-board, closed-loop, laser IRCM for large aircraft to defeat current and future IR missiles in multiple scenarios. Conduct live fire aerial cable car testing at White Sands Missile Range. Fabricate a flight-worthy closed-loop IRCM suite for demonstration on C-17 or other large aircraft.

(U) $1,725 Conduct in-house analyses of current and future IR threat missiles. Refine digital threat models. Develop countermeasure techniques for imaging IR missiles. Integrate a target simulator for imaging IR seekers.

(U) $942 Develop aerospace laser warning sensor technologies for timely alert and response to advanced laser acquisition/tracking sensors, including

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology
PROJECT 63691X	

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

(U) FY 2000 ($ in Thousands) Continued

detecting and locating both high power (dazzle/damage) and low power (laser guided ordnance) signals. Develop low-cost warning technologies for special operations, combat, and mobility aircrew protection.

(U) $2,044 Develop infrared (IR) missile warning technologies to detect advanced, low signature threat missiles. Evaluate distributed aperture algorithms. Collect data. Demonstrate real-time missile warning algorithms for low-cost, uncooled sensors.

(U) $12,347 Total

(U) FY 2001 ($ in Thousands)

(U) $4,307 Develop on-board, closed-loop, laser infrared countermeasures (IRCM) for large aircraft to defeat current and future IR missiles in multiple scenarios. Integrate and flight test closed-loop IRCM technology on a C-17 or other large aircraft.

(U) $1,309 Conduct in-house analyses of current and future IR threat missiles. Complete digital models of IR threat missiles. Simulate expendable countermeasure techniques for conventional and imaging IR missiles. Design combined effects expendables for tactical aircraft to defeat imaging IR missiles.

(U) $1,076 Develop aerospace laser warning sensor technologies for timely alert to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser guided ordnance) signals. Conduct laboratory evaluation of ability of laser warning sensor technology to locate/identify laser hazards and cue appropriate response.

(U) $2,093 Develop electro-optical (EO) and IR missile warning technologies to alert aircrews and aircraft self-protection systems to the approach of advanced, low-signature threats. Evaluate multispectral imaging technology for missile warning and/or distributed aperture sensors.

(U) $1,556 Develop countermeasure technology to defeat passive EO/IR aircraft tracking sensors and ordnance guidance. Investigate gimballess beam steering technologies to reduce weight and drag of countermeasure subsystems.

(U) $10,341 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0604270F, Electronic Warfare (EW) Development.

(U) PE 0604270N, EW Development.

(U) PE 0603203F, Advanced Aerospace Sensors.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology
	PROJECT 63691X

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	22,283	16,526	24,283	21,382	21,326	22,771	24,433	Continuing	TBD
630003	Launch Vehicle Technology	532	0	0	0	0	0	0	Continuing	TBD
634373	Launch and Orbit Transfer Propulsion Technology	20,115	14,771	19,386	18,450	18,350	21,251	22,883	Continuing	TBD
636339	Tactical Propulsion Technology	266	286	0	0	0	0	0	0	TBD
636340	Satellite Control and Maneuvering Propulsion Technology	1,370	1,469	4,897	2,932	2,976	1,520	1,550	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: Project 630003 transfers to PE 0603401F, Project 631026, starting in FY 2000. Strategic sustainment efforts have been consolidated in Project 634373; this involved moving the Post-Boost Control and Non-Destructive Evaluation efforts and associated funding from Project 636340 to Project 634373. The electric propulsion efforts, originally in Project 634373, have been moved to Project 636340. Efforts in Project 636339 will be terminated at the end of FY 2000. Finally, solar thermal efforts have been moved from Project 636340 to Project 634373.

(U) **A. Mission Description**

This program develops and demonstrates advanced rocket propulsion and space launch technologies. This program provides the technological step necessary to transition the most promising rocket propulsion and space launch technologies to applications using full-scale, proof-of-principle demonstrations. The projects within this program are structured to support Air Force Space Command's and Air Combat Command's mission area requirements for space and missile technologies which include the goals established in the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Initiative, a multi-agency/industry effort to focus the development of U.S. rocket propulsion technology. New and improved components will be integrated with the environmentally improved propellants developed in this program to create new propulsion systems for the next generation of launch vehicles and satellites. Anticipated technological advances in this program will improve the performance of expendable systems' payload capabilities by 21% and reduce the launch and operations and support (O&S) costs by 28%. In a reusable launch system, the anticipated improvements are an increase in payload capability of 170% and a reduction in launch and O&S costs of 79%. The advances in propulsion in this program result from the achievement of the 2010 goals of the IHPRPT Initiative. The development of these technologies has been coordinated with National Aeronautics and Space Administration (NASA) to eliminate duplication of efforts. The space launch and missile propulsion industry will leverage the technologies

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion

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

from this program to enhance the country's industrial competitiveness. Note: Congress added $3 million in FY 1999 and $5.5 million in FY 2000 for Integrated High Payoff Rocket Propulsion Technology (IHPRPT).

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	23,982	11,231	10,863	
(U)	Appropriated Value	24,121	16,731		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-139	-6		
	b. Small Business Innovative Research	-682			
	c. Omnibus or Other Above Threshold Reprogram		-91		
	d. Below Threshold Reprogram	-892			
	e. Rescissions	-125	-108		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			13,420	
(U)	Current Budget Submit/FY 2001 PBR	22,283	16,526	24,283	TBD

(U) Significant Program Changes:

The increase in FY 2001 will be used to restore the demonstrations of Boost and Orbit Transfer Vehicle technologies for the Integrated High Payoff Rocket Propulsion Technology program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion — PROJECT: 630003

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
630003 Launch Vehicle Technology	532	0	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops advanced and innovative launch vehicles technologies in the areas of structures (i.e., fairings, interstages, struts, thermal protection systems, etc.), tanks, and operations.

(U) FY 1999 ($ in Thousands)

(U) $150 Continued to define technological needs for future reusable military launch vehicles including operations technologies, lightweight airframe structures, durable composite cryogenic tanks, and structure multifunctionality including thermal and acoustic tailorability.

(U) $100 Continued to define technological needs for future expendable launch vehicles including operations technologies, lightweight airframe structures, durable composite cryogenic tanks, and structure multifunctionality including thermal and acoustic tailorability.

(U) $282 Developed advanced composite launch vehicle structures including grid stiffened shrouds.

(U) $532 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Effort moved to PE 0603401F/Project 631026.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to PE 0603401F/Project 631026.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603853F, Evolved Expendable Launch Vehicle Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603302F Space and Missile Rocket Propulsion	630003

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion — PROJECT: 634373

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634373	Launch and Orbit Transfer Propulsion Technology	20,115	14,771	19,386	18,450	18,350	21,251	22,883	Continuing	TBD

(U) **A. Mission Description**

This project develops advanced and innovative, low-cost rocket turbomachinery and components, low-cost space and missile launch propulsion system manufacturing technologies, and advanced propellants. Characteristics such as environmental acceptability, affordability, reliability, reduced weight, reduced operation and launch costs, and increased life and performance of propulsion systems are emphasized in this project. Technological advances developed in this program will improve the performance of expendable systems' payload capabilities by 21% and reduce the launch and operations and support (O&S) costs by 28%. The advances in propulsion in this program will result from the achievement of the 2010 goals of the Integrated High Payoff Rocket Propulsion Technology Initiative.

(U) FY 1999 ($ in Thousands)

(U) $13,713 Continued to develop propulsion technologies for existing and future launch vehicles. Completed fabrication of oxygen and hydrogen turbopump assemblies and preburner components for integration into an advanced liquid engine test bed.

(U) $3,402 Continued to develop propulsion technologies for existing and future upper stage and orbit transfer vehicles. Completed component testing and began integration of components into demonstrator engine.

(U) $3,000 Developed technologies for the sustainment of strategic systems. Continued development of a multi-use, less detonable (Class 1.3) solid propellant which meets all Intercontinental Ballistic Missile (ICBM) requirements, reduces hardware costs by 25%, and sustains current performance levels. Continued development of evaluation techniques to accurately predict service life.

(U) $20,115 Total

(U) FY 2000 ($ in Thousands)

(U) $1,864 Continue to develop components of turbomachinery components for integration into advanced liquid test bed demonstrator. Continue to develop turbomachinery components for integration in to advanced liquid test bed demonstrator. Initiate fabrication and assembly of combustion chamber and injector. Continue fabrication of oxygen turbopump for integration into an advanced liquid booster engine. Initiate testing of oxygen and hydrogen turbopump assemblies and preburner components for integration into an advanced liquid booster engine. These demonstrated turbomachinery technologies will significantly reduce the life cycle cost of future expendable and reusable liquid rocket engines.

(U) $3,707 Develop propulsion technologies for existing and future upper stage and orbit transfer vehicles. Continue integration of turbopump and chamber into high-pressure cryogenic upper stage test bed engine. Demonstrate these components in engine level tests. Demonstrate the Phase I goals of increased thrust to weight of 30%, decreased hardware/support costs by 15%, and increased reliability by 25% for the 50k lbs. thrust expander cycle upper stage cryogenic engine. Advanced upper stage engine technology will create significant payloads increases for future launch

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion
	PROJECT 634373

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

(U) FY 2000 ($ in Thousands) Continued

vehicles. Demonstrate solar thermal propulsion technologies on ground tests for orbit transfer and maneuvering propulsion technology.

(U) $1,700 Develop technologies for the sustainment of strategic systems. Continue development of a multi-use, non-detonable (Class 1.3) solid propellant which meets all Intercontinental Ballistic Missile (ICBM) requirements, reduces hardware costs by 25%, and maintains current performance levels. Initiate the Strategic Sustainment Demonstration program which integrates advanced propellant, case, and nozzle technologies and demonstrates all cost and performance goals. Continue developing non-destructive evaluation (NDE) technology for large solid rocket motors (SRMs).

(U) $2,000 Develop propulsion technologies for future orbit transfer vehicles (OTVs). Complete high performance Hall thruster propulsion technologies for orbit transfer and maneuvering propulsion technology. Complete component tests, integration of components, and scheduled ground demonstration of flight qualified high performance Hall thruster system. Analyze flight data and correlate with ground test data to complete final report on the 30kW ammonia arcjet thruster.

(U) $5,500 Continue developing propulsion technologies to support the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) Program. Complete the fabrication of the oxygen turbopump for integration into an advance liquid booster engine. Complete the Phase 1 Solid Boost Demo program which develops propulsion technologies for the next generation of space boosters.

(U) $14,771 Total

(U) FY 2001 ($ in Thousands)

(U) $6,547 Continue to develop propulsion technology for existing and future launch vehicles. Continue to develop turbomachinery components for integration in to advanced liquid test bed demonstrator. Continue fabrication and assembly of combustion chamber and injector. Continue fabrication of oxygen turbopump for integration into an advanced liquid booster engine. Continue testing of oxygen and hydrogen turbopump assemblies and preburner components for integration into an advanced liquid booster engine. These demonstrated turbomachinery technologies will significantly reduce the life cycle cost of future expendable and reusable liquid rocket engines. Install oxygen turbopump assembly into test facility and prepare for hot fire testing of pump assembly.

(U) $8,839 Develop propulsion technologies for existing and future upperstage and orbit transfer vehicles. Complete integration of turbopump and chamber into high-pressure cryogenic upper stage test bed engine. Complete demonstration of these components in engine level tests. Continue to demonstrate solar thermal propulsion technologies, such as strut development and pointing and tracking, for orbit transfer and maneuvering propulsion technology. Continue development of high-power Hall thrusters for orbit transfer. Continue program to develop electric propulsion systems for orbit-transfer by developing a high-power Hall thrusters capable of low earth orbit-geosynchronous orbit transfer. Initiate advanced smallsat propulsion demonstration to develop microsat formation flying capability for Air Force imaging requirements.

(U) $4,000 Develop technologies for the sustainment of strategic systems. Initiate the post boost control system (PBCS) program to demonstrate component

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion	PROJECT 634373

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

(U) FY 2001 ($ in Thousands) Continued

technologies with readily available materials to reduce hardware costs, a 90% reduction in hydrazine leakage, and a 5X increase in service life for liquid fuels ballistic missiles. Continue the Strategic Sustainment Demonstration program which integrates advanced propellant, case, and nozzle technologies and demonstrates all cost and performance goals.

(U) $19,386 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, 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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion / PROJECT: 636339

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
636339 Tactical Propulsion Technology	266	286	0	0	0	0	0	0	TBD

(U) **A. Mission Description**

This project develops highly energetic propellants and propulsion systems. Improved case, insulation, and propellant interfaces as well as better performing nozzles will be developed. Technology such as thrust vector control, thrust modulation, signature characterization, and signature reduction will be developed in this project. The emphasis in this project is on rocket propulsion system affordability and weight reduction. Anticipated payoffs from these developments, identified through the Integrated High Payoff Rocket Propulsion Technology Initiative (IHPRPT), include a 49% range increase, 50% size reduction, 100% payload increase, and 21% reduction in time-to-target.

(U) FY 1999 ($ in Thousands)

(U) $266 Began scale-up of selected solid propellant formulations that can be incorporated into the design and manufacture of future air-to-air missile systems for the U.S., France, Germany, and the United Kingdom. These propellants have acceptable hazards, higher performance, lower environmental impact, and reduced exhaust signature characteristics. Completed solid propellant scale-up and finalized rheological and hazards properties. Completed ballistic performance evaluation in U.S. test motors (15 lbs.) and manufactured initial European test motors for their internal evaluation.

(U) $266 Total

(U) FY 2000 ($ in Thousands)

(U) $286 Develop tactical missile technologies. Integrate component technologies and an advanced tactical missile propellants that improve missile thrust and reduce plume exhaust signatures. Manufacture European test motors and selected propellant samples incorporating an advanced high performance, acceptable hazards, low environmental impact, and reduced signature propellant. Ship these rocket test motors to our European partners (France, Germany, and the United Kingdom) and participate in their evaluations of performance, signature, hazards, mechanical, and aging properties.

(U) $286 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion
	PROJECT 636339

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0602303A, Missile Technology.
(U) PE 0603313A, Missile and Rocket Advanced 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.

(U) **E. Schedule Profile**
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion

PROJECT: 636340

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
636340	Satellite Control and Maneuvering Propulsion Technology	1,370	1,469	4,897	2,932	2,976	1,520	1,550	Continuing	TBD

(U) **A. Mission Description**

Chemical, electric, and solar rocket propulsion system technologies for station keeping and on-orbit maneuvering applications are developed in this project. 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 chemical propellants. The payoffs for the Integrated High Payoff Rocket Propulsion Technology Initiative (IHPRPT) include a seven-year increase in satellite on-orbit time, a 50% increase in satellite maneuvering capability, a 25% reduction in orbit transfer operational costs, and a 15% increase in satellite payload.

(U) FY 1999 ($ in Thousands)

(U) $913 Completed test flight and data collection of the Electric Space Experiment (ESEX) space flight aboard the ARGOS satellite.

(U) $357 Compiled and analyzed data from the ESEX experiment.

(U) $100 Completed selection of advanced pulsed-plasma propulsion for engineering model ground test to support MightySat II.2 space flight experiment and TechSat 21.

(U) $1,370 Total

(U) FY 2000 ($ in Thousands)

(U) $269 Develop propulsion systems for satellite formation flying. Complete design of pulsed plasma thruster for use in satellite formation flying. Complete data analysis of the Electric Space Experiment (ESEX) space flight.

(U) $200 Develop propulsion for satellite stationkeeping and repositioning. Initiate fabrication of brass board test hardware of the pulsed plasma thruster. Complete fabrication of power conditioning systems for ground testing of complete PPT system.

(U) $1,000 Continue to test propulsion systems for use in satellite propulsion. Begin integration of flight hardware onto the MightySat II.2 satellite. Once integration is complete, begin testing of the propulsion system.

(U) $1,469 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion	PROJECT 636340

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

(U) FY 2001 ($ in Thousands)

(U)	$538	Continue to develop propulsion systems for satellite formation flying. Begin development of mathematical models to address different propulsion technologies that could be used for small satellite formation flying. Using these models, downselect the optimum propulsion system for use in these types of systems.
(U)	$414	Continue to develop propulsion for satellite stationkeeping and repositioning. Initiate brass board level testing of a pulsed plasma thruster system. Hot fire test the thruster in conjunction with the power processing unit.
(U)	$3,945	Continue to test propulsion systems for use in satellite propulsion. Continue testing of flight hardware onto the MightySat II.2 satellite. Once integration is complete, begin testing of the propulsion system. Prepare for launch of MightySat II.2.
(U)	$4,897	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603311F Ballistic Missile Technology

PROJECT: 634091

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634091	Missile Electronics	15,379	22,725	0	0	0	0	0	0	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program funds the development, and particularly the integrated demonstration, of advanced guidance, navigation, and control packages for ballistic missiles. These technologies are flown as Missile Technology Demonstration flights. Efforts directly support strategic force sustainment, space force applications, and space navigation. Also funded are upgrades for range and safety instrumentation for ballistic missiles. Emphasis is on technologies which increase safety, reduce maintenance, and improve reliability of the currently deployed intercontinental ballistic missile (ICBM) force at a lower life cycle cost. Future precision guidance and navigation technologies are demonstrated on sounding rocket and ICBM flights that support conventional ballistic missiles and hard and deeply buried target defeat capability technology needs. Note: This program was eliminated at the end of FY 1997; however, Congress added funds for Missile Technology Demonstration (MTD) flight testing and Radiation Hardened Electronics in FY 1998, for Ballistic Missile Technology and Range Safety in FY 1999, and for Ballistic Missile Technology in FY 2000.

(U) FY 1999 ($ in Thousands)

(U)	$11,918	Developed technologies for integration of advanced Global Positioning System - Inertial Navigation System (GPS-INS) technology into ballistic missile guidance systems and range instrumentation to meet more stringent range safety requirements. Transitioned proven advanced technologies into range qualification test programs.
(U)	$2,963	Enhanced GPS-INS navigation technologies to improve performance during the plasma blackout phase of ballistic missile reentry by applying current GPS anti-jamming technologies to ballistic missile technologies, developing advanced anti-jamming antenna architectures, and extending radiation hardening technologies to ballistic missile electronics systems.
(U)	$498	Developed technologies for evaluating the service life and aging properties of ballistic missile components and materials such as the component polymeric materials.
(U)	$15,379	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603311F Ballistic Missile Technology
	PROJECT 634091

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

(U) FY 2000 ($ in Thousands)

(U)	$12,943	Demonstrate technologies for integration of advanced GPS-INS technologies into ballistic missile guidance systems and range instrumentation to meet more stringent range safety requirements. GPS-INS range instrumentation systems greatly improve the integrity of missile tracking data in all phases of flight and operate at greatly reduced costs. Conduct range instrumentation flight safety approval and certification efforts on qualified technologies.
(U)	$4,940	Develop and demonstrate Global Positioning System - Inertial Navigation System (GPS-INS) navigation technologies to improve performance during ballistic missile reentry plasma blackout and jamming environments. These technologies will offset the detrimental effects of reentry plasma and jamming on GPS-INS navigation performance. Conduct reentry plasma physics characterization studies, extend existing plasma modeling and simulation tools, and enhance GPS anti-jamming receiver, antenna architectures, and window material technologies.
(U)	$3,755	Validate and demonstrate technologies for evaluating the service life, aging properties, and provide for the subsequent recycling of ballistic missile components and materials while minimizing environmental impacts and costs. Conduct demonstrations and validate advanced technologies for evaluating the aging properties of polymeric materials.
(U)	$1,087	Develop and demonstrate advanced common ballistic missile technologies necessary for Air Force and Navy replacement and life extension programs. Advanced common technologies will provide the required performance at greatly reduced costs to the government. Required technologies include development of solid state electrical and micro-mechanical guidance, navigation, and control (GNC) systems, advanced common vehicle designs capable of meeting mid and far-term GNC requirements, and high temperature materials capable of withstanding demanding reentry conditions.
(U)	$22,725	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603311F Ballistic Missile Technology
	PROJECT: 634091

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	15,955	0	0	
(U)	Appropriated Value	16,000	23,000		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-45			
	b. Small Business Innovative Research	-490			
	c. Omnibus or Other Above Threshold Reprogram		-125		
	d. Below Threshold Reprogram				
	e. Rescissions	-86	-150		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR				
(U)	Current Budget Submit/FY 2001 PBR	15,379	22,725	0	TBD

(U) Significant Program Changes:
Not Applicable.

(U) D. Other Program Funding Summary ($ in Thousands)
(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) E. Acquisition Strategy
Not Applicable.

(U) F. Schedule Profile
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	72,549	102,277	97,327	95,490	83,343	68,837	56,243	Continuing	TBD
631026	Space Structures and Controls Technology	1,648	6,620	0	0	0	0	0	Continuing	TBD
632181	Spacecraft Payloads	10,765	18,076	17,045	17,130	15,194	15,420	16,575	Continuing	TBD
633784	Space Sensors Technology	1,972	2,571	0	0	0	0	0	Continuing	TBD
633834	Integrated Space Technology Demonstrations	33,840	51,074	16,271	17,407	18,174	21,002	19,059	Continuing	TBD
634400	Space Systems Protection	5,573	6,537	1,111	2,329	2,803	3,085	3,563	Continuing	TBD
634844	Discoverer II	14,894	13,098	54,240	50,016	37,608	19,513	6,415	Continuing	TBD
63682J	Spacecraft Vehicles	3,857	4,301	8,660	8,608	9,564	9,817	10,631	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: Discoverer II funding for FY 1999 was appropriated and is being executed under PE 0603856F, but is being reported here for consistency. Discoverer II funding moved from PE 0603856F to Project 634844 in this PE for FY 2000 and beyond. In FY 2000, the spectral sensing work in PE 0603605F, Project 633150, moves into this PE, Project 633784. Also in FY 2000, PE 0603302F, Project 630003, Launch Vehicle Technology, was combined with Project 631026 in this PE. In FY 2001, several of the smaller projects in this PE were merged; Project 631026 work was moved to Project 63682J, and Project 633784 work was moved to Project 632181.

(U) **A. Mission Description**

This program develops advanced spacecraft technologies such as structures, electronics, thermal management systems, power, and sensors and demonstrates them in an appropriate fashion (i.e., component or system, ground, or flight). The broad goals of the program are to decrease the time for innovative space technology to be transitioned to the warfighter and to reduce the associated development costs and risks of future Air Force space-based systems. Developmental efforts are focused on six high-payoff, satellite technology areas: (1) reusable and low-cost launch vehicle technologies; (2) advanced space structures and structural controls; (3) radiation hardened space electronics, satellite control software, and intelligent satellite systems; (4) advanced passive/active space-based sensors; (5) compact, low-cost space

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

power and thermal management; and (6) satellite survivability and protection. In FYs 1999 and out, additional emphasis has been placed on evolutionary growth in space technologies. Also starting in FY 1999, the technology development work supporting the integrated demonstrations of advanced guidance, navigation, and control packages for ballistic missiles is funded by this PE. Note: Congress added $50.8 million in FY 2000 ($3.0 million for Scorpius, $4.0 million for Miniature Threat Reporting System, $5.0 million for Microsat Technology, $15.0 million for Upper Stage Flight Experiment, $15.0 million for Space Maneuvering Vehicle, $5.0 million for Radiation Hardened Microelectronics, $0.8 million for Hyperspectral Imaging, and $3.0 million for Composite Space Launch Payload Dispensers).

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	91,021	76,229	116,300	
(U)	Appropriated Value	76,050	103,529		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-508	-17		
	b. Small Business Innovative Research	-1,710			
	c. Omnibus or Other Above Threshold Reprogram		-561		
	d. Below Threshold Reprogram	-871			
	e. Rescissions	-412	-674		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-18,973	
(U)	Current Budget Submit/FY 2001 PBR	72,549	102,277	97,327	TBD

(U) Significant Program Changes:

FY 2001 Funding Adjustments: $13.0 million moves from FY 2001 to FY 2002-2003 to better align the Discoverer II demonstration program with requirements. Additional adjustments move funds to support higher Air Force priorities.

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COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
631026 Space Structures and Controls Technology	1,648	6,620	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project demonstrates advanced composite structures and structural control technologies for future Air Force space and missile systems. Prior to FY 1995, the Air Force relied on Ballistic Missile Defense Organization (BMDO) funding to address its needs in this technology area. As BMDO budgets have declined, so has their funding in this area, necessitating an increased Air Force investment to maintain critical spacecraft structures and controls technologies. Advanced space structure component efforts focus on the demonstration of new composite structure technologies. The goal is to significantly improve the payload mass fraction and reduce overall spacecraft fabrication time and cost. This project also pays for the development of advanced passive and active spacecraft structural control technologies. Structural vibration and shock suppression technologies are intended to significantly enhance space platform stability, improving the focusing/imaging ability of space-based optical components such as focal plane arrays developed in Project 633784 or solar cells developed in Project 63682J.

(U) FY 1999 ($ in Thousands)

(U) $745 Developed composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Developed spacecraft to demonstrate multifunctional structures technologies.

(U) $258 Developed revolutionary spacecraft structural control and mechanisms technologies for applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communication systems.

(U) $645 Developed launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements.

(U) $1,648 Total

(U) FY 2000 ($ in Thousands)

(U) $1,561 Develop composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Develop spacecraft to demonstrate multifunctional structures technologies. Composite and multifunctional structures will be lighter and more affordable, with improved functionality, reducing fabrication and launch costs and enabling applications such as large aperture sensing systems. Develop spacecraft to demonstrate inflatable and multifunctional structures technologies and fabricate inflatable and multifunctional structures for launch. Develop subscale secondary payload adapter structure.

(U) $389 Develop and demonstrate revolutionary spacecraft structural control and mechanisms technologies for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems. These technologies will enhance platform stability, enabling applications such as precision pointing and sensing systems, as well as protect payloads on orbit and increase payload lifetime. Design miniature vibration suppression systems. Launch complex sensor isolation

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

(U) FY 2000 ($ in Thousands) Continued

platform for demonstration of vibration isolation and pointing. Launch second sensor isolation platform, which is simpler and more user friendly. Continue development of passive and active acoustic attenuation technologies.

(U) $1,136 Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Isolation systems will reduce the launch environment problems, decrease spacecraft weight, and reduce failures. Demonstrate low shock separation systems on ground and in flight. Flight demonstrate first three-axis small launch vehicle isolation system.

(U) $570 Develop advanced composite launch vehicle structures such as grid stiffened shrouds for launch vehicles and lightweight thermal protection structures for reusable launch vehicles. Define technological needs for futures military launch vehicles. Composite structures will be lighter and more affordable, reducing fabrication and launch costs, and allowing larger and heavier payloads to be placed in higher orbits. Develop operational grid-stiffened structures.

(U) $2,964 Develop composite space launch payload dispenser for whole-constellation microsatellite deployment. Payload dispenser technologies will satisfy short- and long-term launch needs by making use of excess Enhanced Expendable Launch Vehicle (EELV) capacity. Design and fabricate high stiffness composite constellation payload dispenser.

(U) $6,620 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Efforts transferred to Project 63682J.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603218C, Research and Support.

(U) PE 0603302F, Space and Missile Launch Technology.

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

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(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 632181

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632181 Spacecraft Payloads	10,765	18,076	17,045	17,130	15,194	15,420	16,575	Continuing	TBD

(U) **A. Mission Description**

This project funds the development, demonstration, and evaluation of radiation hardened space electronic hardware, and satellite control hardware and software for advanced satellite surveillance operations. Improved space-qualifiable electronics and software for data and signal processing are to be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., hardening) commercial data and signal processor technologies for use in Air Force space systems. Advanced electronic packaging technologies that reduce weight and volume are being developed for military space applications. Space data processor technologies like the Advanced Technology Insertion Module (ATIM 32-bit) technology are developed and demonstrated. The Advanced Spaceborne Computer Module (ASCM), ATIM's 16-bit predecessor, is currently baselined into 65 DoD, National Aeronautics and Space Administration (NASA), and commercial programs. Also developed and demonstrated are space signal processor technologies like the Hardened Ada Signal Processor (HASP) program. For mid-term applications, the Improved Space Computer Program (ISCP) 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 DoD satellites. Additionally, this project demonstrates very low-power electronics allowing dramatic size, weight, and power reductions for future Air Force space applications. Low-cost, easily modifiable software and hardware architectures for enhanced satellite ground control and intelligent, autonomous satellite operations to support the space surveillance mission are also developed. The Multi-mission Advanced Ground Intelligent Control (MAGIC) program in this project developed a low-cost, flexible architecture for satellite control and mission operations. In the long-term, this project area focuses on developing fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) FY 1999 ($ in Thousands)

(U)	$8,115	Developed and demonstrated affordable, space-qualifiable, radiation hardened, low-power, high performance microelectronic devices such as advanced data processors, and integrated and next generation digital signal processors.
(U)	$1,076	Developed space-qualifiable, high density advanced packaging technology for digital, analog, and mixed-signal electronic devices. Developed micro-electro-mechanical systems (MEMS) components and MEMS-based space system applications.
(U)	$744	Developed enhanced satellite flight software for application to autonomous distributed satellite formation flying, signal processing, and control.
(U)	$830	Developed modeling and simulation applications for space-based surveillance and distributed satellite system payloads.
(U)	$10,765	Total

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

(U) FY 2000 ($ in Thousands)

(U)	$8,731	Develop advanced radiation hardened microelectronic devices such as advanced space data processors and ultra-high density strategically hardened memories for next generation high performance on-board space electronics. Improve radiation hardened fabrication technologies for component manufacturability. Perform functional proof of design of radiation hardened Power PC processor. Redesign commercial next generation space processor, accounting for single event upsets, 10X reduction in amount of power required per instruction at a central processing unit (CPU) level, and radiation hardened fabrication. Provide software and hardware-in-the-loop simulators for advanced, user definable space processor architecture.
(U)	$1,421	Develop space-qualifiable, high density advanced packaging technology for digital, analog, and mixed-signal electronic devices and micro-electro-mechanical system (MEMS) components and applications, including switches and optical components which exploit MEMS technologies. These technologies decrease size, weight, and power required for space electronic devices while improving performance, reliability and affordability. Design two-dimensional and three-dimensional space qualified packaging technologies and reconfigurable electronics and plug-and-play system approaches for space. Develop technologies to enhance/enable optical cross-links such as light-emitting diodes, laser diodes, and MEMS optics that allow 400 Megabit/second data transfer.
(U)	$2,100	Develop intelligent satellite system technologies for satellite control, precision spacecraft navigation, formation flying, and cluster management technologies for spacecraft constellations. Intelligent satellite systems provide improved capabilities to monitor satellites in real-time, reduce time required for data collection, processing, and dissemination, and decrease anomaly resolution time and ground operation requirements. Design satellite cluster command and control, cluster formation flying, and executive cluster control software. Continue design of ground simulation testbed. Complete agent-based software architecture to increase satellite autonomy and simplify the development of complex systems. Demonstrate initial formation flying and orbit determination and satellite control ground station software.
(U)	$884	Develop simulation, modeling, and analysis (MS&A) tools for space-based surveillance systems and distributed satellite architecture payloads. MS&A tools provide data and validate research and development (R&D) systems engineering level technology trade off decisions for space-based surveillance missions/campaign level assessments and for intelligent satellite systems testbeds. Deliver Next Generation Space Telescope simulation. Develop existing space surveillance simulations to support New World Vista's Global Awareness Virtual Testbed. Deliver enhanced satellite toolkit which encompasses satellite constellation-level, distributed architecture modeling.
(U)	$4,940	Develop key radiation hardened microelectronics processes and components for space applications. Improved processes and higher performance components will create new markets and strengthen the radiation hardened electronics industrial base, ensuring component availability at reasonable cost. Improve fabrication process for, and performance of, radiation hardened Application Specific Integrated Circuits; fabricate and validate evaluation chips. Fabricate high performance, strategic hardened microprocessors (PowerPC 603e equivalent) for space using hardened design techniques and transfer to hardened manufacturing fabrication line. Design and fabricate a 16Mbit radiation hardened memory - a 4X

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

(U) FY 2000 ($ in Thousands) Continued

improvement over current technologies - using innovative techniques and new material application.

(U) $18,076 Total

(U) FY 2001 ($ in Thousands)

(U) $9,104 Develop advanced radiation hardened microelectronic devices, including space data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology for digital, analog, and mixed-signal electronic devices, and micro-electro-mechanical systems (MEMS) components and applications, such as switches and optical components. These devices and technologies enable next generation high performance, small, lightweight, efficient, and reliable on-board space electronic systems. Fabricate and demonstrate radiation hardened Power PC. Insert Next Generation Space Processor design and hardware into flight demonstration system. Design specifications, build, and demonstrate ground-based computer based on Improved Space Architecture concept. Demonstrate MEMS switches for reconfigurable space electronic applications. Continue development of packaging and MEMS technologies to enhance/enable optical cross-links and demonstrate the 400 Megabit/second data transfer. Develop reconfigurable electronics and initial plug-and-play system approaches for space.

(U) $1,584 Continue to develop intelligent satellite system technologies for satellite control, precision spacecraft navigation, formation flying, and cluster management technologies for spacecraft constellations. Intelligent satellite systems provide improved capabilities to monitor satellites in real-time, reduce data collection, processing, and dissemination time, and decrease anomaly resolution time and ground operation requirements. Demonstrate intelligent satellite software in the completed ground testbed for satellite cluster command and control, cluster formation flying, and executive cluster control. Demonstrate enhanced executive cluster controller and deliver final formation flying and orbit determination flight test software and satellite control ground station software.

(U) $1,448 Continue to develop modeling, simulation, and analysis (MS&A) tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. The MS&A tools provide data and validate research and development (R&D) systems engineering level technology trade off decisions for space-based surveillance missions/campaign level assessments and for intelligent satellite systems testbeds. Deliver simulation architecture tools for satellite constellation-level modeling and validate these tools across the broader modeling and simulation space community. Demonstrate existing space surveillance simulations to support New World Vista's Global Awareness Virtual Testbed. Demonstrate MS&A software and tools in the distributed satellite architecture simulation testbed. Complete exploitation of the hyperspectral imaging data received from the Fourier Transform Hyperspectral Imager payload and assemble data images for target identification and image evaluation for commercial and military purposes.

(U) $2,227 Develop advanced space infrared sensors and hardened focal plane detector arrays to enable acquisition, track, and discrimination of hot targets, as well 'cold body' targets such as decoys, satellites, and midcourse warheads. Design low temperature multicolor and low background sensors

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

(U) FY 2001 ($ in Thousands) Continued

with focal plane arrays, higher temperature focal plane array sensors, and higher performance radiation hardened sensors. Develop longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperatures for mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing, low photon noise, space backgrounds.

(U) $2,682 Develop satellite antenna technologies which maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules create large, light space antennas. Satellite antenna technologies will be used to improve affordability and capability of antenna modules for space-based payload subsystems for Air Force surveillance and navigation efforts. Complete design of selected embedded-structural transmit-receive electronics antenna modules. Design antenna modules which address the requirement for minimizing mass and power by embedding lightweight electronics in the structure itself. Continue fabrication of modular phased array antenna tile. Complete data analysis on receive-only sub-antenna array data.

(U) $17,045 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0303601F, MILSTAR Satellite Communications System.
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603311F, Ballistic Missile Technology.
(U) PE 0603215C, Limited Defense System
(U) PE 0603218C, Research and Support.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0604609F, Reliability and Maintainability Technology Insertion Program (RAMTIP).
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

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

(U) Not Applicable.

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 633784

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633784 Space Sensors Technology	1,972	2,571	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project funds the development of military space-based ground surveillance technologies. The project's work focuses on advancing space-based applications of commercial sensors while improving the performance, schedule, maturity, cost, and/or risk reduction. The focus of the space sensor effort is to meet spaceborne sensor needs for national missile defense and intelligence, surveillance, and reconnaissance missions.

(U) FY 1999 ($ in Thousands)

(U) $248 Developed and demonstrated space-based reconnaissance/surveillance sensor technologies for advanced mid-wave infrared detectors and hybrid detector arrays.

(U) $1,559 Developed technologies for Space-Based Radar (SBR) Air Moving Target Indication (AMTI) Transmit and Receive Antenna Module (TRAM), antenna beamsteering algorithms for improved detection and tracking, and antenna vibration compensation schemes.

(U) $165 Developed models for the SBR AMTI.

(U) $1,972 Total

(U) FY 2000 ($ in Thousands)

(U) $1,404 Develop advanced space infrared sensors and hardened focal plane detector arrays to enable acquisition, track, and discrimination of hot targets, as well as 'cold body' targets such as decoys, satellites, and midcourse warheads. Continue development of radiation hardened mercury cadmium telluride 128 x 128 focal plane array. Develop 1024 x 1024 long wavelength mercury cadmium telluride focal plane array. Demonstrate feasibility of a polarization autocue for focal plane arrays. Characterize performance of higher temperature multispectral infrared focal plane arrays.

(U) $459 Develop satellite antenna technologies which maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules create large, light space antennas. Satellite antenna technologies will be used to improve affordability and capability of antenna modules for space-based payload subsystems for Air Force surveillance and navigation efforts. Design selected embedded-structural transmit-receive electronics antenna modules. Address requirement for minimizing mass and power by embedding lightweight electronics in the antenna structure itself. Fabricate a modular phased array antenna tile. Complete fabrication and launch receive-only sub-antenna array and begin data analysis.

(U) $708 Develop hyperspectral imaging data exploitation methodologies for military remote sensing applications with the Fourier Transform HyperSpectral Imager (FTHSI). The FTHSI payload will demonstrate the capability of providing the warfighter data concerning terrain

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

(U) FY 2000 ($ in Thousands) Continued

categorization, feature extraction, geological formation mapping, and trafficability within an area observed from space. Launch the FTHSI payload on-board the MightySat II.1 satellite. Initiate analysis of the hyperspectral imaging data received from the Fourier Transform HyperSpectral Imager (FTHSI) payload. Begin assembly of data images for target identification and image evaluation for commercial and military purposes.

(U) $2,571 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Efforts transferred to Project 632181.

(U) $0 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0303601F, MILSTAR Satellite Communications System.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0602702F, Command/Control/Communication Technology.

(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.

(U) PE 0604711F, Extremely High Frequency Satellite Communications Research and Development.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633834	Integrated Space Technology Demonstrations	33,840	51,074	16,271	17,407	18,174	21,002	19,059	Continuing	TBD

(U) **A. Mission Description**

The Integrated Space Technology Demonstration (ISTD) program is a series of advanced technology demonstrations designed to address the Air Force Space Command (AFSPC) mission needs, as identified through their Integrated Planning Process, 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 operational environment, while at the same time affording the user community the opportunity to assess the technologies and determine their applicability to specific operational needs. The ISTD program is intended to fly these demonstrations on three year centers (launch to launch) in order to ensure that the technologies are state-of-the-art, as well as relevant to current mission needs. The program attempts to leverage DoD, civil, and commercial space systems in order to reduce the cost of the demonstrations. Warfighter-1, for example, leverages ORBIMAGE's Orbview-4 commercial remote sensing spacecraft to fly a hyperspectral sensor. Leveraged programs offer additional insight into how the civil and commercial space systems can be exploited to provide operational capability at a fraction of the cost of dedicated military systems.

(U) FY 1999 ($ in Thousands)

(U)	$18,794	Developed and integrated components for the Warfighter-1 ISTD Program, including payload and mobile ground station components and the modified data exploitation algorithms.
(U)	$992	Defined concept and developed acquisition strategy for Warfighter-2 ISTD Program.
(U)	$928	Developed advanced precision ballistic missile navigation technologies to support range instrumentation and safety requirements, improve accuracy after reentry, and support conventional weapon delivery systems.
(U)	$5,828	Developed technologies for autonomous and manual on-orbit control of microsatellites and for autonomous microsatellite navigation and inspection. Conducted the XSS-10 flight demonstration of a microsatellite to demonstrate the 'proof of principle'.
(U)	$2,429	Developed the two-stage near-orbital demonstrator for low-cost liquid launch vehicle technologies.
(U)	$4,869	Developed and tested technologies for solar orbital transfer vehicles (SOTV) such as high performance thermionic energy converters and high temperature insulation materials. Developed preliminary design of a space experiment to validate key solar orbital transfer vehicle technologies such as thermionic energy converters, lightweight solar concentrators, and cryogenic propellant systems.
(U)	$33,840	Total

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	PROJECT 633834

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

(U) FY 2000 ($ in Thousands)

(U)	$12,141	Develop Warfighter-1, the first in a series of Integrated Space Technology Demonstration systems. Warfighter-1 will provide an inexpensive space-based hyperspectral imagery system for technology validation by the user in a tactical environment. Hyperspectral imaging sensors provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Complete development of the Warfighter-1 hyperspectral sensor, mission data center, and mobile ground station. Perform sensor characterization and integration and test on the payload, spacecraft, and space vehicle. Prepare for FY 2001 launch.
(U)	$599	Develop and demonstrate precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments. These technologies will mitigate the detrimental effects of reentry plasma and jamming on Global Positioning System (GPS) navigation performance. Conduct reentry plasma physics characterization studies and start development of miniaturized jam-resistant GPS receivers.
(U)	$790	Develop hyperspectral imaging technologies for space-borne assets to provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Complete development of the Warfighter-1 hyperspectral imaging sensor payload on-board processing capability.
(U)	$4,940	Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Microsatellite technologies will revolutionize satellite operations and support applications such as near-earth object inspection and satellite servicing. Launch first microsatellite in the XSS microsatellite series to test autonomous microsatellite operations including satellite inspection.
(U)	$2,964	Develop scalable booster technologies for low-cost launch vehicles. These technologies will reduce launch vehicle life cycle cost by 5-10X. Demonstrate the Sprite orbital vehicle for launching Air Force small payloads at significantly reduced cost. Develop and test 20,000-lb. thrust flight-weight ablative Sprite booster engine. Design, fabricate, and test prototype Sprite 2K upper stage engine. Demonstrate hydroxy ammonium nitrate tetraethylammoniumnitrate (HANTEAN) mixing gas generator tank pressurization technology.
(U)	$14,820	Develop and demonstrate technologies for a military unique reusable satellite bus and upper stage for the Military Spaceplane system. This effort will provide the Air Force with a vehicle for demonstrating critical Air Force technologies and concept of operations. Develop technologies for a second tail number, leveraging the technology investment in the NASA X-37, and address specific Air Force requirements including space operations and operability technologies.
(U)	$14,820	Develop and demonstrate a low-cost, liquid propellant, expendable upper stage in a cooperative effort with NASA. These technologies will meet Air Force requirements for an affordable expendable upper stage for the Military Spaceplane system, including non-toxic, storable liquid propellants. Prepare for launch in FY 2001.
(U)	$51,074	Total

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	PROJECT 633834

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

(U) FY 2001 ($ in Thousands)

(U)	$6,482	Develop Warfighter-1, the first in the series of Integrated Space Technology Demonstration (ISTD) systems. Warfighter-1 will provide an inexpensive space-based hyperspectral imagery system for technology validation by the user in a tactical environment. Space-based hyperspectral imaging sensors provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Perform launch operations and start on-orbit evaluation of the hyperspectral sensor and associated ground operations. Conduct Warfighter-1 user utility demonstrations, satellite technology validation, and data exploitation analysis and assessment. Start final report detailing the evaluation and lessons learned from the technology demonstration and commercial leveraging.
(U)	$4,585	Develop the second ISTD system. This demonstration will provide the warfighter a cost-effective means of evaluating one of the competing mission concepts. Select the mission concept and develop the technical requirements and acquisition strategy. Execute acquisition plan for a fourth quarter FY 2001 contact award. Begin fabrication of demonstration system components.
(U)	$138	Develop and demonstrate precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments. These technologies will mitigate the detrimental effects of reentry plasma and jamming on Global Positioning System (GPS) navigation performance. Conduct reentry plasma physics characterization and demonstration planning, and continue development and demonstration of miniaturized jam-resistant GPS receivers.
(U)	$2,978	Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Microsatellite technologies will revolutionize satellite operations and support applications such as near-earth object inspection and satellite servicing. Begin design of second satellite in the XSS microsatellite series. Study bus requirements and potential designs. Develop Johnson Space Center GPS and proximity operations sensor package.
(U)	$2,088	Develop technologies for the Communications/Navigation Outage Forecasting System (C/NOFS) demonstration. C/NOFS will demonstrate the capability for forecasting outages to GPS navigation and satellite communications links, providing the warfighter with information on communications and navigation outages, allowing preemptive use of backup systems and alternate links, aiding anomaly resolution, and facilitating mission /operations planning. Develop data processing unit. Verify payload interface. Support spacecraft development and pre-planning of sensor suite integration and testing.
(U)	$16,271	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 633834

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

(U) Related Activities:

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology — PROJECT: 634400

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634400 Space Systems Protection	5,573	6,537	1,111	2,329	2,803	3,085	3,563	Continuing	TBD

(U) **A. Mission Description**

This project funds the development and demonstration of technologies required to assure operation of U.S. space assets in potentially hostile warfighting environments. Work performed includes assessment of critical components, subsystems, and systems' threat susceptibility and vulnerability. This project also develops technologies to mitigate identified vulnerabilities. Further, technology options are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment. Efforts under this project will be closely integrated with exploratory space technologies such as those developed under PE 0602601F, Projects 621010 and 628809, and advanced space technologies developed under this PE in Projects 631026, 632181, 633784, and 63682J. Where appropriate, end products include integrated demonstrations with technologies developed in Project 633834. Through this project, the Air Force assumes responsibility for critical spacecraft survivability technology from the Ballistic Missile Defense Organization (BMDO).

(U) FY 1999 ($ in Thousands)

(U) $139 Expanded the capability of the multi-threat assessment tool by adding selected directed energy effects.

(U) $139 Completed countermeasure analysis task, examining weight and power improvements.

(U) $435 Completed fabrication and began testing of the radio frequency (RF) threat warning/attack reporting (TW/AR) receiver.

(U) $4,860 Prepared radar warning receiver miniaturization for power and weight savings for the Miniaturized Satellite Threat Reporting System (MSTRS). Began preparation for the MSTRS risk reduction prototype hardware space flight scheduled for shuttle flight STS-107.

(U) $5,573 Total

(U) FY 2000 ($ in Thousands)

(U) $1,255 Prepare and use multi-threat assessment tool to assess space-based electro-optical sensor responses to various candidate laser countermeasures. Provides space platform designers a rapid and robust assessment tool for accurate assessment of various countermeasures. Identify passive satellite countermeasures and develop appropriate mitigation techniques.

(U) $553 Develop satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize the receipt of intentional and unintentional ground-based RF and laser signals. Satellite threat warning technologies provide the warfighter information related to possible hostile acts directed at mission critical satellites and aid in satellite anomaly resolution. Fabricate and test space-qualified RF hardware and develop proof of concept laser sensor design and laboratory brassboard.

(U) $777 Coordinate integration and testing of MSTRS on host experiment platform for Space Shuttle risk reduction flight. The flight test will provide engineering performance analysis of key MSTRS hardware components in a space environment and provide users early insight into MSTRS

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology
PROJECT 634400	

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

(U) FY 2000 ($ in Thousands) Continued

operational performance characteristics.

(U) $3,952 Continue evolution of Miniaturized Satellite Threat Reporting System (MSTRS) that warns against ground-based, broad-band Radio Frequency (RF) threats to satellites using a radar warning receiver as well as meakoning, intrusion, jamming, and interference receivers. Miniaturization enables incorporation of threat warning technologies on a variety of space platforms. Develop receiver system miniaturization technologies for power and weight savings.

(U) $6,537 Total

(U) FY 2001 ($ in Thousands)

(U) $50 Use multi-threat assessment tool to assess space-based electro-optical sensor responses to various candidate laser countermeasures. Provides space platform designers a rapid and robust assessment tool for accurate assessment of various countermeasures. Begin development of passive satellite countermeasures and appropriate mitigation techniques.

(U) $665 Continue to develop satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize the receipt of intentional and unintentional ground-based RF and laser signals. Satellite threat warning technologies provide the warfighter information related to possible hostile acts directed at mission critical satellites and aid in satellite anomaly resolution. Complete design, fabricate, and test laser sensor brassboard. Begin design of integrated prototype RF receiver/laser sensor hardware with weight and power savings compared to individual sensor packages.

(U) $396 Develop RF threat warning receiver for a one-year long space flight. Complete Radio RF receiver data analysis, evaluate receiver performance to identify design changes to optimize performance, and incorporate changes into receiver design to reduce performance risk for the one-year flight. Conduct assessment of weapons effects on satellite components and systems.

(U) $1,111 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603410F, Space Systems Environmental Interactions Technology.

(U) PE 0603605F, Advanced Weapons Technology.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology
PROJECT: 634400	

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

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 634844

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634844 Discoverer II	14,894	13,098	54,240	50,016	37,608	19,513	6,415	Continuing	TBD

(U) **A. Mission Description**

Discoverer II (D-II) is a space-based radar/ground moving target indicator (SBR/GMTI) risk-reduction demonstration. The program, a two-satellite technical demonstration recommended by the Defense Science Board, develops and demonstrates the technologies that would be inherent in an SBR/GMTI tactical surveillance architecture. The cost goal of the program is to enable affordable acquisition of an operational SBR architecture for worldwide surveillance and targeting by mitigating the technical risks through the D-II demonstration. The National Reconnaissance Office (NRO) is an investment partner in this project and submits its budget request under the 'Discoverer II MTI Demo'. The Defense Advanced Research Projects Agency (DARPA) is also a funding partner due to the technical innovation and development nature of D-II. DARPA submits its budget request under the 'Aerospace Surveillance Technologies, Project SGT-02'. The Air Force also budgets for the launch integration and vehicle costs under PE 0305953F, Evolved Expendable Launch Vehicle. A senior oversight group consisting of SAF/AQ, the Director of NRO, and the Director of DARPA oversees D-II. The Air Force has the Senior Acquisition Executive responsibilities and DARPA has Program Executive Officer responsibilities (through Critical Design Review (CDR)).

(U) FY 1999 ($ in Thousands)

(U) $7,068 Supported jointly funded effort to conduct design trades and analyses leading to candidate objective system and demonstration system designs by awarding three system integration (SI) contracts. Core activities focused on cost/performance trades and completion of an Integrated Master Plan/Schedule. The initial Interim Evaluation Review was conducted in fourth quarter FY 1999.

(U) $7,076 Supported jointly funded risk reduction efforts in key risk areas to include antenna design and fabrication, and exploitation software. Completed Thinned Transmitter/Receiver (T/R) Module Electronically Scanned Array Design.

(U) $750 Conducted mission utility analysis and concept of operations studies.

(U) $14,894 Total

(U) FY 2000 ($ in Thousands)

(U) $8,413 Support jointly funded effort to complete objective system and demonstration system preliminary designs through conduct of a competitive downselect process culminating in selection of a single System Integrator contractor's design. Conduct risk mitigation and demonstration test planning.

(U) $4,685 Support jointly funded risk reduction efforts in key risk areas to include: design and fabrication for a low-cost, lightweight, space-qualifiable, Electronically Scanned Array antenna; and advanced signal processing for High-Range-Resolution Ground Moving Target Indicators, high resolution Synthetic Aperture Radar mode imaging, and terrain mapping technical feasibility and implementation concerns for Digital Terrain

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 634844

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

(U) FY 2000 ($ in Thousands) Continued

Elevation Data. Conduct mission utility analysis and concept of operations studies.

(U) $13,098 Total

(U) FY 2001 ($ in Thousands)

(U) $30,270 Support jointly funded effort to conduct detailed design and long lead procurement for satellite and ground demonstration system. Support risk reduction activities in support of a successful Critical Design Review.

(U) $18,628 Support jointly funded construction and component testing of spacecraft bus and payload. Support jointly funded software testing, integration, test, and data reduction. Support risk reduction activities.

(U) $5,342 Support jointly funded risk reduction efforts in key risk areas to include: design and fabrication for a low-cost, lightweight, space-qualifiable, Electronically Scanned Array antenna; and advanced signal processing for High-Range-Resolution Ground Moving Target Indicators, high resolution Synthetic Aperture Radar mode imaging, and terrain mapping technical feasibility and implementation concerns for Digital Terrain Elevation Data. Conduct mission utility analyses and concept of operations studies.

(U) $54,240 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0305953F, Evolved Expendable Launch Vehicle.

(U) National Reconnaissance Office (NRO) MTI Radar Technology Project.

(U) SGT-02, DARPA Aerospace Surveillance Technologies.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 63682J

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63682J Spacecraft Vehicles	3,857	4,301	8,660	8,608	9,564	9,817	10,631	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates compact, low-cost, spacecraft and ballistic missile power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation work focuses on lightweight, low-cost, low volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen (NiH2) and sodium sulfur (NaS) spacecraft batteries and flywheel energy storage systems for extended (five-ten year) satellite missions. Power distribution efforts focus on producing lightweight, high efficiency, standardized power busses for use on future Air Force space programs. This project also funds the development and demonstration of the non-nuclear technologies associated with space nuclear power systems such as power conversion, conditioning, and power system thermal management. In addition, investigations into alternative technologies to increase space vehicle power subsystem performance, lifetime, survivability, and safety while reducing costs/risks are conducted. In FY 1995, the Air Force assumed responsibility for the Ballistic Missile Defense Organization's (BMDO) goal to develop spacecraft thermal management technologies. Examples of this are cryogenic coolers necessary to maintain passive (e.g., infrared focal plane array) sensors in low-light backgrounds through this project.

(U) FY 1999 ($ in Thousands)

(U) $1,474 Developed and evaluated performance of space conventional power generation technologies such as advanced multijunction solar cells, thin film solar cells, and a solar-to-electric converter power system for space operation.

(U) $1,472 Developed space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system.

(U) $791 Developed advanced cryocooler technology for application to a 10K cryocooler capable of meeting the load, weight, and power requirements for space-based infrared concepts.

(U) $120 Developed spacecraft thermal management systems such as advanced capillary pumped loop systems.

(U) $3,857 Total

(U) FY 2000 ($ in Thousands)

(U) $1,687 Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible arrays of thin film solar cells, and radiation resistant solar cell modules. Advanced conventional power generation technologies will make more power available for satellites with high power requirements, require less storage for launch, use new and easier methods to deploy, and be lighter and more affordable. Begin development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Continue development and evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 63682J

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$1,375	Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. These advanced energy storage technologies will reduce energy storage mass, replace separate spacecraft attitude control systems, and enable satellites with high peak power requirements such as space antennas and space-based laser systems. Begin flywheel ground demonstration. Begin development of technologies to increase flywheel safety.
(U)	$1,239	Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications at temperatures ranging from 10K to 150K. Cryocoolers enable extended missions for infrared sensor-based space surveillance systems, as well as increase the operational range, life, and reliability of very long wavelength infrared sensors. Complete five-year life cycle test of a 60K cryocooler. Integrate the Reverse Brayton cryocooler into the Hubble telescope. Complete 10K engineering development model cryocooler. Deliver protoflight quality 95K cryocooler.
(U)	$4,301	Total

(U) FY 2001 ($ in Thousands)

(U)	$1,965	Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible arrays of thin film solar cells, and radiation resistant solar cell modules. Advanced conventional power generation technologies will make more power available for satellites with high power requirements, require less storage for launch, use new and easier methods to deploy, and be lighter and more affordable. Continue development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Demonstrate thermal to electric conversion cells. Continue evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.
(U)	$1,345	Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. These advanced energy storage technologies will reduce energy storage mass, replace separate spacecraft attitude control systems, and enable satellites with high peak power requirements such as space antennas and space based laser systems. Continue flywheel ground demonstration and development of flywheel safety technologies. Begin microflywheel development.
(U)	$1,189	Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications at temperatures ranging from 10K to 150K. Cryocoolers enable extended missions for infrared sensor-based space surveillance systems, as well as increase the operational range, life, and reliability of very long wavelength infrared sensors. Fabricate and deliver 10K demonstration cryocooler and optimize technology for application to a 10K protoflight demonstration cryocooler. Complete in-house performance evaluation on the 95K cryocooler.
(U)	$2,276	Develop composites for launch vehicles and spacecraft structures, including grid stiffened launch vehicle shrouds and lightweight thermal protection structures for reusable launch vehicles, and for space applications, such as lightweight space antennas. Develop spacecraft to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology — PROJECT: 63682J

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

(U) FY 2001 ($ in Thousands) Continued

demonstrate multifunctional structures technologies. Composite and multifunctional structures will be lighter and more affordable, with improved functionality, reducing fabrication and launch costs and enabling applications such as large aperture sensing systems. Flight demonstrate operational grid stiffened structure. Continue development of inflatable structures. Begin ground test of multi-functional structures. Develop full-scale Evolved Expendable Launch Vehicle (EELV) secondary payload adapter structure.

(U) $1,885 Develop and demonstrate revolutionary spacecraft structural control and mechanisms technologies for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems for sensors and communications systems. Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. These technologies will enhance platform stability, enable applications such as precision pointing and sensing, protect payloads on orbit and increase payload lifetime, reduce launch environment problems, decrease spacecraft weight, and reduce failures. Test miniature vibration suppression systems. Develop non-linear payload isolation systems. Ground demonstrate active acoustic attenuation system. Flight demonstrate simplified low shock separation device.

(U) $8,660 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603302F, Space and Missile Launch Technology.

(U) PE 0603218C, Research and Support.

(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603410F Space Systems Environmental Interactions Technology

PROJECT: 632822

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632822	Space Environmmental Impact Tests	3,263	4,027	3,412	3,746	4,307	4,383	4,953	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program's objectives are to improve the survivability and reliability of current and future DoD space systems, and develop and demonstrate cost-effective solutions to mitigate hazardous space-environmental interactions. These hazards include dangerous electrical discharges due to excess charge buildup on spacecraft components, degradation, and failure of structures and electronics due to long-term radiation doses, and single-event upsets (processor errors, memory corruption, etc.) due to high-energy penetrating radiation. As DoD dependence on space systems for mission critical operations and the use of unhardened commercial components increase, these effects will become more prevalent and serious. Advanced technology goals of this program are: (1) develop and demonstrate small, low-power, high performance space environmental monitoring systems; (2) provide improved specifications and analysis tools for design and application of advanced components and systems in DoD space systems; and (3) develop an autonomous on-board space-environmental hazard detection and control system to provide real-time warning and mitigation of space-environmental conditions likely to cause degraded satellite performance. These goals will be achieved through continued analysis and exploitation of data from current and past space experiments and through space flight of new experiments and prototype systems that investigate areas of concern to DoD spacecraft operations. Note: In FY 2000, Congress added $0.4 million for space survivability.

(U) FY 1999 ($ in Thousands)

(U) $1,959 Launched upgraded space plasma sensor and began development of a third-generation sensor for a flight with the Communications/Navigation Outage Forecast System (C/NOFS) to support Air Force Space Command environment specification and forecast systems.

(U) $644 Executed joint program with National Aeronautics and Space Administration (NASA) to improve high-voltage spacecraft charging hazard analysis tools for DoD and NASA spacecraft.

(U) $660 Supported joint United States/British Space Test Program to provide on-board hazard detection of space environmental conditions that degrade satellite performance. Began design of small passive spacecraft charge control system to eliminate spacecraft charging hazards.

(U) $3,263 Total

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603410F Space Systems Environmental Interactions Technology

PROJECT: 632822

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands)

(U)	$1,200	Develop environmental sensors to specify and forecast scintillation and other hazardous space environmental conditions that degrade satellite systems and communications. Communications/navigation outage forecasting allows preemptive use of alternate links in times of outages to maintain communication for the warfighter. Specifying and predicting hazardous space conditions will allow improved system design, lifetime, and operational capabilities. Conduct space flight test to demonstrate capability of advanced space plasma sensor to detect environment irregularities that impact Command, Control, Communications, and Intelligence (C3I). Complete fabrication of space-based, all-sky camera for detecting solar disturbances; begin integration for space flight test. Complete fabrication of relativistic electron and proton detector with capabilities to determine spectral resolution of the most damaging high-energy particle populations.
(U)	$1,325	Support initiatives to improve capability to specify and predict space environmental impacts on operational space systems such as spacecraft charging and meteor effects. Spacecraft design and space environment specification and analysis tools are required to improve space system performance, reduce cost, and provide for situational awareness and anomaly resolution for more miniaturized spacecraft, electromagnetic propulsion, and high-power systems. Complete and release dynamic Air Force geosynchronous space codes for space environment specification and effects determination. Complete spacecraft charging analysis tool for geosynchronous environments affecting many DoD communications and surveillance spacecraft. Develop web-based spacecraft charging design tool.
(U)	$1,107	Develop technology to warn of spacecraft charging and other deleterious conditions for DoD and commercial spacecraft and investigate technologies for alteration of space particle environment. The ability to specify and warn of spacecraft charging and related hazards, which can cause component and system level failures, will prevent loss of space assets and capabilities and will provide a capability for a global situational awareness of hazards. Space particle control technology will permit the reduction of hazardous particle environments for naturally or artificially triggered events and the enhancement of particle environments to degrade hostile assets. Demonstrate capability of compact environment anomaly sensors to specify hazardous conditions local to the spacecraft on two space test flights in differing orbits and validate concept of operations to provide global situational awareness by cross-calibration.
(U)	$395	Develop miniaturized chemical contamination and kinetic impact sensors for DoD operational spacecraft. Develop tools for space environmental effects specification and analysis compatible with DoD operational software systems. Advanced space optical systems, such as the planned space-based laser, are extremely sensitive to chemical contamination and require on-board, autonomous systems to monitor and warn of performance degradation. Develop space environment specification and analysis tools that are user-friendly, low-cost, and run on commonly available operational platforms. Design of space environment distributed anomaly sensor for space particle, chemical contamination, and kinetic impact hazards. Transition of leading Air Force space environment specification and analysis software to common Air Force operating system.
(U)	$4,027	Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603410F Space Systems Environmental Interactions Technology
	PROJECT 632822

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

(U) FY 2001 ($ in Thousands)

(U)	$1,396	Complete ground testing of space environmental sensor for flight with the Communications/Navigation Outage Forecast System (C/NOFS). Support integration, launch, and on-orbit operations of instrumentation to provide improved space radiation hazard specification and forecasting. Complete space test of plasma sensor prototype for C/NOFS spacecraft. Complete integration of space-based, all-sky camera to detect solar disturbances. Begin integration of relativistic electron and proton detector for mission to map the dynamic radiation belts and quantify the hazards to space systems.
(U)	$1,071	Advance spacecraft survivability through collaborative experiments and development of design tools needed for advanced power, communications, and surveillance systems. Complete web-based spacecraft charging design tool. Begin analysis of miniaturized charge control system and space power tether system performance.
(U)	$945	Develop technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards to DoD and commercial spacecraft. Develop technologies to mitigate the effect of the space environment on DoD space systems. Technologies to control the level of spacecraft charging and high-energy radiation effects will significantly improve space system reliability and availability, reduce operational costs, and provide techniques to degrade hostile space assets. Complete compact environment anomaly sensor validation. Demonstrate new compact environment anomaly sensor capabilities for geosynchronous orbit environments on Air Force operational satellites. Begin transition and integration of prototype miniaturized charge control system into spacecraft. Begin ground-tests of global particle enhancement and depletion technologies.
(U)	$3,412	Total

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

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

	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget (FY 2000 PBR)	3,436	3,677	4,021	
(U) Appropriated Value	3,457	4,077		
(U) Adjustments to Appropriated Value				
a. Congressional/General Reductions	-21	-1		
b. Small Business Innovative Research	-81			

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603410F Space Systems Environmental Interactions Technology
	PROJECT 632822

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

		FY 1999	FY 2000	FY 2001	Total Cost
	c. Omnibus or Other Above Threshold Reprogram		-22		
	d. Below Threshold Reprogram	-74			
	e. Rescissions	-18	-27		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-609	
(U)	Current Budget Submit/FY 2001 PBR	3,263	4,027	3,412	TBD

(U) Significant Program Changes:
Not Applicable.

(U) D. Other Program Funding Summary ($ in Thousands)
(U) Related Activities:
(U) PE 0602601F, Spacecraft Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) E. Acquisition Strategy
Not Applicable.

(U) F. Schedule Profile
(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603444F MAUI SPACE SURVEILLANCE SYSTEMS

PROJECT: 634868

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634868	Maui Space Surveillance Systems	0	0	4,625	4,627	4,625	4,622	4,617	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: This activity was transferred to this PE from PE 0305910F, Spacetrack, starting in FY 2001.

(U) **A. Mission Description**

This program has responsibility for the Maui Space Surveillance System in Hawaii. The Maui Space Surveillance System (MSSS) is a space surveillance network atop Haleakala, Maui, Hawaii, that consists of a 0.6 meter Laser Beam Director, 0.8 meter Beam Director/Tracker, 1.2 meter twin telescopes, 1.6 meter telescope, and 3.7 meter Advanced-Electro Optical System (AEOS). AEOS will optimize research and development capabilities, as well as improve the quality of space images taken from the ground. MSSS serves as a contributing sensor to the Space Surveillance Network providing data products to include visual imagery, photometric and radiometric signatures, and metric positional data to the Space Control Center, the Combined Intelligence Center, and Air Force Space Command.

(U) FY 1999 ($ in Thousands)

(U) $0 Previously accomplished in PE 0305910F, Spacetrack.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Being accomplished in PE 0305910F, Spacetrack.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $1,035 Enhance operational utility of MSSS data products. Update the Space Object Identification (SOI) tools for AEOS sensors. Conduct daylight optical imaging studies/analyses and research in optimization of multiple channels for the 1.6 meter telescope. Demonstrate utility of high accuracy metrics through high accuracy orbit maintenance. Develop techniques to detect and maintain orbits for small objects below current Space Surveillance Network capabilities; demonstrate utility of providing high accuracy orbit maintenance.

(U) $2,074 Provide technical support to operational users and visiting experimenters using the MSSS assets.

(U) $1,516 Conduct upgrades for MSSS. Demonstrate AEOS enhancements.

(U) $4,625 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603444F MAUI SPACE SURVEILLANCE SYSTEMS
	PROJECT 634868

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	0	0	0	
(U)	Appropriated Value	0	0		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research				
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram				
	e. Rescissions				
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			4,625	
(U)	Current Budget Submit/FY 2001 PBR	0	0	4,625	TBD

(U) Significant Program Changes:

Not Applicable.

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

(U) Related Activities:

(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) **E. Acquisition Strategy**

Not Applicable.

(U) **F. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	21,878	20,753	22,731	21,494	23,670	24,244	23,521	Continuing	TBD
63670A	Ordnance Technology	9,255	8,683	22,731	21,494	23,670	24,244	23,521	Continuing	TBD
63670B	Guidance Technology	12,623	12,070	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: Beginning in FY 2001, Project 63670B is combined with Project 63670A.

(U) **A. Mission Description**

This program develops, integrates, and demonstrates advanced affordable state-of-the-art technologies for improving the effectiveness of air launched conventional weapons against fixed, buried, and mobile surface targets and airborne targets. This program includes development of: (1) conventional ordnance technologies including warheads, fuzes, explosives, munition integration, and lethality and vulnerability assessments; and (2) advanced guidance technologies including seekers, navigation and control, target detection and identification algorithms, and simulation assessments for low-cost precision and adverse weather autonomous seekers. Payoffs from this program are more effective, reliable, and affordable air-delivered conventional munitions employable on manned and unmanned aerospace vehicles against surface and airborne targets in the battlefield environment under adverse weather and reduced visibility conditions.

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	22,791	21,479	22,077	
(U)	Appropriated Value	23,244	21,033		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-453	-28		
	b. Small Business Innovative Research	-685			
	c. Omnibus or Other Above Threshold Reprogram		-114		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology

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

		FY 1999	FY 2000	FY 2001	Total Cost
	d. Below Threshold Reprogram	-105			
	e. Rescissions	-123	-138		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			654	
(U)	Current Budget Submit/FY 2001 PBR	21,878	20,753	22,731	TBD

(U) Significant Program Changes:
Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology — PROJECT: 63670A

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63670A Ordnance Technology	9,255	8,683	22,731	21,494	23,670	24,244	23,521	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates the operational effectiveness and military utility of conventional ordnance and guidance technologies delivered from manned and unmanned aerospace vehicles. The project includes development of conventional ordnance including warheads, fuzes, explosives; hard target warheads; bombs, submunitions, and their dispensing mechanisms; weapon airframes and carriage; munition integration; and lethality and vulnerability assessments. This project also develops and demonstrates affordable, autonomous, and adverse-weather advanced guidance technologies for conventional armament, including precision terminal seekers; autonomous seekers for operation in adverse weather; midcourse navigation sensors for standoff delivery weapons; and target detection and identification processing algorithms for reducing target location error and false alarm rates, while improving target kill probability.

(U) FY 1999 ($ in Thousands)

(U) $3,307 Developed and demonstrated advanced conventional armament warhead technologies, including heavy metal liners, less sensitive, high blast penetrator explosives, dense metal warhead cases, fragmentation of thick-walled penetrators, advanced warhead shapes for improved penetration, improved warhead metals and design for high impact loading, and directional mass focus warheads. Advanced warhead technologies will provide better target penetration capabilities and enhanced kill probability against fragmentation sensitive targets.

(U) $1,900 Developed and demonstrated advanced conventional armament fuze technologies including hard target penetration, low-cost proximity for surface targets, and target imaging detection devices.

(U) $4,048 Integrated advanced conventional armament technologies including innovative aerospace vehicle carriage and release equipment, release concepts for small weapons, compact fin folding and deployment mechanisms, and compact airframe design and subsystem integration. Munition integration technologies will provide the capability of multiple carriage of small weapons, and allow communication between the aerospace vehicle and the weapons.

(U) $9,255 Total

(U) FY 2000 ($ in Thousands)

(U) $3,660 Develop and demonstrate advanced conventional armament warhead technologies including heavy metal liners, less sensitive, high blast penetrator explosives, dense metal warhead cases, fragmentation of thick-walled penetrators, advanced warhead shapes for improved penetration, improved warhead metals and design for high impact loading, and directional mass focus warheads that will provide improved target penetration capabilities, enhanced kill probability against fragmentation sensitive targets, and reduced sorties that will improve pilot survivability and increase aircraft longevity. Design a warhead that is capable of defeating soft targets associated with chemical/biological production and storage.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology
	PROJECT 63670A

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

(U) FY 2000 ($ in Thousands) Continued

Explore concepts for neutralizing chemical/biological agents with minimum collateral damage. Complete design of a trimode warhead and weapon electronics for lethal Suppression of Enemy Air Defenses (SEAD) and armor/interdiction missions.

(U) $2,852 Develop and demonstrate advanced air-delivered munition fuze technologies including impact shock tolerance for hard target penetration, low-cost height of burst fuzing for fixed surface targets, and target imaging for mobile targets that will improve munitions effectiveness, allow smaller warheads and munition airframes, thereby increasing strike aircraft loadouts and improving sortie effectiveness. Fabricate brassboard multiple event hard target fuze and evaluate its performance by laboratory testing under high-G shock conditions expected for future penetrating weapons. Evaluate capability of tactical ladar seeker to provide accurate fuzing information for trimode warhead.

(U) $2,171 Develop innovative air-delivered munition carriage/release equipment, miniature weapon release concepts, and airframe size reduction concepts such as folding fins that will provide the capability to safely carry and launch multiple small weapons, and provide communication between the aerospace vehicle and the weapons, thereby increasing weapon load outs, improving sortie effectiveness and reducing munition airlift requirements for current and future Air Force and Navy strike aircraft. Conduct concept evaluations to establish a low risk operational concept for Unmanned Conventional Aerial Vehicle weapons employment. Complete affordable small munition dispenser design, fabricate wind tunnel model of small munition dispenser, and evaluate performance with wind tunnel tests. Fabricate brassboard small munition dispenser test hardware for ground and flight test.

(U) $8,683 Total

(U) FY 2001 ($ in Thousands)

(U) $4,040 Develop and demonstrate advanced conventional armament warhead technologies that will provide improved target penetration capabilities, enhanced kill probability against fragmentation sensitive targets, and reduced sorties to improve pilot survivability and increase aircraft longevity. Ground test a chemical/biological defeat warhead to characterize effectiveness against production/storage capabilities. Continue developing and evaluating concepts for neutralizing a broad spectrum of chemical/biological agents. Fabricate the trimode warhead and associated weapon electronics, designed in FY 2000, for lethal SEAD and weapons interdiction missions.

(U) $5,080 Develop and demonstrate advanced air-delivered munition fuze technologies that will improve munitions effectiveness, allow smaller warheads and munition airframes, thereby increasing strike aircraft loadouts and improving sortie effectiveness. Conduct initial field test of multiple event hard target fuze brassboard design. Develop brassboard design of an integrated fuze, improved target detection device, and directional warhead package.

(U) $2,489 Develop innovative air-delivered munition carriage/release equipment, miniature weapon release concepts, and airframe size reduction concepts that will provide the capability to safely carry, launch, and provide communication between the aerospace vehicle and the multiple miniature weapons, thereby increasing weapon load outs, improving sortie effectiveness for current and future strike aircraft while reducing munition airlift

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology
PROJECT 63670A	

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

(U) FY 2001 ($ in Thousands) Continued

requirements. Continue Unmanned Combat Aerial Vehicle/miniature munition integration and planning support for flight test demonstration. Complete ground and flight test of brassboard small munition dispenser.

(U) $2,995 Develop and demonstrate advanced conventional armament seeker technologies for application to the development of miniature munitions with the capability to autonomously detect, acquire, and guide to targets of interest in adverse weather and battlefield conditions and increase the probability of kill and minimize collateral damage while providing increased weapons load out and improved sortie effectiveness. Develop preliminary design of a terminal ladar seeker for a miniature munition that will be effective against high value fixed targets. Fabricate and captive flight test a low-cost tactical-sized ladar seeker for miniature munitions compatible with Unmanned Combat Aerial Vehicles.

(U) $3,084 Develop and demonstrate advanced conventional armament navigation and control technologies to provide increased armament navigation accuracy, improved standoff range, and enhanced weapon control and operation in electronic jamming environments. Initiate interface design between target detection device, fuze, directional warhead, and weapon terminal guidance seeker. Complete design and fabrication of a integrated ladar terminal seeker and Inertial Navigation System/Global Positioning System navigation and control system.

(U) $5,043 Integrate advanced conventional guidance technologies 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 hardened fixed ground targets to reduce sortie rates, improve mission effectiveness, and reduce collateral damage. Complete flight readiness review and final subsystem integration of an autonomous guidance seeker against ground fixed and mobile targets. Conduct free flight tests and analyze flight test data of a powered miniature munition with integrated ladar seeker and Inertial Navigation System/Global Positioning System guidance to validate design and determine target false alarm rate.

(U) $22,731 Total

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

Not Applicable.

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

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology	PROJECT 63670A

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology — PROJECT: 63670B

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
63670B Guidance Technology	12,623	12,070	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates affordable, autonomous, and adverse weather advanced guidance technologies for conventional armament delivered from manned and unmanned aerospace vehicles. This project develops the following technologies: precision terminal seekers for enhanced target destruction; autonomous seekers for operation in adverse weather for increased accuracy; midcourse navigation sensors for standoff delivery weapons; and target detection and identification processing algorithms for reducing target location error and false alarm rates, while improving target kill probability.

(U) FY 1999 ($ in Thousands)

(U) $7,752 Developed and demonstrated advanced conventional armament seeker technologies including laser radar, millimeter wave, synthetic aperture radar, and conformal seeker arrays for multi-mode applications. These affordable seeker technologies will provide the capability to autonomously detect, acquire, and guide to targets of interest in adverse weather conditions while increasing probability of kill.

(U) $1,082 Developed and demonstrated advanced conventional armament navigation and control technologies including weapon guidance laws, state vector estimators, autopilots, inertial navigation, aerodynamic control, and anti-jam global positioning system techniques. These technologies will provide increased armament navigation accuracy and enhanced weapon control and operation in a electronic jamming environment.

(U) $3,789 Integrated advanced conventional guidance technologies including seekers, navigation and control, signal and image processing/algorithm technologies, laser radar algorithms, super resolution techniques for millimeter waves and synthetic aperture radar, optical processing techniques, and demonstrated advanced conventional armament guidance capabilities. This guidance capability will provide better adverse weather performance, faster processing of target information, higher probability of target detection, and an operationally acceptable target false alarm rate.

(U) $12,623 Total

(U) FY 2000 ($ in Thousands)

(U) $3,699 Develop and demonstrate advanced conventional armament seeker technologies that enable the development of miniature munitions with the capability to autonomously detect, acquire, and guide to targets of interest including fixed targets and ground mobile, in adverse weather conditions while increasing probability of kill and minimizing collateral damage to provide the Air Force and Navy increased weapons load out, improved sortie effectiveness, increased pilot survivability, and reduced aircraft attrition. Fabricate Laser Detection and Ranging (LADAR) brassboard seeker to conduct ground and captive flight tests against fixed and mobile targets. Design a tactical-sized seeker with increased range and resolution capability against a variety of ground targets in adverse terrain and weather conditions.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology
	PROJECT 63670B

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

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,438	Develop and demonstrate advanced conventional armament navigation and control technologies including weapon guidance laws, state vector estimators, autopilots, inertial navigation, aerodynamic control, and anti-jam global positioning system techniques, to provide increased armament navigation accuracy, improved standoff range, and enhanced weapon control and operation in electronic jamming environments to provide the Air Force with accurate, adverse weather standoff capability that will reduce aircraft attrition, increase pilot survivability, improve weapon accuracy, and increase probability of kill. Complete lattice wing design to extend range of small direct attack bombs. Fabricate lattice wing range extension kits and conduct flight tests to determine effectiveness.
(U)	$5,933	Integrate advanced conventional guidance technologies including seekers, navigation and control, signal and image processing/algorithm technologies, laser radar algorithms, super resolution techniques for millimeter waves and synthetic aperture radar, optical processing techniques, and demonstrated advanced conventional armament guidance capabilities to provide improved adverse weather performance, faster processing of target information, higher probability of target detection, an operationally acceptable target false alarm rate, more robust mission planning capabilities, and enhance the effectiveness of miniature munitions against both hardened fixed targets and mobile ground targets to reduce sortie rates, improve probability of one kill per weapon, reduce logistics requirement by requiring fewer munitions, and decrease pilot workload. Fabricate autonomous guidance search and attack test hardware to demonstrate a capability against ground mobile targets. Investigate optical correlator technology for improving terminal accuracy in standoff weapons.
(U)	$12,070	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort moved to Project 63670A.
(U)	$0	Total

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

Not Applicable.

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

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology	PROJECT 63670B

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	51,477	56,805	33,371	33,904	37,496	41,646	45,354	Continuing	TBD
633150	Advanced Optics Technology	14,226	18,697	545	760	777	4,253	5,115	Continuing	TBD
633151	High Power Solid State Laser Technology	9,540	8,866	5,692	5,959	8,489	9,727	10,096	Continuing	TBD
633152	High Power Microwave Technology	7,926	7,490	8,658	9,290	9,932	8,686	8,858	Continuing	TBD
633647	High Energy Laser Technology	19,785	21,752	18,476	17,895	18,298	18,980	21,285	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program demonstrates advanced directed energy and optical imaging concepts. Speed-of-light weapons and long-range, high resolution optical imaging through the turbulent atmosphere offer significant payoffs for many Air Force missions, such as theater missile defense, suppression of enemy air defenses, and control of space. This program has already demonstrated many major technological breakthroughs such as removing significant atmospheric distortions from optical transmissions (e.g., laser beams) and producing high power solid state and chemical lasers. Major emphasis areas include: high power microwave and high energy laser technologies; long-range optical imaging; and high power solid state lasers. Within high energy lasers the emphasis is on developing methods to increase the power on target. This is done by continuing to remove more of the atmospheric degradations and to develop more efficient laser devices. Because of the unique effects associated with high power microwaves there are many potential applications ranging from low power disruptions to high power destruction of electronic devices. Thus, a wide range of high power microwave technologies are being developed. Long-range optical imaging offers high resolution images of space objects from the ground for applications such as satellite status assessments. Long-range imaging technologies are demonstrated at the Starfire Optical Range at Kirtland Air Force Base, NM, and at the Maui Space Surveillance System (MSSS) in Hawaii. High power solid state lasers offer great potential for very small optical sources at many wavelengths for applications such as infrared illuminators and infrared countermeasure sources as well as weapon applications. This PE will continue to develop a wide range of directed energy technologies for many DoD applications. Note: Congress added $6 million for Field Laser Radar upgrades, $12 million for Geo Laser Imaging National Testbed (GLINT), and $2.5 million for LaserSpark Missile Countermeasures in FY 2000.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	53,317	38,995	34,225	
(U)	Appropriated Value	53,653	57,495		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-336			
	b. Small Business Innovative Research	-1,654			
	c. Omnibus or Other Above Threshold Reprogram		-312		
	d. Below Threshold Reprogram	102			
	e. Rescissions	-288	-378		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-854	
(U)	Current Budget Submit/FY 2001 PBR	51,477	56,805	33,371	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to higher priorities within the Science and Technology (S&T) Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633150

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633150 Advanced Optics Technology	14,226	18,697	545	760	777	4,253	5,115	Continuing	TBD

(U) **A. Mission Description**

This project develops advanced optical technologies for locating, identifying, and analyzing distant and/or dim objects. This work supports high energy laser applications in target verification, accurate and sustainable laser beam placement on target, and near-real-time damage assessment. Several advanced technologies including nonlinear optics (NLO), adaptive optics, and specialized optical processing are being developed. The goal is high quality optical image reconstruction, concentrating on removing turbulent atmosphere-induced distortions. Many of the technologies developed/being developed have significant application to astronomy research.

(U) FY 1999 ($ in Thousands)

(U) $705 Continued to develop and demonstrate advanced technologies which increase resolution and data fusion for very long-range optical imaging to support missions such as space object identification and ground target identification from space.

(U) $468 Continued to develop nonlinear optics technologies for non-mechanical corrections in optical imaging.

(U) $101 Continued to develop and demonstrate signature technology for identifying and assessing health and status of satellites out to geosynchronous orbit.

(U) $7,196 Continued to develop technologies for active imaging of geosynchronous space objects.

(U) $5,756 Continued upgrades to the Field Laser Demonstrator for increased sensitivity to obtain very accurate data on space objects and to evaluate techniques for remote sensing of the atmosphere.

(U) $14,226 Total

(U) FY 2000 ($ in Thousands)

(U) $305 Develop nonlinear optics technologies for non-mechanical beam correction for laser beam projection and optical imaging. Investigate the use of a single NLO device to optically correct a subscale bifocal relay mirror breadboard. Test the laboratory breadboard at operationally significant wavelengths into the infrared.

(U) $150 Investigate advanced concepts to deploy and use very large optical mirrors in orbit for applications that support missions such as imaging and laser beam projection and relay. Investigate and develop the materials and techniques for instilling shape and curvature memory into thin membrane mirrors so that they will deploy on orbit to a predetermined shape and curvature. This eliminates pressure canopies which cause optical distortions.

(U) $242 Investigate novel signature techniques for assessing the operational status of satellites out to geosynchronous orbit. Continue the evaluation of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology
	PROJECT 633150

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

(U) FY 2000 ($ in Thousands) Continued

techniques for identifying classes of satellites at geosynchronous range. Transition those identification techniques that are successful to the Air Force Space Command for operational use. Investigate new techniques for individual satellite identification and for health status assessments.

(U) $12,000 Continue to develop technologies for active imaging of geosynchronous space objects. Complete design, verify through simulation design parameters, and buy initial hardware for receiver for the Geo Light Imaging National Testbed at White Sands Missile Range, NM.

(U) $6,000 Continue upgrades to the Field Laser Demonstrator for increased sensitivity to obtain very accurate data on space objects and to evaluate techniques for remote sensing of the atmosphere. Continue to install a laser radar system on the Advanced Electro Optical System telescope on Maui, HI. Perform experiments for space applications such as high accuracy orbital measurements, imaging for target identification, and satellite status assessment.

(U) $18,697 Total

(U) FY 2001 ($ in Thousands)

(U) $180 Develop nonlinear optics technologies for non-mechanical beam correction for laser beam projection and optical imaging. Demonstrate with a breadboard, applications such as target designation and remote sensing in a controlled environment. Pursue the development of these technologies in a scalable manner for beam projection using an orbiting platform with nonlinear optics correction techniques.

(U) $280 Investigate advanced concepts to deploy and use very large optical mirrors in orbit for applications that support missions such as imaging and laser beam projection and relay. Continue to pursue component development of nonlinear optical materials/devices that can be scaled to much larger sizes with required speed, resolution, and greater power handling capability.

(U) $85 Investigate novel signature techniques for assessing the operational status of satellites out to geosynchronous orbit. Field test and demonstrate advance signature techniques for determining the health, status, and operational assessment of satellites out to geosynchronous range. Develop techniques to permit processing of multiple wavelength signatures simultaneously through aperture sharing elements that could be available for an early transition to operational assets.

(U) $545 Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603605F Advanced Weapons Technology	633150

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

(U) Related Activities:

(U) PE 0603444F, Maui Space Surveillance Systems.

(U) PE 0602102F, Materials.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)								DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development			PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology					PROJECT: 633151

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633151 High Power Solid State Laser Technology	9,540	8,866	5,692	5,959	8,489	9,727	10,096	Continuing	TBD

(U) **A. Mission Description**

This project continues to yield revolutionary breakthroughs in compact, robust, and affordable laser system technology for a wide range of military applications requiring small compact laser sources with low to moderate optical power. This is a long-term technology development project with both near-term and long-term goals. 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 applications including aircraft 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. Secondly, wavelength specific solid state lasers for military applications such as infrared countermeasures are developed.

(U) FY 1999 ($ in Thousands)

(U)	$1,982	Continued to develop laser diodes for improved performance/higher power as sources in near-term applications such as illumination, designation, and communication and for incorporation into laser diode array architectures.
(U)	$1,127	Continued to develop scalable laser arrays (fiber/diode) for improved performance in applications requiring high power levels and beam quality such as designating/tracking sources for airborne laser and ground-based laser applications and as weapon sources for degrade and damage in aircraft self-protection applications.
(U)	$3,908	Continued to develop semiconductor diode lasers and optically-pumped semiconductor lasers to support current advanced infrared countermeasures system upgrades to tactical fixed and rotary-winged aircraft. Development focused on concepts with the potential for high efficiency, compact infrared laser sources covering Bands 2 and 4.
(U)	$2,523	Continued to develop the basic laser source and target coupling technologies needed to damage/destroy missile seeker components of next generation advanced imaging infrared-guided air-to-air and surface-to-air missiles.
(U)	$9,540	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology
	PROJECT 633151

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

(U) FY 2000 ($ in Thousands)

(U)	$4,204	Develop low-cost, scalable, high power solid state laser architectures by integrating doped fiber lasers with diode-laser pump sources for directed energy applications such as unmanned aerial vehicle designators/imagers and next generation weapons applications such as space-based lasers and airborne lasers. Demonstrate high electrical efficiency (approximately 20%) and compact packaging, exhibiting high power density (10 milliwatts per cubic centimeter) to enable applications requiring laser mobility. Demonstrate a 100 watt, packaged fiber laser.
(U)	$4,211	Develop and demonstrate laser source and beam control technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrate a reliable and scalable, one watt average power, four micron wavelength, solid state laser for current generation threats to aircraft platforms.
(U)	$451	Develop and demonstrate novel target coupling technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrate ultra-fast laser beam control and target coupling effects for countering focal plane array seekers.
(U)	$8,866	Total

(U) FY 2001 ($ in Thousands)

(U)	$3,858	Develop low-cost, scalable, high power solid state laser architectures by integrating doped fiber lasers with diode-laser pump sources for directed energy applications such as unmanned aerial vehicle designators/imagers and next generation weapons applications such as space-based and airborne lasers. Demonstrate high electrical efficiency (approaching 25%) and compact packaging, exhibiting high power density (30 milliwatts per cubic centimeter) to enable applications requiring laser mobility. Demonstrate a fiber laser module at several 100s of watts of power.
(U)	$1,338	Develop and demonstrate laser source and beam control technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrate a reliable and compact five watt average power, four micron wavelength solid state laser for countering current generation threats to aircraft platforms.
(U)	$496	Develop and demonstrate novel target coupling technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrate a pulsed/ultrafast laser source capable of countering focal plane array seekers.
(U)	$5,692	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633151

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

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633152

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633152 High Power Microwave Technology	7,926	7,490	8,658	9,290	9,932	8,686	8,858	Continuing	TBD

(U) **A. Mission Description**

This project develops high power microwave (HPM) generation technologies. 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 weapons 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. The technologies developed in this project will demonstrate the applicability of HPM that can deny/degrade/damage/destroy electronic systems and subsystems for missions such as suppression of enemy air defense, command and control warfare, and aircraft self-protection.

(U) FY 1999 ($ in Thousands)

(U) $3,041 Continued to develop and demonstrate HPM suppression of enemy air defense technologies to render inoperative electronic components of an adversary's Integrated Air Defense System.

(U) $3,223 Continued to develop HPM technologies to support advanced tactical applications.

(U) $1,172 Continued to develop and demonstrate HPM technologies to render inoperative command and control warfare technologies.

(U) $490 Continued to develop and demonstrate nonlethal active denial technology.

(U) $7,926 Total

(U) FY 2000 ($ in Thousands)

(U) $4,263 Develop and demonstrate HPM technologies to render inoperative sample electronic components of an adversary's Integrated Air Defense System. Integrate pulse power and radio frequency source components for an integrated critical experiment for single shot technologies. Demonstrate a repetitively pulsed subscale breadboard HPM system to validate approach and applicability of HPM munitions.

(U) $2,406 Develop and demonstrate HPM technologies to render inoperative sample command and control components of an adversary. Conduct effects experiments to define optimal source parameters for command and control warfare applications. Evaluate technical capabilities of current HPM source concepts through field experiments. Conduct laboratory experiments to demonstrate brassboard compact device critical to development of air-delivered submunitions. Develop initial air-delivered HPM submunition payload design. Conduct validation of computer models developed under applied research funds.

(U) $821 Develop, demonstrate, and evaluate active denial technology for multiple mission applications including future peacekeeping assignments. Develop and demonstrate high specific power non-lethal directed energy source technology for man-portable applications. Demonstrate vehicle-mounted non-lethal directed energy weapons technology.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633152

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

(U) FY 2000 ($ in Thousands) Continued

(U) $7,490 Total

(U) FY 2001 ($ in Thousands)

(U) $3,723 Develop and demonstrate high power microwave (HPM) technologies to render inoperative electronic components of an adversary's Integrated Air Defense System. Demonstrate and quantify the effectiveness of a repetitively pulsed system against electronic targets of interest. Conduct a full power breadboard demonstration to validate repetitively pulsed capability.

(U) $3,204 Develop and demonstrate HPM technologies to render inoperative command and control components of an adversary. Conduct field experiments with brassboard devices to demonstrate command and control warfare effectiveness. Conduct ground-based, field experiments demonstrating effectiveness of air-delivered HPM sub-munition. Transition selected technologies. Apply computer codes to predict coupling to targets and validate their accuracy.

(U) $1,231 Develop, demonstrate, and evaluate active denial technology for multiple mission applications including future peacekeeping assignments. Complete demonstrations of vehicle-mounted non-lethal directed energy weapons technology. Start hardware development for ancillary subsystems for man-portable applications.

(U) $500 Develop active denial technologies for airborne platform applications as recommended by Phase I of the Directed Energy Applications in Tactical Airborne Combat study. Analyze critical technologies for airborne active denial, including beam control, source efficiency, antenna gain, and aircraft integration.

(U) $8,658 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602202F, Human Systems 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.

(U) **E. Schedule Profile**

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 633152

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

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633647

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
633647 High Energy Laser Technology	19,785	21,752	18,476	17,895	18,298	18,980	21,285	Continuing	TBD

(U) **A. Mission Description**

This project provides for the development, demonstration, and detailed assessment of technology needed for high energy laser weapons. Near-term focus is on ground-based and airborne high energy laser missions, although the technology developed for this project is directly applicable to most high energy laser applications. Critical technologies demonstrated include laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Detailed computational models to establish high energy laser weapon effectiveness and satellite and missile vulnerability will be developed. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most high energy laser applications. The beam control technology developed in this project has a significant benefit to the astronomy community.

(U) FY 1999 ($ in Thousands)

(U) $2,085 Continued to develop and demonstrate the technology for scalable, high efficiency, high energy laser devices for potential weapon applications.

(U) $1,493 Performed vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing system level protection against laser threats.

(U) $746 Continued to investigate and develop advanced, high energy laser optical components.

(U) $9,677 Performed atmospheric compensation and laser beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification.

(U) $5,784 Continued to characterize atmospheric attenuation and distortion on laser beam propagation from airborne platforms, conducted atmospheric compensation and beam control experiments, and developed an airborne ultra-precision inertial pointing brassboard to enhance boost phase theater ballistic missile tracking.

(U) $19,785 Total

(U) FY 2000 ($ in Thousands)

(U) $500 Develop and demonstrate the technology for scalable, high efficiency, high energy laser devices for potential weapon applications. Complete assessment of an efficient, wavelength-shifted chemical oxygen-iodine laser (COIL) device, for application as a moderate- to high-power illuminator laser. Using COIL computer models, evaluate candidate advanced COIL concepts to identify promising approaches for significant improvements.

(U) $960 Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems protected against laser threats. Re-define the counterspace system-level

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology
	PROJECT 633647

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

(U) FY 2000 ($ in Thousands) Continued

lethality criterion for high energy lasers, based on the evaluation of data from individual satellite vulnerability assessments. Transition to the Space Warfare Center an improved tool for the analysis of high resolution optical images for space surveillance. Complete studies to evaluate capabilities for data fusion between optical imagery and radar data from space surveillance.

(U) $200 Investigate and develop advanced, high energy laser optical components for future weapon systems. Continue the investigation of high performance optical coatings (ultra-low absorption, low scatter) to enable uncooled high energy laser optical components, with emphasis on low-stress designs applicable to lightweight mirror and window substrates.

(U) $8,850 Perform atmospheric compensation/beam control experiments from large aperture ground-based platforms to support applications ranging from weaponization to space object identification. Characterize and optimize the performance of the advanced adaptive optics system on the 3.5 meter telescope at the Starfire Optical Range (SOR) in compensating for the optical distortions induced by atmospheric turbulence, including the stressing low elevation angles. Conduct satellite illumination experiments on a range of unaugmented space objects to evaluate and anchor detailed computer models. Demonstrate active (daylight) tracking of selected space objects at low bandwidth. Begin investigation of advanced adaptive optics concepts with the potential to improve compensation performance at lower elevation angles. Continue the development of a 50-watt sodium-wavelength laser, for use as the high-altitude beacon for high-performance, full-aperture compensation of the SOR 3.5 meter telescope.

(U) $8,742 Develop and evaluate beam control/compensation techniques for atmospheric attenuation and distortion on laser beam propagation from airborne platforms for applications such as theater missile defense. Continue evaluation of advanced concepts for active tracking and atmospheric compensation under propagation conditions representative of typical airborne laser engagement scenarios. Then conduct laboratory experiments under precisely controlled conditions to evaluate and optimize performance under realistic turbulence conditions. Conduct realistic extended-beacon tracking and atmospheric compensation experiments against an instrumented target board on the side of an aircraft, under propagation conditions scaled to represent those expected in airborne laser engagement scenarios using the Atmospheric Compensation Testbed, at North Oscura Peak, White Sands Missile Range, NM.

(U) $2,500 Investigate the Laser Spark missile countermeasure technology. Develop and demonstrate the infrared countermeasures effectiveness of the multiple internal laser effects (MILE) associated with plasma/sparks. Perform laboratory testing of MILE on advanced focal plane array (FPA) seeker mockups using properly formatted laboratory lasers. Develop flyout simulations of MILE on conical scan and FPA seekers. Complete effectiveness studies on seekers in operational scenarios. Perform initial design planning and coordination for a limited field demonstration of aimpoint control and countermeasure effectiveness on in-flight seekers.

(U) $21,752 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633647

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

(U) FY 2001 ($ in Thousands)

(U)	$702	Perform vulnerability assessments on potential high energy laser targets to provide critical data for designing laser systems which can defeat a range of targets and to provide critical data for designing systems protected against laser threats. Review/develop the system-level deny/disrupt/damage/destroy criterion for counterspace high energy laser systems, based on new data from satellite vulnerability assessments. Provide data from sure-safe analysis to U.S. Space Command, for use in the potential revision of standards for laser illumination of space objects used by the Laser Clearinghouse. Implement an improved architecture enhancing data fusion and exploitation of optical and radar sensor data for space surveillance missions.
(U)	$202	Investigate and develop advanced, high energy laser optical components for future weapon systems. Demonstrate performance of high performance, low stress optical coatings, to enable uncooled high energy laser optical components using lightweight substrates.
(U)	$8,761	Perform atmospheric compensation/beam control experiments from ground-based platforms to support applications ranging from weaponization to space object identification. Integrate the Rayleigh beacon laser and wavefront sensor with the Starfire Optical Range (SOR) 3.5 meter telescope and begin Rayleigh guidestar atmospheric compensation optimization against stars and satellite targets. Complete the development and begin integration of a 50-watt sodium-wavelength laser, for use as the high-altitude laser guidestar beacon for high-performance, full-aperture compensation of the SOR 3.5 meter telescope. Begin development of the sodium-wavelength beacon wavefront sensor and the wavefront reconstruction processor for atmospheric compensation.
(U)	$8,811	Develop and evaluate beam control/compensation techniques for atmospheric attenuation and distortion on laser beam propagation from airborne platforms for applications such as theater missile defense. Continue evaluation of additional advanced concepts for active tracking and atmospheric compensation using adaptive optics under propagation conditions representative of typical airborne laser engagement scenarios. Conduct static and dynamic active tracking and atmospheric compensation experiments using advanced concepts under propagation conditions scaled to represent those expected in airborne laser engagement scenarios using the upgraded Atmospheric Compensation Testbed, White Sands Missile Range, NM. Compare experimental results with the predictions of detailed wave-optics computer simulations to evaluate and optimize performance.
(U)	$18,476	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 633647

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

(U) Related Activities:

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0603319F, Airborne Laser Demonstration.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603707F Weather Systems Technology

PROJECT: 632688

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632688 Weather Support Technology	1,419	0	0	0	0	0	0	0	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: This project was terminated at the end of FY 1999.

(U) **A. Mission Description**

This program demonstrates and transitions new technologies for warfighters and their associated weather support forces to enable full spectrum dominance. Technologies developed include new impact decision aids that will be incorporated into automated mission planning systems to optimize tactics and precision guided munitions selection. Other technologies will support operational laser system design and operational concept development. Initiatives are also planned to improve the accuracy of environmental forecasts produced by the Air Force Weather Agency and Air Force Space Command. Technologies delivered will enhance information superiority by improving tailored weather forecasts in data denied areas. Other models will enhance satellite survivability by improving space environmental forecasts.

(U) FY 1999 ($ in Thousands)

(U) $750 Developed and transitioned Target Acquisition Weather Software V1.0 to Air Combat Command (ACC). Software was used in predicting impact of weather on precision-guided munitions during mission execution planning.

(U) $565 Developed and demonstrated software that incorporates the impact of weather on precision-guided munitions during preparation of the Air Tasking Order (Weather Automated Mission Planning Software) to ACC.

(U) $104 Transitioned, for operational use, upgraded software that incorporates ACC and Air Force Special Operations Command (AFSOC) feedback on performance of Night Vision Goggle Operations Weather Software.

(U) $1,419 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Not Applicable.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Not Applicable.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603707F Weather Systems Technology
	PROJECT 632688

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	1,564	0	0	
(U)	Appropriated Value	1,568			
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-4			
	b. Small Business Innovative Research	-32			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-105			
	e. Rescissions	-8			
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR				
(U)	Current Budget Submit/FY 2001 PBR	1,419		0	TBD

(U) Significant Program Changes:

Not Applicable.

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

(U) Related Activities:

(U) PE 0305160F, Defense Meteorological Satellite Program.

(U) PE 0305111F, Weather Service.

(U) PE 0602601F, Spacecraft Technology.

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

(U) **E. Acquisition Strategy**

Not Applicable.

(U) **F. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603723F Environmental Engineering Technology

PROJECT: 632103

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632103 Environmental Quality Technology	2,459	5,435	0	0	0	0	0	0	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

This program develops and demonstrates advanced technologies to address Air Force-unique environmental compliance, site remediation, and pollution prevention problems. Specific projects develop and demonstrate advanced technologies to reduce hazardous emissions from weapon systems, minimize Air Force industrial waste, eliminate toxic pollutant releases from Air Force operations as directed by the National Environmental Policy Act, and solve environmental reclamation problems. Improving these capabilities aids the Air Force in maintaining environmental quality, preparing timely responses to public concerns, preparing accurate environmental impact statements, and minimizing unfavorable legal challenges to Air Force operations. Note: In FY 2000, the Air Force terminated this program. However, Congress added $1.5 million in FY 2000 to restore this program and added another $4.0 million for Environmental Systems Management Analysis and Reporting Network (E-SMART).

(U) FY 1999 ($ in Thousands)

(U) $714 Developed and demonstrated technologies and design criteria for monitoring, characterization, assessment, process control, and disposal to reduce environmental impact of Air Force operations by integrating real-time Dense Non-Aqueous Phase Liquid (DNAPL) sensing instrumentation with horizontal directional drilling technology. Completed development and demonstration of protocol for intrinsic remediation of DNAPLs.

(U) $1,550 Developed scientific and engineering tools to reduce weapon system sustainment costs by initiating integration of energy generation and water recovery unit operations with treatment systems for Air Force operations including Air Logistics Centers.

(U) $195 Demonstrated technologies to reduce/destroy wastes and reduce contamination of the environment by Air Force operations and to comply with the Clean Air Act by completing development of the recirculating paint booth with biofilter.

(U) $2,459 Total

(U) FY 2000 ($ in Thousands)

(U) $1,482 Develop novel reactor systems to reduce weapon system life cycle costs for logistics and sustainment. Develop rapid Mixed Base Hydrogen Peroxide (MBHP) production in support of directed energy weapon systems. Develop deployable waste management systems for Air Expeditionary Forces (AEF).

(U) $3,953 Eliminate hardware, software, and data format incompatibilities by defining an universal architecture for constructing modular monitoring

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603723F Environmental Engineering Technology / PROJECT: 632103

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

(U) FY 2000 ($ in Thousands) Continued

networks applicable to fixed installations and deployed 'bare base' operations. Demonstrate an automated hazard warning and response capability suitable for use in fixed base and deployed operations. Validate the Environmental Systems Management Analysis and Reporting Network (E-SMART) as a viable architecture for warning of operational toxic materials.

(U) $5,435 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates advanced technologies to address Air Force-unique environmental problems.

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

	FY 1999	FY 2000	FY 2001	Total Cost
(U) Previous President's Budget (FY 2000 PBR)	2,579	0	0	
(U) Appropriated Value	2,663	5,500		
(U) Adjustments to Appropriated Value				
a. Congressional/General Reductions	-84			
b. Small Business Innovative Research	-57			
c. Omnibus or Other Above Threshold Reprogram		-30		
d. Below Threshold Reprogram	-49			
e. Rescissions	-14	-35		
f. Other				
(U) Adjustments to Budget Years Since FY 2000 PBR				
(U) Current Budget Submit/FY 2001 PBR	2,459	5,435	0	TBD

(U) Significant Program Changes:

In FY 2000, the Air Force terminated this program. However, Congress added $1.5 million to restore this program and another $4.0 million for Environmental Systems Management Analysis and Reporting Network (E-SMART).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603723F Environmental Engineering Technology / PROJECT: 632103

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602202F, Human Effectiveness Applied Research.

(U) PE 0602203F, Aerospace Propulsion.

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

(U) PE 0603211F, Aerospace Structures.

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

(U) PE 0603716D, Strategic Environmental Research and Development Program.

(U) PE 0603851D, Environmental Security Technology Certification Program

(U) PE 0604706F, Life Support Systems.

(U) PE 0604708F, Other Operational Equipment.

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

(U) **E. Acquisition Strategy**

Not Applicable.

(U) **F. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	10,272	7,828	7,429	8,047	7,594	9,135	8,880	Continuing	TBD
632810	Advanced Image/Information/Optical Memory Technology Applications	8,023	3,520	4,368	5,022	5,693	6,827	6,961	Continuing	TBD
632863	Integrated Photonics	2,249	4,308	0	0	0	0	0	Continuing	TBD
634850	Collaborative C2	0	0	3,061	3,025	1,901	2,308	1,919	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, the efforts in Project 632863, Integrated Photonics, will be conducted in PE 0603203F, Project 63665A. Prior to FY 2001, the efforts in Project 634850, Collaborative C2, were performed in PE 0603253F, Projects 632735 and 63666A.

(U) **A. Mission Description**

This program develops and demonstrates Aerospace Command, Control, Communications, and Intelligence (C3I) technologies for collaborative command and control with emphasis on a coalition/joint environment. This includes the areas of information and knowledge production, data fusion, data links, wideband storage, and processing, retrieval, and exploitation of C3I databases. A family of exploitation tools to extract information from multi-sensor data sources will be developed. An enabling fusion architecture to work with existing and future fusion engines will also be designed and built to correlate and integrate this information to produce a consistent knowledge of the battle space over a distributed and collaborative C2 environment. Information storage and retrieval technologies for secure global database distribution, of sufficient capacity and speed to meet Air Force requirements, will be developed. A collaborative C2 operations foundation between dispersed command centers will be developed to demonstrate split force operations and enable decision making in a distributed aerospace information framework. The resultant product of this program will be a consistent and complete battlespace representation that is a key component of the Battlespace Infosphere concept set forth in the Air Force Scientific Advisory Board Study SAB-TR-98-02, 'Information Management to Support the Warrior' dated October 19, 1998. Note: This PE title and mission description have been changed to reflect the realignment of the information technology research and development to achieve the goal of Information Dominance expressed in 'Joint Vision 2010' and the Air Force long-range strategic plan, 'Global Engagement.'

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

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 a military utility and address warfighter needs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	10,993	9,122	4,920	
(U)	Appropriated Value	11,025	7,922		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-32			
	b. Small Business Innovative Research	-322			
	c. Omnibus or Other Above Threshold Reprogram		-43		
	d. Below Threshold Reprogram	-341			
	e. Rescissions	-58	-51		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			2,509	
(U)	Current Budget Submit/FY 2001 PBR	10,272	7,828	7,429	TBD

(U) Significant Program Changes:
In FY 2001, funds were added to increase emphasis on collaborative command and control.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration

PROJECT: 632810

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632810	Advanced Image/Information/Optical Memory Technology Applications	8,023	3,520	4,368	5,022	5,693	6,827	6,961	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates techniques and algorithms to meet weapon systems requirements for processed and fused multi-source information needed for mission planning, navigation, targeting, and terrain analysis. It provides generic language translation processing techniques, state-of-the-art algorithms for Air Force exploitation of digitally processed image and spatial (i.e., latitude, longitude, and elevation) database products, automated capabilities to reference and display hypermedia (multi-media) information, and defensive information warfare technologies. This project also develops erasable optical data storage systems with high capacity and fast input/output speed for fighter aircraft (to provide fast airborne access to mission-oriented data and the digital terrain system) and electronic surveillance aircraft (for on-board sensor data recording, operational mission planning requirements, and large data storage requirements (i.e., high-volume, soft-copy, digital imagery exploitation)). Algorithms will be developed to automate the selection, retrieval, and downloading of information stored on mass storage devices that are distributed across the data network. Three-dimensional (3-D) memory systems will be developed for volumetric digital data storage. This new mass storage technology will demonstrate ultra-high data density and fast, parallel data access within a low-cost, compact system.

(U) FY 1999 ($ in Thousands)

(U)	$1,376	Developed and demonstrated advanced imagery information, sensor fusion, and spatial database technologies to enhance warfighter mission planning, navigation, targeting, and terrain analysis.
(U)	$1,657	Designed, developed, and demonstrated automated capabilities to harvest, process, disseminate, and display intelligence and sensor data to improve the sensor exploitation process.
(U)	$2,351	Continued to develop and demonstrate 3-D optical information data handling, storage, and access technologies including erasable and read-only memories.
(U)	$1,163	Continued to design, develop, and demonstrate optical disk and interface technologies that can be implemented in joint theater operations, including a parallel Write Once Read Many Times (WORM) 3-D memory and Jukebox Redundant Array of inexpensive devices.
(U)	$1,476	Designed, developed, and demonstrated mission planning and rehearsal capabilities for theater battle management including semi-automated, objectives-based planning and assessment for Command and Control requirements.
(U)	$8,023	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration — PROJECT: 632810

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

(U) FY 2000 ($ in Thousands)

(U)	$600	Develop and demonstrate advanced signal exploitation technologies. Develop and demonstrate advanced imagery and signal intelligence information, sensor fusion engine, and spatial database technologies to enhance warfighter mission planing, navigation, targeting, and terrain analysis. Develop and demonstrate a standard open fusion architecture with a sensor fusion capability to provide a complete and accurate representation in real-time of the current military situation.
(U)	$1,220	Develop and demonstrate advanced data handling and event visualization technologies. Develop and demonstrate automated capabilities to locate, retrieve, process, distribute, and display intelligence and sensor data to improve the sensor exploitation process. Develop a decision support system to automate extraction, visualization, and analysis of information in text.
(U)	$900	Develop and demonstrate advanced storage and memory technologies. Develop smart memory/associative recall information data handling, storage, and access technologies to enable advanced fusion processing techniques. Continue to develop and demonstrate optical disk and interface technologies that can be implemented in joint theater operations, including WORM devices.
(U)	$800	Design, develop, and demonstrate mission planning and rehearsal capabilities for theater battle management, including the demonstration of software for joint Command and Control (C2) requirements.
(U)	$3,520	Total

(U) FY 2001 ($ in Thousands)

(U)	$1,100	Develop and demonstrate advanced signal exploitation technologies. Develop and demonstrate advanced imagery and signal intelligence information, adaptive sensor fusion engine, and spatial database technologies for transition to Common Operational Picture (COP). Continue to develop planning and assessment technologies to support strategy development and campaign assessment in a distributed environment supporting the battlespace infosphere.
(U)	$2,044	Develop and demonstrate advanced data handling and event visualization technologies. Develop and demonstrate automated capabilities to access, extract, process, and display multi-source intelligence and sensor databases to improve the sensor exploitation process for near-real-time situational awareness. Develop and demonstrate event visualization, natural language processing for information extraction, collaborative analysis tools, situation, and activity assessment capability for decision support operations.
(U)	$1,224	Develop and demonstrate advanced storage and memory technologies. Continue to develop smart memory and associative recall technologies for strategic and tactical applications. Continue development and demonstration of ultra-dense storage, and fast parallel access technologies for write-once, read-many and erasable memories. This technology enhances sensor exploitation for increased situational awareness and interactive simulation for distributed mission training.
(U)	$4,368	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration
	PROJECT 632810

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, and Communications (C3).

(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.

(U) **E. Schedule Profile**

(U)

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration — PROJECT: 632863

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632863 Integrated Photonics	2,249	4,308	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

Current electronic systems are susceptible to electromagnetic interference, electromagnetic pulse, and radio frequency (RF) interference. Size constraints, speed, and reliability also limit traditional electronic systems. Photonics-based systems process information in the form of light (photonic) signals and will provide major improvements in tactical and strategic Command, Control, and Communications (C3) systems by enabling small-size, high-performance, high-capacity, survivable alternatives to electronic-based systems. This project develops and demonstrates advanced hardware technology in optical processing, adaptive transmission, and nonlinear optical processing.

(U) FY 1999 ($ in Thousands)

(U) $829 Developed, demonstrated, and tested analog and digital hardened optical component processing technologies to provide real-time data for pre- and post-mission analysis, as well as sensor integration and automatic target identification using multispectral surveillance systems.

(U) $841 Developed and demonstrated microwave/millimeter-wave photonics components, processing, and subsystems for advanced, optically-controlled, reconfigurable RF systems at increased frequencies.

(U) $579 Developed high performance optical control systems for Super High Frequency phased array antennas providing extremely wide angle coverage, broadband performance, and anti-jam capability for satellite communications. Started development of a True Time Delay processor.

(U) $2,249 Total

(U) FY 2000 ($ in Thousands)

(U) $282 Develop, integrate, demonstrate, and test analog and digital optical micro-network processing technologies and components to provide real-time data for pre- and post-mission analysis, as well as sensor integration and automatic target identification using multispectral surveillance systems for air and space platforms.

(U) $1,956 Develop and demonstrate microwave/millimeter-wave photonics processing and subsystems for advanced, optically-controlled, radio frequency (RF) systems at increased frequencies.

(U) $700 Develop high performance control systems for RF phased array antennas providing extremely wide angle coverage, broadband performance, and anti-jam capability for Global Positioning System (GPS) applications. Continue to develop a photonics True Time Delay processor.

(U) $1,370 Complete development and demonstration of three-dimensional optical information data handling, storage, and access technologies including erasable and read-only memories.

(U) $4,308 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration — PROJECT: 632863

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

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort moved to PE 0603203F, Project 63665A.
(U)	$0	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, and Communications (C3).

(U) PE 0603789F, C3I Advanced 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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration — PROJECT: 634850

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634850 Collaborative C2	0	0	3,061	3,025	1,901	2,308	1,919	Continuing	TBD

(U) **A. Mission Description**

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 permit advanced integrated information architectures for the near-real-time transfer of large volumes of information over existing and future command, control, and communications systems. The application of these new technologies will allow reconfiguration and adaptation of existing operational aerospace systems to support seamless integrated operations, and facilitate an affordable implementation of the battlespace infosphere concept. These are enabling technologies for collaborative command and control, simulation-based acquisition, and distributed mission training.

(U) FY 1999 ($ in Thousands)

(U) $0 Previously accomplished in PE 0603253F.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Previously accomplished in PE 0603253F.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $1,087 Develop and demonstrate next generation distributed collaborative environments. Assess and demonstrate the application of these technologies to simulation-based acquisition, pre-planning for distributed mission training, and problem solving for a lean and agile Expeditionary Aerospace Force.

(U) $974 Define and develop integrated aerospace information architectures. Define and develop integrated information architectures that enable information collection assets on airborne and space platforms to be automatically optimally tasked, and the collected information shared in near-real-time among expeditionary aerospace forces. Assess the application of these technologies to the time-critical target domain. Develop and demonstrate aerospace architecture technology to provide an affordable battlespace infosphere operation. This will allow reconfiguration and adaptation of existing operational aerospace systems to support seamless integrated operations.

(U) $1,000 Develop technology to increase aerospace platform information transfer capacity. Develop technology to increase aerospace platform information transfer capacity for exchange of time-critical threat, sensor, and command and control information between aircraft and cooperating space, airborne, and surface communication assets. Continue the development of communications technologies that support collaborative command and control. Complete a space-based air traffic communications and positioning brassboard demonstrating the capability to meet Federal

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration
	PROJECT: 634850

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

(U) FY 2001 ($ in Thousands) Continued

Aviation Administration and International Civil Aviation Organization directed Global Air Traffic Management requirements in fighter and bomber aircraft.

(U) $3,061 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, and Communications (C3).

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603728F Battlespace C2 Technology

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	7,150	0	0	0	0	0	0	Continuing	TBD
632527	Software Life Cycle Tools	2,053	0	0	0	0	0	0	Continuing	TBD
632530	Distributed Systems Reliability and Survivability	2,179	0	0	0	0	0	0	Continuing	TBD
632532	Knowledge-Based Systems	2,918	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, all dynamic command, control, and execution efforts performed in this PE move to PE 0603789F, Project 634872, Dynamic Aerospace Command, Control, and Execution.

(U) **A. Mission Description**

This program develops and demonstrates technologies needed to control cost, reduce risk, and increase efficiency and effectiveness of software and computers required for Air Force mission critical combat systems. The Air Force has experienced a dramatic escalation in the cost of acquiring and maintaining embedded computer software for increasingly complex military systems which must be reliable and survivable in the battlefield environment. The requirement for survivable tactical and strategic computing systems has driven the need for automatic integration and interoperability of multiple processing elements, automatic redistribution of data and functions, and location-independent access to data. Distributed processing techniques, which can dynamically reconfigure Command, Control, Communications, and Computer (C4) systems to accommodate lost components or nodes, are required to ensure survivable mission critical command and control functions. Note: In FY 2000, Congress zeroed funding for this PE.

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

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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603728F Battlespace C2 Technology

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	7,748	4,507	5,932	
(U)	Appropriated Value	7,827	0		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-79			
	b. Small Business Innovative Research	-216			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-343			
	e. Rescissions	-39			
	f. Other		0		TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			-5,932	
(U)	Current Budget Submit/FY 2001 PBR	7,150	0	0	TBD

(U) Significant Program Changes:
In FY 2000, Congress zeroed funding for this Program Element.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603728F Battlespace C2 Technology; PROJECT: 632527

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632527 Software Life Cycle Tools	2,053	0	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

Advanced computer systems in Air Force weapon systems require software life cycle tools and technology to reduce costs, improve quality, and enhance productivity. This project develops, evaluates, and transitions new software technology that reduces cost, while improving software, systems, and productivity factors. It develops software life cycle support environments which incorporate both laboratory and commercial off-the-shelf (COTS) products. This project provides a vehicle for software technology integration, transition, and evaluation under operational and field conditions. Technologies for system requirements analysis, reuse of software components, software quality specification, measurement, assessment, and high performance (parallel) computer software engineering are also produced.

(U) FY 1999 ($ in Thousands)

(U)	$981	Demonstrated technology for the capture and exploitation of design information for building systems that readily and economically evolve. Demonstrated technologies for packaging diverse software capabilities such as visualization, hyper-programming, dynamic testing, and object-oriented languages to reduce life cycle costs of software intensive Air Force systems.
(U)	$772	Developed and tested the ability to mathematically represent architectural, functional, and Quality of Service (safety, performance, reliability, security, fault tolerance, etc.) properties to enable automatic design analysis and performance evaluation of software systems.
(U)	$300	Develop and test the capability to integrate program code of dynamic and static languages within the same module, and develop and test dynamic language software development tools.
(U)	$2,053	Total

(U) FY 2000 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603728F Battlespace C2 Technology
PROJECT: 632527	

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, and Communications (C3).

(U) PE 0603726F, Aerospace Information Technology Systems Integration.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE: February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603728F Battlespace C2 Technology — PROJECT: 632530

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632530 Distributed Systems Reliability and Survivability	2,179	0	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops software technology to provide distributed computer information handling for future Command, Control, Communications, and Computer (C4) systems. These technologies integrate numerous heterogeneous processing networks and provide secure, seamless access to information. Future C4 systems must be reconfigurable, operate in real-time, and be survivable, as well as capable of integrating the full spectrum of multimedia data. These systems will operate in an 'information pull' mode where the users' requests for information are filled without explicit action on the part of the user to locate, retrieve, or merge data. An object-oriented architecture provides a common perspective which integrates the communications control system and the distributed computing environment.

(U) FY 1999 ($ in Thousands)

(U)	$1,050	Integrated information warfare technologies into multi-networked distributed computing environments. Demonstrated the ability to adapt to a limited bandwidth (low-speed) interconnection and to reconfigure the network in a distributed computing environment.
(U)	$522	Demonstrated the utility of artificial intelligent agents for the retrieval of multimedia data across a wide area network.
(U)	$607	Demonstrated adaptive, reconfigurable distributed computing environments across heterogeneous networks to support crisis management and survivability.
(U)	$2,179	Total

(U) FY 2000 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603728F Battlespace C2 Technology
	PROJECT 632530

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, andCommunications (C3).

(U) PE 0603726F, Aerospace Information Technology Systems Integration.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603728F Battlespace C2 Technology

PROJECT: 632532

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632532 Knowledge-Based Systems	2,918	0	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

Knowledge-based computer systems provide the capability to automatically solve reasoning problems. This effort develops computer technologies which automate the problem solving process associated with human thought. It has three major thrusts. The first, knowledge-based analysis, provides software tools and techniques to develop and evaluate knowledge-based intelligent information tools to support robust, real-time, large-scale information systems. The second, knowledge-based planning, applies artificial intelligence (AI) technology to provide increased cost-effectiveness in diverse planning applications such as air operations planning and execution management, employment and deployment planning, logistics planning, resource allocation, and scheduling processes. The third, knowledge-based software techniques, exploits knowledge-based methods to achieve major improvements in software development and support activities.

(U) FY 1999 ($ in Thousands)

(U)	$462	Developed dynamic data mining techniques and collaborative decision-based and knowledge-based agents for large-scale information systems.
(U)	$1,704	Demonstrated artificial intelligence planning and scheduling tools for imprecise environments and developed agents for adaptive replanning. Demonstrated strategies for efficient planning scenario generation in various military domains.
(U)	$752	Demonstrated knowledge-based evolutionary design tools and test capabilities to monitor and evaluate the satisfaction and capture of requirements and rationale for software systems.
(U)	$2,918	Total

(U) FY 2000 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	No Activity.
(U)	$0	Total

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

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603728F Battlespace C2 Technology
	PROJECT 632532

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, andCommunications (C3).

(U) PE 0603726F, Aerospace Information Technology Systems Integration.

(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.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

	COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	12,286	17,193	19,468	20,059	18,945	18,840	20,488	Continuing	TBD
632335	Advanced C3 Technology	3,762	4,044	0	0	0	0	0	Continuing	TBD
634072	Correlation and Fusion	6,340	10,720	9,940	7,530	4,590	4,613	5,284	Continuing	TBD
634216	Warfighter Information Usage, Management, and Integration Technologies	2,184	2,429	4,191	7,014	6,955	6,554	6,602	Continuing	TBD
634872	Dynamic Aerospace C2 & Execution	0	0	5,337	5,515	7,400	7,673	8,602	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2001, the efforts in Project 632335, Advanced C3 Technology, will be incorporated into Project 634216, Warfighter Information Usage, Management, and Integration Technologies. Prior to FY 2001, the efforts in Project 634872, Dynamic Aerospace C2 and Execution, were accomplished in PE 0603728F.

(U) **A. Mission Description**

This program develops and demonstrates Aerospace Command, Control, Communications, and Intelligence (C3I) technologies to 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. Information Correlation and Fusion Technology will provide affordable operational data capabilities for all pertinent personnel to understand militarily relevant situations, on a consistent basis, with the precision and timeliness needed to accomplish the mission. These capabilities will allow identification of hostile actions/targets or other items of high interest at long-ranges by C3I platforms. Warfighter Information Usage, Management, and Integration technologies will develop reliable, secure, jam-resistant, inter-operable, multimedia, worldwide global information exchange capabilities because the Air Force requires assured communications and reach-back between ground and aerospace battle management resources. Dynamic Aerospace Command, Control, and Execution 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. It will provide the global awareness under any condition to plan and respond to an opponent's operations while retaining critical capabilities of Coalition/Joint forces. The resultant products of this program will be technologies needed to build the capability to dynamically plan and replan over a secure network. Note: This PE title and mission description have been changed to reflect realignment of the information technology research and development to achieve the goal of Information Dominance expressed in 'Joint Vision 2010' and the Air Force long-range strategic plan, 'Global Engagement.'

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development

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

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	13,179	17,402	14,985	
(U)	Appropriated Value	13,235	17,402		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-56			
	b. Small Business Innovative Research	-373			
	c. Omnibus or Other Above Threshold Reprogram		-94		
	d. Below Threshold Reprogram	-452			
	e. Rescissions	-68	-115		
	f. Other				TBD
(U)	Adjustments to Budget Years Since FY 2000 PBR			4,483	
(U)	Current Budget Submit/FY 2001 PBR	12,286	17,193	19,468	TBD

(U) Significant Program Changes:

In FY 2001, funds were added to increase emphasis on dynamic command, control, and execution efforts.

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BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603789F C3I Advanced Development	PROJECT: 632335

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
632335 Advanced C3 Technology	3,762	4,044	0	0	0	0	0	Continuing	TBD

(U) **A. Mission Description**

This project develops Command, Control, and Communications (C3) technology for contingency and joint operations focusing on the concepts of force deployment, sustainment, and employment. Dynamic, hostile battlefield environments demand near instantaneous transmission and processing of vast amounts of C3 information for real-time decision making. This project develops and integrates technologies for: low probability of intercept/anti-jam transmission; modular, programmable, multi-level secure communications; secure survivable networks; advanced displays and interfaces; and battle management decision support capabilities for survivable, distributed Command and Control (C2) facilities with smaller forward deployed footprints. Multiband/multimode programmable radios will be enhanced to address the transmission link requirements of Joint combat theater communications.

(U) FY 1999 ($ in Thousands)

(U) $1,656 Developed and demonstrated programmable devices and monolithic microwave integrated circuit technology in survivable radios and transceivers for critical ground and aerospace communications.

(U) $1,376 Demonstrated advanced networking technologies to provide efficient, secure, interoperable, and deployable communications systems, including dynamic, integrated, self-healing networking.

(U) $730 Demonstrated theater battle management and time-critical air operations technologies to provide field commanders essential operational decision support and rapid response capabilities. Completed the brassboard Joint Defensive Planner (JDP) capability.

(U) $3,762 Total

(U) FY 2000 ($ in Thousands)

(U) $1,466 Develop and demonstrate improved communications technologies that provide reliable, efficient, secure, interoperable, and dynamic deployable communications for Air Combat Command, thus improving mission effectiveness through optimized resource management. Develop and demonstrate a user-friendly radio communications capability that can automatically sense and adapt to its environment and demand for service.

(U) $1,978 Demonstrate integrated and distributed networking and information system technologies to provide efficient, secure, interoperable, and deployable information systems. Develop and demonstrate a multi-level secure information system manager.

(U) $600 Demonstrate theater battle management and time-critical air operations technologies to provide field commanders essential operational decision support and rapid response capabilities. Complete JDP demonstration. Complete initial replanning tool for Tactical Air Control Parties. Demonstrate initial decision aid capability to determine weather impacts on force and mission planning.

(U) $4,044 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603789F C3I Advanced Development / PROJECT: 632335

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

(U) FY 2001 ($ in Thousands)

(U)	$0	Effort moved to Project 634216.
(U)	$0	Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0603617F, C3 Applications.
(U) PE 0603737D, Advanced Research Projects Agency.
(U) PE 0603006A, C3 Technology.
(U) PE 0602702F, Command, Control, and Communications (C3).
(U) PE 0602232N, C3 Technology.
(U) PE 0603726F, Aerospace Information Technology Systems Integration.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development PROJECT 634072

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634072 Correlation and Fusion	6,340	10,720	9,940	7,530	4,590	4,613	5,284	Continuing	TBD

(U) **A. Mission Description**

In order to ensure maximum target engagement ranges and a first-shot, first-kill capability, the Air Force must be able to detect, positively identify, and track hostile targets. This project develops and demonstrates sensor processing techniques, track and fusion algorithms, and correlation techniques in order to enhance target detection and tracking ranges. This project develops and integrates the necessary suite of complementary passive and active hostile target identification technologies for command and control platforms. These technologies will enhance the performance of identification and threat assessment systems for improved acquisition, tracking, and target engagement ranges for theater operations.

(U) FY 1999 ($ in Thousands)

(U) $2,725 Developed and evaluated acoustic analysis algorithms, radar identification technologies, and intelligent technologies for assured detection, tracking, and identification of hostile airborne targets using multiple off-board sensors.

(U) $1,011 Continued to develop a bistatic airborne testbed and refined concepts that increased the survivability of fielded systems by quietly detecting and tracking combat threats.

(U) $2,604 Continued design of real-time airborne demonstration of all-source advanced correlation capability for time-critical targets and developed teraflop signal processor technology.

(U) $6,340 Total

(U) FY 2000 ($ in Thousands)

(U) $3,411 Develop, demonstrate, and transition passive exploitation systems to provide target identification for battlespace infosphere situational awareness. Develop and demonstrate technologies for over-the-horizon situation awareness through passive exploitation of signals emanating from weapon systems. Develop an integrated approach for positive target identification utilizing advanced resource management and cueing techniques.

(U) $3,329 Develop and demonstrate an all-source advanced capability for the detection and tracking of time-critical targets. Develop fusion systems and architectures capable of exploiting multiple sources to find, fix, track, and identify moving air and ground targets. Develop fusion algorithms and tools to exploit fused sensor information to provide higher levels of intelligence such as enemy force structures, lines of communication, and possible courses of action. Continue development of affordable teraflop signal processor technology. Demonstrate a 2x improvement in high performance computing software affordability. Demonstrate a 2x reduction in communication requirements through on-board data reduction.

(U) $3,980 Develop advanced fusion technology to evaluate the capability of Unmanned Combat Aerial Vehicles (UCAV) to operate in a Command,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT 634072

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

(U) FY 2000 ($ in Thousands) Continued

Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated command, control and communications (C3) network. Develop system simulations for the Mission Control Station to demonstrate that it can achieve and sustain assured, on-demand access and connectivity of sufficient bandwidth within acceptable latencies as a critical node on the Unmanned Combat Aerial Vehicles (UCAV) C3 network. Demonstrate technology to guarantee secure and robust communication capability of the UCAV system.

(U) $10,720 Total

(U) FY 2001 ($ in Thousands)

(U) $1,504 Develop passive exploitation algorithms to enhance the identification of time-critical targets. Exploit information in acoustic, image, and signal intelligence to identify targets for situational awareness and targeting. Develop the technologies to use multiple source correlation of sensor reports to perform target identification and optimize allocation of sensor resources.

(U) $1,825 Develop and demonstrate an all-source advanced capability for the detection and tracking of time-critical targets. Develop fusion systems and architectures capable of exploiting multiple sources to find, fix, identify, and track moving air and ground targets, and to detect and track targets employing camouflage, concealment, and deception (CCD) techniques. Continue to develop fusion algorithms and tools to exploit fused sensor information to provide higher levels of intelligence such as enemy force structures, lines of communication, and possible courses of action.

(U) $1,108 Develop and demonstrate embedded high performance processors for real-time knowledge and information-based processing to achieve exploitation and rapid fielding of an affordable fusion capability for all-source intelligence surveillance and reconnaissance data. Demonstrate a 4x affordability in embedded high performance processing through a reduction in size, weight, and power, thereby reducing the system footprint and cost of deployed systems. Demonstrate a 2x improvement in high performance computing software affordability through the continued maturation of software standards, such as Vector Signal Image Processing Library (VSIPL) and Message Processing Interface (MPI), which serve to protect the software investment over hardware generations.

(U) $3,237 Continue to develop advanced fusion technology to evaluate the capability of UCAV to operate in a Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated C3 network. Develop and demonstrate command and control (C2) technologies for the dynamic command and control of multiple vehicles under a highly dynamic mission environment. Develop and demonstrate, through simulation, the software elements for both the air vehicle and Mission Control Station required for the dynamic command and control of multiple vehicles.

(U) $2,266 Develop and demonstrate technologies to support the affordable UCAV air vehicle unit recurring flyaway (URF) goal in a C4ISR data-rich environment as part of an integrated C3 network. Initiate the integration of the C2 software elements into the Mission Control Station and UCAV air vehicle. State-of-the-art tools will be used to maximize the reuse of software components.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603789F C3I Advanced Development / PROJECT: 634072

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

(U) FY 2001 ($ in Thousands) Continued
(U) $9,940 Total

(U) **B. Project Change Summary**
Not Applicable.

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0602702F, Command, Control, and Communications (C3).
(U) PE 0603742F, Combat Identification Technology.
(U) PE 0603726F, Aerospace Information Technology Systems Integration.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) **D. Acquisition Strategy**
Not Applicable.

(U) **E. Schedule Profile**
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603789F C3I Advanced Development
	PROJECT: 634216

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634216	Warfighter Information Usage, Management, and Integration Technologies	2,184	2,429	4,191	7,014	6,955	6,554	6,602	Continuing	TBD

(U) **A. Mission Description**

This project will develop and demonstrate the advanced technologies required to implement an interoperable, worldwide Information For The Warrior (IFTW) construct capable of supporting near-real-time multimedia (i.e., voice, data, video, and imagery) information exchange between ground and airborne platforms. The IFTW technology will provide 'reachback' (i.e., updating information and mission changes to enroute aircraft) and 'in-transit visibility' of the aircraft and cargo status at Command and Control centers. The IFTW capabilities will be enhanced through the incremental development, demonstration, and integration of advanced information management, network management, and communications transmission technologies. It will address interoperation across echelon, Service, and multi-national force boundaries, as well as provide support for mobile command and control, and sensor-to-shooter operations. This program directly responds to user deficiencies as expressed by the Joint Staff (Command, Control, Communications, Computers, and Intelligence for the Warrior), the Air Force (Theater Deployable Communications), Air Mobility Command (Air Mobility Master Plan and Airborne Situational Awareness), and the Defense Information Systems Agency (Far-Term Defense Information Systems Network).

(U) FY 1999 ($ in Thousands)

(U) $682 Designed, developed, demonstrated, and integrated advanced information communication mediation management technologies for IFTW joint task force and international operations.

(U) $750 Designed, developed, demonstrated, and integrated advanced airborne, super-high frequency communications and low-cost, phased array antenna technologies.

(U) $752 Designed, developed, demonstrated, and integrated advanced network and bandwidth management and technologies, including agents and routers, for IFTW in joint and international environments.

(U) $2,184 Total

(U) FY 2000 ($ in Thousands)

(U) $820 Design, develop, integrate, and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach in a mobility environment. Design and develop intelligent agent and information structure management techniques. Develop an Intelligent Information Manager agent to throttle and regulate mission information flow among Air Mobility Command (AMC) components based on changing system capabilities.

(U) $855 Design, develop, integrate, and demonstrate modular, reprogrammable radio communications technologies for commercial and military global

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603789F C3I Advanced Development
	PROJECT: 634216

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

(U) FY 2000 ($ in Thousands) Continued

reach in an airborne mobility environment. Continue to develop and demonstrate user-friendly, assured multiband and wideband wireless intelligent networking capability that automatically senses and adapts to its environment and demand for service. Develop the Media Access Controller for integrating all near-term legacy Air Mobility Command (AMC) radios, medium-term multi-band radios, and available commercial system components into a synergistic information transport mechanism

(U) $754 Design, develop, integrate, and demonstrate advanced protocol network and commercial management technologies to validate communications between air platforms and Command and Control centers at Scott Air Force Base for global reach in a mobility environment. Develop the Intelligent Communications Controller network management technology to provide seamless connectivity and assured delivery through all the networks connected to provide reachback and in transit visibility for AMC.

(U) $2,429 Total

(U) FY 2001 ($ in Thousands)

(U) $880 Design, develop, integrate, and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach in a mobility environment. Continue to develop an intelligent information manager agent to throttle and regulate mission information flow among AMC components based on changing system capabilities. Demonstrate to AMC the capabilities to perform heterogeneous data base access and mission/user profiles under a web-based architecture.

(U) $460 Design, develop, integrate, and demonstrate modular, reprogrammable radio communications technologies for commercial and military global reach in an airborne mobility environment. Continue to develop the Media Access Controller for integrating all near-term legacy AMC radios, medium-term multi-band radios, and available commercial system components into a synergistic information transport mechanism.

(U) $688 Design, develop, integrate, and demonstrate advanced protocol network 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. Continue to develop technology to dynamically reconfigure the network and communications systems to optimally match the requirements for information transfer with changing transmission path availability. Demonstrate the capability to perform adaptive routing, quality-of-service based architecture, and smart bandwidth management.

(U) $826 Develop and demonstrate improved communications technologies that provide reliable, efficient, secure, interoperable, and dynamic deployable communications to Air Combat Command, thus improving mission effectiveness through optimized resource management. Develop and demonstrate an Intelligent Adaptive Communications Controller (IACC) system to efficiently and effectively control the use of diverse communications media to provide increased aggregate bandwidth. Develop and integrate applications to provide mechanisms that intelligently and dynamically negotiate quality of service and bandwidth management techniques between applications and network transport services. Develop and integrate management mechanisms to provide dynamic, intelligent, management, and control of information system resources.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603789F C3I Advanced Development
PROJECT: 634216	

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

(U) FY 2001 ($ in Thousands) Continued

(U)	$506	Develop and demonstrate intelligent networking technology to provide assured, seamless, battlespace connectivity to the aerospace forces with a greatly reduced footprint. Continue to develop a capability to support a multilevel secure information system manager. Develop and demonstrate user-friendly, assured multiband and wideband wireless intelligent networking capability that automatically senses and adapts to its environment and service demands, as well as detects, protects, and reacts against intrusion and disruption of service.
(U)	$831	Develop and demonstrate theater battle management and time-critical air operations technologies to provide field commanders essential operational decision support and rapid response capabilities. Complete weather impact decision aid capability and develop space weather impact decision aid capability. Develop master caution panel capability to centrally monitor and manage command and control assets.
(U)	$4,191	Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602702F, Command, Control, and Communications (C3).

(U) PE 0603726F,Aerospace Information Technology Systems Integration.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

PROJECT: 634872

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634872 Dynamic Aerospace C2 & Execution	0	0	5,337	5,515	7,400	7,673	8,602	Continuing	TBD

(U) **A. Mission Description**

In order to perform command, control, and execution for the Expeditionary Aerospace Force (EAF), 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 command and control 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. Dynamic effects-based operations will develop and demonstrate a new generation of planning assessment technologies that enable 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. Knowledge-based intelligent information technologies will be developed to support robust, real-time, large-scale Air Force command and control (C2) systems. This project will develop and demonstrate distributed command and control technologies that provide the commander and staff with seamless access to tailored multi-media, multi-spectral data within a mobile, dynamic command and control center.

(U) FY 1999 ($ in Thousands)

(U) $0 Previously accomplished in PE 0603728F.

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $0 Previously accomplished in PE 0603728F.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $1,485 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. Develop the effects based operations capability through active template technologies to provide recommended priorities, resource availability, and provide the information to the battle managers in time to achieve mission objectives. Develop and demonstrate model abstraction to replicate/replay military exercises, provide near-real-time dynamic situation assessment, and identify preferred courses of action for decision making, while predicting likely outcomes.

(U) $1,706 Develop and demonstrate distributed C2 technologies that are scalable and reconfigurable and provide seamless access to tailored multi-media, multi-spectral data for commanders and staff within mobile, dynamic command and control centers. Develop technology that integrates offensive, defensive, and support elements into an aerospace command center that provides the EAF a cohesive environment for planning,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development
	PROJECT 634872

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

(U) FY 2001 ($ in Thousands) Continued

execution, and assessment. Develop and integrate multi-user collaborative interaction technology for adaptive visualization and presentation to enhance joint force battle plan simulation, assessment, and implementation focused on aerospace operations.

(U) $2,146 Develop and demonstrate knowledge-based intelligent information tools to support robust, real-time, large-scale aerospace command and control (C2) systems. Demonstrate knowledge-based C2 technologies in support of continuous planning and scheduling. Develop and integrate planning and information-based intelligent agents for adaptive replanning. Develop and demonstrate the capability to enhance decisions by providing commanders and decision makers a totally integrated perspective of available forces and employment options, including both operational and supporting element capabilities and limitations within an info-centric environment such as the Air Mobility Command Mobility 2000 Initiative.

(U) $5,337 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602702F, Command, Control,and Communications (C3).

(U) PE 0603726F, Aerospace Information Technology Systems Integration.

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

(U) **D. Acquisition Strategy**

Not Applicable.

(U) **E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603876F Space Based Laser

COST ($ in Thousands)		FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	32,610	72,864	63,216	63,141	63,005	63,628	64,248	Continuing	TBD
634779	Space Based Laser	0	72,864	63,216	63,141	63,005	63,628	64,248	Continuing	TBD
644779	Space-Based Laser	32,610	0	0	0	0	0	0	0	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

(U) **A. Mission Description**

The Space Based Laser (SBL) program was created to provide the nation with a highly effective, continuous, global boost phase intercept option for both theater and national missile defense. An SBL system could defend against missiles without putting the lives of US military personnel at risk. The possible speed of light defense allows for boost phase intercept at the earliest possible moment, offering the highest probability that intercepted missile fragments (possibly containing active chemical/biological or nuclear materials) will fall within the attacker's territory, rather than defended territory. The SBL system could also provide many ancillary mission capabilities, including air defense, global surveillance, and target detection and designation.

The SBL program is structured to research the feasibility and operational contribution of performing boost phase missile defense from space. The Ballistic Missile Defense Organization (BMDO) directed energy program (Project 1360, PE0603173C in FY 2000, PE0603174C in FY 2001 and out) has been addressing several key critical technology issues, such as the Hydrogen Fluoride laser performance and modeling; optics experiments; laser and optics integration; and Acquisition, Tracking, Pointing, and Fire Control (ATP/FC) tests. The Air Force began contributing to the SBL program in FY 1999. The combined AF/BMDO budget funds further technology development and risk reduction efforts leading to an Integrated Flight Experiment (IFX) that will provide opportunities for more complete ground and space flight testing. The IFX is a critical step in proving the feasibility of destroying ballistic missiles in their boost phase from space.

The Air Force program funding increase in FY 2000 and beyond will aid the intense efforts planned for technology risk reduction, integrated system testing, and development of an IFX. The technology risk reduction activities include uncooled laser resonator optics, phase conjugation beam clean-up, and ATP. Ground experiments will demonstrate major risk area engineering design units (gain generator, resonator, beam control). Technology risk reduction and component demonstration prior to flight hardware development are important parts of the IFX program. The IFX will culminate in integration, performance of a series of on-orbit experiments, and demonstration of SBL boost phase intercept feasibility.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603876F Space Based Laser

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

This PE is in Budget Activity 3 (Advanced Technology Development) because it is performing technology development and risk reduction activities on the path to an Integrated Flight Experiment (IFX).

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

		FY 1999	FY 2000	FY 2001	Total Cost
(U)	Previous President's Budget (FY 2000 PBR)	34,884	63,840	63,779	
(U)	Appropriated Value	35,000	73,840		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-116			
	b. Small Business Innovative Research	-1,131			
	c. Omnibus or Other Above Threshold Reprogram		-400		
	d. Below Threshold Reprogram	-961			
	e. Rescissions	-182	-576		
	f. Other				
(U)	Adjustments to Budget Years Since FY 2000 PBR			-563	
(U)	Current Budget Submit/FY 2001 PBR	32,610	72,864	63,216	TBD

(U) Significant Program Changes:

$10M congressional add in FY 2000 for planning, engineering, and design of SBL test facility.

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

DATE: February 2000

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603876F Space Based Laser

PROJECT: 634779

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
634779 Space Based Laser	0	72,864	63,216	63,141	63,005	63,628	64,248	Continuing	TBD

(U) **A. Mission Description**

The Air Force started contributing funds to the Space Based Laser (SBL) program in FY 1999. The funds were classified as Budget Activity 4. In FY 2000, the Air Force reclassified the funds to Budget Activity 3 to better align the Integrated Flight Experiment (IFX) project with other technology experiments.

(U) FY 1999 ($ in Thousands)

(U) $0 Activity shown under BPAC 644779

(U) $0 Total

(U) FY 2000 ($ in Thousands)

(U) $65,701 IFX Development

(U) $581 Architecture & Affordability Study

(U) $750 Advanced Mirror System Development

(U) $457 Lethality, Analysis & Architecture (AFSPC and AFRL efforts)

(U) $5,375 IFX Program Support

(U) $72,864 Total

(U) FY 2001 ($ in Thousands)

(U) $52,466 IFX Development

(U) $1,000 Architecture & Affordability Study

(U) $500 Advanced Mirror System Development

(U) $2,900 Lethality, Analysis & Architecture (AFSPC and AFRL efforts)

(U) $6,350 IFX Program Support

(U) $63,216 Total

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

$10M congressional add in FY 2000 for planning, engineering, and design of SBL test facility (included under IFX development).

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

(U) RDT&E, BMDO, R-29, Support Technologies-Adv Tech Dev

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603876F Space Based Laser
	PROJECT: 634779

(U) **D. Acquisition Strategy**

BMDO and the Air Force are jointly funding the SBL IFX risk reduction activities. The SBL IFX contract award was made in Feb 1999. The SBL IFX contract brings together three major contractors under a Joint Venture (JV) agreement to accomplish the SBL IFX. The JV is structured under a Total System Authority (TSA) arrangement allowing the contractor broad authority and responsibility for program success (planning, baselining, resource management, etc.).

(U) **E. Schedule Profile**

(U) Integrated Flight Experiment (IFX) Contract Award 2Q99
(U) IFX Contract Definitization 1Q00
(U) Requirements Review-1 1Q00
(U) Architecture & Affordability Study Final Report 3Q00
(U) Requirements Review-2 3Q00
(U) SBL IFX System Requirements Review (SRR) 1Q01
NOTE: Schedule profile reflects both AF and BMDO funding.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603876F Space Based Laser
	PROJECT 644779

COST ($ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
644779 Space-Based Laser	32,610	0	0	0	0	0	0	0	TBD

(U) **A. Mission Description**

The Air Force started contributing funds to the Space Based Laser (SBL) program in FY 1999. The funds were classified as Budget Activity 4. In FY 2000, the Air Force reclassified the funds to Budget Activity 3 to better align the Integrated Flight Experiment (IFX) project with other technology experiments.

(U) FY 1999 ($ in Thousands)

(U)	$1,150	Awarded Integrated Flight Experiment (IFX) Contract
(U)	$3,482	Conducted Alpha Laser Optimization (ALO) Beam Control and Flow Conditions
(U)	$8,600	Completed Concept Definition Studies and Completed Affordability & Architecture Study Phase I
(U)	$5,425	Conducted Advanced Phase-conjugation Experiment (APEX) risk reduction efforts
(U)	$1,250	Advanced Mirror System Development (joint effort with NASA, AFRL, and NRO)
(U)	$6,300	AFSPC support efforts and AFRL technology investment
(U)	$6,403	Program, FFRDC, and SETA support
(U)	$32,610	Total

(U) FY 2000 ($ in Thousands)

(U)	$0	Activity shown under BPAC 634779
(U)	$0	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Activity shown under BPAC 634779
(U)	$0	Total

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

None.

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

(U) RDT&E, BMDO, R-29, Support Technologies-Adv Tech Dev

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE February 2000
BUDGET ACTIVITY: 03 - Advanced Technology Development	PE NUMBER AND TITLE: 0603876F Space Based Laser
	PROJECT: 644779

(U) **D. Acquisition Strategy**

BMDO and the Air Force are jointly funding the SBL IFX risk reduction activities. The SBL IFX contract award was made in Feb 1999. The SBL IFX contract brings together three major contractors under a joint venture agreement to accomplish the SBL IFX. The JV is structured under a Total System Authority (TSA) arrangement allowing the contractor broad authority and responsibility for program success (planning, baselining, resource management, etc.).

(U) **E. Schedule Profile**

(U) Integrated Flight Experiment (IFX) Contract Award 2Q99
(U) IFX Contract Definitization 1Q00
(U) Requirements Review-1 1Q00
(U) Architecture & Affordability Study Final Report 3Q00
(U) Requirements Review-2 3Q00
(U) SBL IFX System Requirements Review (SRR) 1Q01
NOTE: Schedule profile reflects both AF and BMDO funding.