DEPARTMENT OF THE AIR FORCE

RDT&E DESCRIPTIVE SUMMARIES FOR

FISCAL YEAR 2002 AMENDED BUDGET SUBMISSION

VOLUME I

JUNE 2001

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Fiscal Year 2002 Amended Budget Submission
RDT&E Descriptive Summaries, Volume I
June 2001

INTRODUCTION AND EXPLANATION OF CONTENTS

(U) DISCLAIMER: This administration has not addressed FY 2003-2007 requirements. All FY 2003-2007 budget estimates included in this book are notional only and subject to change.

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 FY2002 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 FY2002 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 050402 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

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
BUDGET ACTIVITY 1: BASIC RESEARCH	
BUDGET ACTIVITY 2: APPLIED RESEARCH	
0602102F Materials	In FY 2002, Project 4915, Deployed Air Base Technology, efforts were transferred from PE 0602201F, Aerospace Vehicle Technologies, Project 4397, Air Base Technology, to align resources with the Air Force Research Laboratory organization.
0602201F Aerospace Vehicle Technologies	In FY 2002, this PE was renamed Aerospace Vehicle Technologies (formerly Aerospace Flight Dynamics). Not reflected in current documentation submission.
	In FY 2002, selected efforts from Project 2401, Structures, transferred to Project 2403, Flight Control/Vehicle-Pilot Interface, and Project 2404, Aeromechanics, within the PE.
	In FY 2002, Project 4397, Air Base Technology, transferred efforts to PE 0602102F, Materials, Project 4915, Deployed Air Base Technology, to align resources with the Air Force Research Laboratory organization.
0602202F Human Effectiveness Applied Research	In FY 2002, Project 1900, Environmental Quality Technology, was terminated.
0602203F Aerospace Propulsion	In FY 2002, Project 3012, Advanced Propulsion Technology, efforts were transferred from PE 0603202F, Human Effectiveness Applied Research, Project 3066, Turbine Engine Technology, and 0603216F Aerospace Prop and Power Technology, Project 668A, Aircraft Propulsion Subsys Int, and Project 681B, Advanced Turbine Engine Gas Generator, to align resources with the Air Force Research Laboratory organization.
0602204F Aerospace Sensors	In FY 2002, Project 4916, Electromagnetic Tech, efforts were transferred from PE 0602702F, Command, Control and Communications, Project 4600, Electromagnetic Tech, to align resources with the Air Force Research Laboratory organization.
0602602F Conventional Munitions	In FY 2002, Project 2068, Advanced Guidance Technology, was separated from Project 2502, Ordnance Technology for clarity of describing the different technologies.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
0602702F Command, Control and Communications	In FY 2002, Project 4600, Electromagnetic Tech, transferred efforts to PE 0602204F, Aerospace Sensors, Project 4916, Electromagnetic Tech. In FY 2002, selected efforts in Project 5581, Command and Control (C2) Technology, Project 4519, Communications Technology, and Project 4594, Information Technology, transferred to Project 4917, Collaborative Technology, within this PE to align resources with the Air Force Research Laboratory organization.
BUDGET ACTIVITY 3: ADVANCED TECHNOLOGY DEVELOPMENT	
0603106F Logistics Systems Technology	In FY 2002, Project 2745 Logistics Performance and Support Technology (S&T), transferred efforts to PE 0603231F, Crew Systems and Personnel Protection Technology, Project 4923, Logistics Readiness and Sustainment, to align resources with the Air Force Research Laboratory organization.
0603112F Advanced Materials for Weapon Systems	In FY 2002, Project 4918, Deployed Air Base Demonstrations, efforts were transferred from PE 0603205F, Flight Vehicle Technology, Project 4398, Air Base Technology.
0603202F Aerospace Prop Subsystems Integration	In FY 2002, Project 668A, Aircraft Propulsion Subsystem Integration, transferred efforts to PE 0603216F, Aerospace Propulsion and Power Technology, Project 4921, Aircraft Propulsion Subsystem Integration, to align resources with the Air Force Research Laboratory organization.
0603203F Advanced Aerospace Sensors	In FY 2002, Project 665A, Advanced Aerospace Sensors Technology efforts were transferred from PE 0603253F, Advanced Sensor Integration, Projects 2735, Avionics Integration Technology, and 666A, Sensor Fusion & Integration Tech.
0603205F Flight Vehicle Technology	In FY 2002, Project 2978, Flight Vehicle Technologies, transferred efforts to PE 0603211F, Aerospace Technology Development/Demo, Project 4920, Flight Vehicle Technology Integration. In FY 2002, Project 4398, Air Base Technology, transferred efforts to PE 0603112F, Advanced Materials for Weapon Systems, Project 4918, Deployed Air Base

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
0603211F Aerospace Technology Development/Demo	In FY 2002, this PE was renamed Aerospace Technology Development/Demo (formerly Aerospace Structures). Not reflected in current documentation submission. In FY 2002, Project 4920, Flight Vehicle Technology Integration efforts were transferred from PE 0603205F, Flight Vehicle Technology, Project 2978, Flight Vehicle Technologies, and PE 0603245F, Flight Vehicle Technology Integration, Project 2568, Flight Vehicle Technology Integration, to align resources with the Air Force Research Laboratory
0603216F Aerospace Prop and Power Technology	In FY 2002, Project 4921, Aircraft Propulsion Subsystems Integration, efforts were transferred from PE 0603202F, Aircraft Propulsion Subsystem Integration, Project 668A, Aircraft Propulsion Subsystem Integration, to align projects with the Air Force Research Laboratory organization. In FY 2002, Project 4922, Space & Missile Rocket Propulsion, efforts were transferred from PE 0603302F, Space & Missile Rocket Propulsion, Project 6340, Satellite Control and Maneuvering Propulsion Technology, to align resources with the Air Force Research Laboratory organization.
0603227F Personnel, Training and Simulation Technology	In FY 2002, Project 2743, Advanced Training/Force Management, transferred efforts to PE 0603231F, Crew Systems and Personnel Protection Technology, Project 4924, Distributed Mission Training Technology, to align resources with the Air Force Research Laboratory organization. In FY 2002, Project 4923, Logistics Readiness and Sustainment, efforts were transferred from PE 0603106F, Logistics Systems Technology, Project 2745, Logistics Performance and Support Technology, to align resources with the Air Force Research Laboratory
0603231F Crew Systems and Personnel Protection Technology	In FY 2002, Project 4924, Distributed Mission Training Technology efforts were transferred from 0603227F, Personnel, Training and Simulation Tech, Project 2743, Advanced Training/Force Management, to align resources with the Air Force Research Laboratory organization.
0603245F Flight Vehicle Technology Integration	In FY 2002, Project 2568, Flight Vehicle Technology Integration, transferred efforts to PE 0603211F, Aerospace Technology Development/Demo, Project 4920, Flight Vehicle Tech Integration.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
0603253F Advanced Sensor Integration	In FY 2002, Projects 2735, Avionics Integration Technology, and 666A, Sensor Fusion & Integration Tech, transferred efforts to PE 0603203F, Advanced Aerospace Sensors, Project 665A, Advanced Aerospace Sensors Technology.
0603302F Space & Missile Rocket Propulsion	In FY 2002, all rocket propulsion technology efforts performed in Project 6340, Satellite Control and Maneuvering Propulsion Technology, transferred to PE 0603216F Aerospace Prop and Power Technology, Project 4922, Space & Missile Rocket Propulsion, to align resources with the Air Force Research Laboratory organization. In FY 2002, Project 6339, Tactical Propulsion Technology, was terminated.
0603401F Advanced Spacecraft Technology	In FY 2002, Project 4400, Space Systems Protection, efforts were transferred from PE 0603410F, Space Systems Environmental Interactions Technology, Project 2822, Space Environmental Impact Tests, to align resources with the Air Force Research Laboratory organization. In FY 2002, Project 4938, Space Developmental Planning, includes new start efforts.
0603410F Space Systems Environmental Interactions Technology	In FY 2002, Project 2822, Space Environmental Impact Tests, transferred efforts to PE 0603401F, Advanced Spacecraft Technology, Project 4400, Space Systems Protection, to align resources with the Air Force Research Laboratory organization.
0603601F Conventional Weapons	In FY 2002, Project 63670B was separated from Project 670A for clarity in describing the different technology development and demonstration programs.
0603726F Aerospace Info Tech Sys Integration	In FY 2002, Project 2810, Advanced Image/Information/Optical Memory Technology Applications, transferred efforts to Project 4072, Dominant Battlespace Awareness, PE 0603789F, C3I Advanced Development, to align resources with the Air Force Research Laboratory organization. In FY 2002, Project 4850, Collaborative C2, transferred efforts to Project 4925, Collaborative C2, PE 0603789F, C3I Advanced Development, to align resources with the Air Force Research Laboratory organization.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	**Remarks**
0603789F C3I Advanced Development	In FY 2002, Project 4072, Dominant Battlespace Awareness, efforts were transferred from PE 0603726F, Aerospace Info Tech Sys Integration, Project 2810, Advanced Image/Information/Optical Memory Technology Applications, to align resources with the Air Force Research Laboratory organization.
	In FY 2002, Project 4925, Collaborative C2, efforts were transferred from PE 0603726F, Aerospace Info Tech Sys Integration, Project 4850, Collaborative C2, to align resources with the Air Force Research Laboratory organization.
0603876F Space Based Laser	In FY 2002, all funding was transferred to the Ballistic Missile Defense Organization (BMDO) program.
BUDGET ACTIVITY 4: DEMONSTRATION AND VALIDATION	
0603319F Airborne Laser Program	In FY 2002, all funding was transferred to the Ballistic Missile Defense Organization (BMDO) program.
0603421F Global Positioning System	In FY 2002, this is a new PE. In FY 2002, Project 4993, GPS Block III efforts transferred from PE 0603421F, NAVSTAR Global Positioning System, Project 3030, Navstar GPS Space & Control.
0603434F NPOESS (Space)	In FY 2002, Project 4056, NPOESS, includes new start efforts.
	In FY 2002, Project 4056, NPOESS, several efforts were terminated.
0603438F Space Control Technology	In FY 2002, Project 2611, Technology Insertion Plan & Analysis, includes new start
	In FY 2002, Project 2611, Technology Insertion Plan, transferred efforts to PE 0305935F, Space Control, Project 4929, Space Control Technology.
0603617F Command, Control and Communication	In FY 2002, this Program has been terminated.
0603851F ICBM - DEM/VAL	In FY 2002, Project 1021, ICBM Propulsion Applications, and Project 1024, ICBM Command & Control (C2) Applications, include new efforts.
0603854F Wideband Gapfiller System (RDT&E) Space	In FY 2002, Project 2679, Global Broadcast Service (GBS), efforts were transferred to PE 0603840F, Global Broadcast Service (GBS), Project 4887, Global Broadcast Service.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	**Remarks**
BUDGET ACTIVITY 5: ENGINEERING AND MANUFACTURING DEVELOPMENT	
0207701F Full Combat Mission Training	In FY 2002, this is a new PE. In FY 2002, Project 5012, Distributed Mission Training, efforts transferred from PE 0604227F, Distributed Mission Training (DMT), Project 4673, Distributed Mission Training, to provide more effective program management and
	In FY 2002, Project 5012, Distributed Mission Training efforts were transferred from PE 0604227, Distributed Mission Training (DMT), Project 4673, Distributed Mission Training, to provide more effective program management and oversight.
0401318F CV-22	In FY 2002, this is a new PE. In FY 2002, Project 4103, CV-22, includes new start efforts.
0603840F Global Broadcast Service (GBS)	This is a new PE in FY 2002. In FY 2002, Project 4887, Global Broadcast Service, efforts transferred from PE 0603854 Wideband Gapfiller System (RDT&E) Space, Project 2679, Global Broadcast Service (GBS).
0604840F EW Development	In FY 2002, Project 2462, Compass Call (CC), transferred efforts to PE 0207253, Compass Call (CC), Project 4804 Compass Call (CC).
0604227F Distributed Mission Training (DMT)	In FY 2002, Project 4673, Distributed Mission Training, transferred efforts to PE 0207701F, Full Combat Mission Training, Project 5012, Distributed Mission Training, to provide more effective program management and oversight.
0604240F B2 Advanced Technology Bomber	In FY 2002, Project 3843, B-2 (ATB), includes new start efforts.
0604251F Space Based Radar EMD	In FY 2002, Project 5009, SBR Concept and Tech Development, includes new start efforts.
0604328F Extended Range Cruise Missile (ERCM)	In FY 2002, this is a new PE. In FY 2002, Project 4978, ERCM, includes new start efforts.
0604329F Small Diameter Bomb (SBD)	In FY 2002, this is a new PE. In FY 2002, Project 5006, Small Diameter Bombs (SBD), includes new start efforts.
0604602F Armament/Ordnance Development	In FY 2002, Project 3133, Bombs and Fuzes, includes new start efforts.

PROGRAM ELEMENT COMPARISON SUMMARY

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Program Element	Remarks
0604617F Agile Combat Support	In FY 2002, Project 2895, Civil Engineering Readiness, efforts were transferred from PE 0208031F, War Reserve Material - Equipment/Secondary Items, Project 4668, Shelter Development, to provide a more manageable CE Readiness effort. In FY 2002, Project 4910, Aeromedical Readiness, efforts were transferred from PE 0604703F, Aeromedical Systems Development, Project 2866, Aeromedical/Casualty Care Sys Development, to provide a more manageable CE Readiness effort.
0604703F Aeromedical Systems Development	In FY 2002, Project 2866, Aeromedical/Casualty Care Sys Development transferred efforts to PE 0604617F Agile Combat Support, Project 4910, Aeromedical Readiness, to provide a more manageable CE Readiness effort.
0604735F Combat Training Ranges	In FY 2002, Project 2286, Combat Training Ranges Equipment, includes new start efforts.
0604800F Joint Strike Fighter EMD	In FY 2002, Project 3831, Joint Strike Fighter, efforts were transferred from PE 0603800F, Joint Strike Fighter, Project 2025, Joint Strike Fighter.
0604805F DUAP Commercial Operations & Support Savings Initiative	In FY 2002, this Program has been terminated.
0604851F ICBM - EMD	In FY 2002, Project 4371, Safety Enhanced Reentry Vehicle (SERV), Project 5007, Global Positioning System (GPS) Metric Tracking Program, and Project 133B, Rapid Execution and Combat Targeting (REACT) Replacement, include new start efforts.
BUDGET ACTIVITY 6: MANAGEMENT AND SUPPORT	
0604256F Threat Simulator Development	In FY 2002, Project 3321, EW Ground Test Resources, includes new start efforts.
0604759F Major Test and Evaluation Investment	In FY 2002, Project 4597, AF Test Investments, includes new start efforts.
0605807F Test & Evaluation Support	In FY 2002, Project 06TS, Test & Evaluation Support, includes new start efforts.
0605860F RSLP (Space)	In FY 2002, Project 1023, Rocket System Launch Program (RSLP), includes new start efforts.
0804731F General Skill Training	In FY 2002, this is a new PE. In FY 2002, Project 4980, R&D Computer Forensic Analyst Tools, includes new start efforts.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
BUDGET ACTIVITY 7: OPERATIONAL SYSTEM DEVELOPMENT	
0203761F Warfighter Rapid Acquisition Process	In FY 2002, this is a new PE. In FY 2002, Project 4936, Warfighter Rapid Acquisition Process, efforts were transferred from PE 0207027F, AC2ISR, Project 4814, Expeditionary Force Experiment (EFX).
	In FY 2002, Project 4936, Warfighter Rapid Acquisition Process, includes new start efforts.
0207027F AC2ISR	In FY 2002, Project 4814, Expeditionary Force Experiment (EFX), transferred efforts to 0203761F, Warfighter Rapid Acquisition Process, Project 4936, Warfighter Rapid Acquisition Process.
	In FY 2002, Project 4814, Expeditionary Force Experiment (EFX), transferred efforts to 0207028F, Joint Expeditionary Force Experiment, Project 4373, Joint Expeditionary Force Experiment, and Project 4991, Joint Distributed Engineering Plant (JDEP).
	In FY 2002, Project 4478, Command, Control, Computer & Intelligence Enhancement efforts transferred to PE 0208060F Theatre Missile Defense, Project 4372, Time Critical
0207028F Joint Expeditionary Force Experiment	In FY 2002, this is a new PE. In FY 2002, Project 4373, Joint Expeditionary Force Experiment, and Project 4991, Joint Distributed Engineering Plant (JDEP) include efforts transferred from PE 0207027F, AC2ISR., Project 4814, Expeditionary Force Experiment (EFX).
0207138F F-22 Squadrons	In FY 2002, this is a new PE. In FY 2002, Project 4785, F-22, includes new start efforts.
0207253F Compass Call	In FY 2002, Project 4804, Compass Call (CC), efforts were transferred from PE 064805F, EW Development, Project 2462, Compass Call (CC).
0207277F CSAF Innovation Program	In FY 2002, this is a new PE. In FY 2002, Project 4931, Eagle Vision, efforts were transferred from PE 0305208F, Project 4826, Common Imagery Ground/Surface Systems.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
0207410F Aerospace Operations Center (AOC)	In FY 2002, this is a new PE. In FY 2002, Project 4372, Time Critical Targeting, efforts were transferred from PE 0208060, Theatre Missile Defense, Project 4478, Command, Control, Communication, Computer and Intelligence Enhancement.
0207417F Airborne Warning & Control System	In FY 2002, Project 411L, Airborne Warning & Control System, includes new start efforts.
0207423F Advanced Communications System	In FY 2002, Project 4934, Tactical Air Control Party (TACP), includes new start efforts.
	In FY 2002, Project 1013, Theater Deployable Communications, was terminated.
	In FY 2002, Project 2982, Anti-Jam Radio Communications, was terminated.
0207438F Theater Battle Management (TMD) C4I	In FY 2002, Project 4821, Distributed Common Ground System Interoperabitliy, efforts were transferred to Project 4826, Common Imagery Ground/Surface Systems.
0207581F Joint Stars	In FY 2002, Project 0003, JSTARS, includes new start efforts.
0207601F USAF Modeling and Simulation	In FY 2002, Project 5005, EA for Air/Space Natural Environment (ANSE) efforts were transferred from PE 0308601F, Modeling and Simulation Support, Project 4566, EA for Air/Space Natural Environment (ANSE), to provide a more manageable Modeling, Simulation, and Analysis effort.
	In FY 2002, Project 5004, Joint Model Transition (JMT) efforts were transferred from PE 0308601F, Modeling and Simulation Support, Project 1011, Legacy Model Transition (LMT), to provide a more manageable Modeling, Simulation, and Analysis effort.
0208031F War Reserve Materials - Equipment/Secondary Items	In FY 2002, Project 4468, Shelter Development, efforts were transferred to PE 0604617F, Agile Combat Support, Project 2895, Civil Engineering Readiness.
0208060F Theater Missile Defense	In FY 2002, Project 4478, Command, Control, Computers & Intelligence Enhancement, transferred efforts to PE 0207410F, Aerospace Operation Center (AOC), Project 4372, Time Critical Targeting.
032015F E-4B National Airborne Operations Center	In FY 2002, Project 4777, E-4B Aircraft Modernization, includes new start efforts.

PROGRAM ELEMENT COMPARISON SUMMARY

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Program Element	**Remarks**
0303131F Minimum Emergency Communications Network (MEECN)	In FY 2002, Project 4521, DIRECT, includes new start efforts.
0303141F Global Combat Support System	In FY 2002, Project 4655, Integrated Log Sys-Supply (ILS-S) efforts were separated into six projects within the same PE to provide a more efficient and manageable program. In FY 2002, Project 4928, Electronic Business/Electronic Commerce, includes new start efforts.
0303601F MILSATCOM Terminals	In FY 2002, Project 2487, MILSATCOM Terminals, includes new start efforts.
0305165F NAVSTAR GPS	In FY 2002, Project 3030, Navstar GPS Space & Control, transferred efforts to PE 0603421F, NAVSTAR Global Positioning System, Project 4993, GPS Block III.
0305202F Dragon U-2 (JMIP)	In FY 2002, efforts in Project 4818, Imaging and Targeting System transferred to Project 4945, High Altitude Systems, within the same PE.
0305205F Endurance Unmanned Aerial Vehicle	In FY 2002, Project 4755, Predator, includes new start efforts.
0305206F Airborne Reconnaissance Systems	In FY 2002, Project 4817, Joint Sigint Avionics Family (JSAF), efforts were terminated.
0305906F NCMC - TW/AA Systems	In FY 2002, Project 3881, Integrated TW/AA, transferred efforts to Project 4806, N/UWSS NORAD/USSPACECOM Warfight Sys, within the same PE.
0305910F SPACETRACK (Space)	In FY 2002, Project 4930, Space Based Space Surveillance, and Project 5010, Space Situational Awareness Initiatives, include new start efforts.
0305935F Space Control	In FY 2002, Project 4929, Space Control Technology, transferred efforts to PE 0603438F, Space Control Technology, Project 2611, Technology Insertion Plan & Analysis.

PROGRAM ELEMENT COMPARISON SUMMARY

INTRODUCTION AND EXPLANATION OF CONTENTS

Program Element	Remarks
0308601F Modeling and Simulation Support	In FY 2002, Project 4566, EA for Air/Space Natural Environment (ANSE), transferred efforts to PE 0207601F, USAF Modeling and Simulation, Project 5005, EA for Air/Space Natural Environment (ANSE), to provide a more manageable Modeling, Simulation, and Analysis effort.
	In FY 2002, Project 1011, Legacy Model Transition (LMT), transferred efforts to PE 0207601F, USAF Modeling and Simulation, Project 5004, Joint Model Transition (JMT), to provide a more manageable Modeling, Simulation, and Analysis effort.
0401130F C-17 Aircraft	In FY 2002, Project 4886, LAIRCM, transferred efforts to PE 0401134F, Large Aircraft IR Countermeasures, Project 4885, LAIRCM.
	In FY 2002, Project 2569, C-17, includes new start efforts.
0401134F Large Aircraft IR Countermeasures	In FY 2002, this is a new PE. In FY 2002, Project 4885, LAIRCM, efforts transferred from PE 0401130F, C-17 Aircraft, Project 4886, LAIRCM.
0401218F KC-135S	In FY 2002, Project 4494, KC-135 Aging Aircraft Program, includes new start efforts.

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

DATE **June 2001**

BUDGET ACTIVITY
01 - Basic Research

PE NUMBER AND TITLE
0601102F Defense Research Sciences

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	208,178	212,688	220,869	213,788	218,015	222,679	227,606	232,731	Continuing	TBD
2301	Physics	25,029	25,303	22,308	22,719	23,370	24,352	24,896	25,459	Continuing	TBD
2302	Solid Mechanics and Structures	15,550	11,384	11,545	11,839	12,049	12,020	12,277	12,550	Continuing	TBD
2303	Chemistry	26,604	26,490	29,072	27,479	27,905	29,108	29,765	30,440	Continuing	TBD
2304	Mathematical and Computer Sciences	31,601	32,849	35,404	33,051	32,880	32,670	33,413	34,170	Continuing	TBD
2305	Electronics	23,603	24,023	26,453	24,477	24,496	24,378	24,925	25,488	Continuing	TBD
2306	Materials	12,808	13,952	16,506	14,950	15,575	16,515	16,877	17,254	Continuing	TBD
2307	Fluid Mechanics	9,637	9,623	10,046	10,561	11,275	12,180	12,440	12,717	Continuing	TBD
2308	Propulsion	19,577	21,449	20,819	19,121	19,636	20,162	20,608	21,073	Continuing	TBD
2310	Atmospheric Sciences	5,469	0	0	0	0	0	0	0	Continuing	TBD
2311	Space Sciences	8,334	14,758	15,095	15,475	16,066	16,650	17,015	17,397	Continuing	TBD
2312	Biological Sciences	12,850	14,432	13,972	14,331	14,732	15,066	15,394	15,737	Continuing	TBD
2313	Human Performance	12,403	14,081	13,004	12,997	13,113	12,504	12,764	13,054	Continuing	TBD
4113	External Research Programs Interface	4,713	4,344	6,645	6,788	6,918	7,074	7,232	7,392	Continuing	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
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	0

Note: FY 2003- FY 2007 budget numbers do not reflect the DoD strategy review results.
In FY 2001, Project 2310, Atmospheric Sciences, was eliminated as a separate project with the space sciences efforts moved into Project 2311, Space Sciences.
In FY 2001, Congress added $1M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for the detection of nosocomial infections. In FY 2001, the funding was realigned to PE 0602202F, Human Effectiveness Applied Research, project 7757, to align funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312. However, this effort is described in PE 0602202F, Project 7757.

(U) A. Mission Description

The Defense Research Sciences program comprises extramural research activities in academia and industry, and performs in-house investigations in the Air Force Research Laboratory. The program element funds fundamental broad-based scientific and engineering research in areas critical to Air Force weapon systems. These areas are: (1) physics; (2) solid mechanics and structures; (3) chemistry; (4) mathematical and computer sciences; (5) electronics; (6) materials; (7) fluid mechanics; (8) propulsion; (9) space sciences; (10) biological sciences; and (11) human performance. All projects are coordinated through the Defense Reliance process to harmonize efforts, eliminate duplication, and ensure the most effective use of funds across the Department of Defense. All research areas are subject to long-range planning and technical review by tri-Service scientific planning groups. Note: In FY 2001, Congress added $3.5 million for the Center for Adaptive Optics, $3.0 million for Coal-Derived Jet Fuel, $1.0 million for Chabot Observatory, and earmarked $0.6 million of appropriated funds for the National Solar Observatory.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	213,822	206,149	204,094	
(U)	Appropriated Value	216,305	214,649		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2			
	b. Small Business Innovative Research	-5,118			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-804			
	e. Rescissions	-2,203	-1,961		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Adjustments to Budget Years Since FY 2001 PBR			16,775	
(U)	Current Budget Submit/FY 2002 PBR	208,178	212,688	220,869	TBD

(U) Significant Program Changes:

Fiscal Year 2002 increase of $10.0M for nanosatellites, quantum computing, materials engineering, super energetic propellants, and plasma dynamics for next generation aerospace vehicles is part of the recent DoD Strategy Review.

Fiscal Year 2002 additional increase of $5.0M reflects zero percent real growth.

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

DATE
June 2001

BUDGET ACTIVITY
01 - Basic Research

PE NUMBER AND TITLE
0601102F Defense Research Sciences

PROJECT
2301

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2301	Physics	25,029	25,303	22,308	22,719	23,370	24,352	24,896	25,459	Continuing	TBD

(U) A. Mission Description

The Physics project will provide fundamental knowledge to improve Air Force lasers, avionics, sensors, and satellites. The research also will enhance capabilities in electromagnetic countermeasures, protection against nuclear weapons effects, communications, small satellites, and non-destructive and non-intrusive testing and analysis. This project primarily supports research in laser and optical physics; atomic, molecular, and imaging physics; and plasma physics.

(U) FY 2000 ($ in Thousands)

(U) $9,514 Performed 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. Investigated the physics of semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Studied a new high-power laser to replace oxygen-iodine for next generation airborne lasers. Examined pico-second and femto-second lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Evaluated micro-electro-mechanical systems (MEMS) to enable specialized devices for micro-satellite applications.

(U) $7,313 Conducted research in plasma physics to investigate fundamental atomic and molecular interactions for future directed energy weapons, affordable low-observables, and space communications and surveillance. Examined 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.

(U) $4,423 Studied 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. Identified interactions of atoms in strong electromagnetic fields to discover novel lasers for Air Force applications. Examined isomeric, high density energy storage for flash radiation devices and to make long flight missions possible without refueling.

(U) $3,779 Continued 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) $25,029 Total

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

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$9,896	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 next generation airborne lasers. 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)	$7,631	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)	$4,276	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)	$3,500	Study the performance of the new 30-meter infrared adaptive optical telescope at the Center for Astronomical Active Optics. Continue research on adaptive optics to enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers.
(U)	$25,303	Total

(U) FY 2002 ($ in Thousands)

(U)	$10,037	Perform laser and optical physics research for new concepts in solid state lasers, especially fiber lasers, to attain compact, inexpensive modules in the one kilowatt average power range. The results of this research will enable spoofing and fatal damage of infrared-seeking missiles, improve high performance radars, and new directed energy weapons. Study techniques for integrating modules to achieve multiple power levels at affordable cost and useful size for application to airborne or space platforms. Study concepts for achieving very high resolution of deep space objects using very large aperture adaptive telescopes. Explore novel low-cost light sources for high-power ultraviolet lasers capable of high intensity and spectral brightness for disinfection of biological agents, the synthesis of chemical agents, and safely stripping aircraft paint.

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

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $7,807 Conduct research in plasma physics to investigate fundamental interactions between charged particles and electromagnetic fields for future directed energy weapons, affordable low-observables, and space communications/surveillance. Explore physics relating to the power-efficient production and maintenance of substantial volumes of low-temperature plasma at atmospheric pressures for plasma-based aerodynamic drag reduction. Investigate the controlled resistive, conducting, and dielectric behavior of plasmas, and the effects of plasmas on absorption, reflection, and transmission of electromagnetic waves to create new stealth aircraft mechanisms. Examine the viability of using collisional ionized gas volumes to shield friendly assets from directed energy threats.

(U) $4,464 Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions for use in improved explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Quantify interactions of atoms in strong electromagnetic fields to enable novel lasers for Air Force applications. Continue research on isomeric, very high density energy storage for flash radiation devices to diminish or eliminate refueling on long endurance flights. Investigate the use of holographic films for correction of distortion and aberration in space surveillance telescopes.

(U) $22,308 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, 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.

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BUDGET ACTIVITY
01 - Basic Research

PE NUMBER AND TITLE
0601102F Defense Research Sciences

PROJECT
2302

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2302 Solid Mechanics and Structures	15,550	11,384	11,545	11,839	12,049	12,020	12,277	12,550	Continuing	TBD

(U) A. Mission Description

The Solid Mechanics and Structures project seeks to improve the capabilities of existing aerospace materials and structures and to develop revolutionary and more affordable structures for future Air Force systems. This project will develop fundamental knowledge of the aero-elastic and acoustic behavior of airframes and engine structures. The project also will further basic understanding of the dynamic behavior of launch vehicles and space structures. 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. Primary research areas will be composite materials mechanics, structural mechanics, and structural dynamics.

(U) FY 2000 ($ in Thousands)

(U) $3,264 Studied mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles to enable revolutionary improvements in design and capability of air and space weapon systems. Examined 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. Sought 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) $10,010 Expanded structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission uninhabited air vehicles. Evaluated the behavior of distributed sensor and actuator systems to achieve major improvements in the design and performance prediction of aerospace weapon systems. Identified system techniques to analyze vehicle integrity and achieve major increases in structural longevity of Air Force weapon systems.

(U) $2,276 Performed 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. Devised fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems.

(U) $15,550 Total

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BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2302**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$2,389	Study mechanics of composite materials to investigate new structural concepts and the underpinning mechanics principles to 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 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)	$7,331	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 techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapons.
(U)	$1,664	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 to enable micro-electro-mechanical systems (MEMS) that can sense environments and respond accordingly (smart structures).
(U)	$11,384	Total

(U) FY 2002 ($ in Thousands)

(U)	$2,423	Study mechanics of materials to accelerate utilization of advanced materials such as composites, high-temperature alloys, and ceramic matrix composites in aerospace vehicles, turbine engines, space systems, and weapon systems. Explore synergistic combinations of information technology and multiscale modeling to design new materials and new structures. Explore nanomechanics to bridge the gap between continuum mechanics and atomistic modeling. Establish theoretical foundations for multifunctional mechanics, including nonlinear behavior, to enable the development of multifunctional structures used in advanced space systems such as microsatellites and micro vehicles.
(U)	$5,016	Conduct research into structural and material aspects of high-cycle metal fatigue and other aging mechanisms of aircraft. Develop techniques for predictive computer simulation of structural response. Research metal fatigue-generation due to vibration of jet engine compressor and turbine blades and the interaction of blade motion with fluid mechanics. Study material science to identify and mitigate material degeneration in a timely and cost-efficient manner. Develop techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapon systems.
(U)	$4,106	Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

multi-mission uninhabited air vehicles. Evaluate the behavior of distributed sensor and actuator systems to improve the design and performance prediction of aerospace systems. Research predictive techniques capable of modeling the interaction of structural motion with high-speed aerodynamics characteristic of uninhabited air vehicles. Continue investigating the mechanical and dynamic behavior of micro-scale structures to enable micro-electro-mechanical systems (MEMS) that can sense environments and respond accordingly (smart structures).

(U) $11,545 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 0602201F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0602203F, Aerospace Propulsion.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2303**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2303 Chemistry	26,604	26,490	29,072	27,479	27,905	29,108	29,765	30,440	Continuing	TBD

(U) A. Mission Description

The Chemistry project supports research to significantly improve the ability to understand and control chemical reactions. The research will allow development of new materials and improve synthesis of existing materials. The research also will permit the improved control of energy flow/storage and better control of interactions between materials and their environments. Research will address chemical dynamics and energy transfer processes that foster advances in laser weaponry; allow prediction of infrared, optical, and radar signatures; and enable the synthesis of new propellants. Critical research topics will 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. The program also will explore surface interactions that limit the performance of electronic devices, compact power sources, and lubricant materials. The primary areas of research include molecular dynamics, theoretical chemistry, polymer chemistry, and surface and interfacial science.

(U) FY 2000 ($ in Thousands)

(U) $11,767 Performed molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Devised methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Sought fundamental knowledge to formulate new high energy density materials for rocket propellants.

(U) $8,939 Conducted polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions for advanced polymeric materials that significantly improve aircraft and spacecraft performance and life-spans. Evaluated spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigated polymer coatings to enable advanced sensors applications. Developed fundamental knowledge to formulate materials that have suitable optical transitions for highly efficient optical limiting properties to enable flexible communications in space operations. Evaluated high temperature nanocomposite polymers for superior space propulsion.

(U) $5,898 Studied 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. Investigated surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Explored the reactions and mechanisms for protection of aluminum aircraft from corrosion. Investigated novel three-dimensional surface nano-structures for sensor, optical, and power applications.

(U) $26,604 Total

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

(U) A. Mission Description Continued

(U)	FY 2001 ($ in Thousands)	
(U)	$11,716	Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and 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)	$8,900	Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions for advanced polymeric materials that significantly improve 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 optical transitions suitable for highly efficient optical limiting properties.
(U)	$5,874	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)	$26,490	Total
(U)	FY 2002 ($ in Thousands)	
(U)	$11,910	Perform molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and develop predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Seek understanding of mechanisms of using ion and plasma chemistry to reduce drag and/or enhance combustion. Synthesize novel chemical monopropellants for satellite and rocket applications. Determine the gain and loss mechanisms in chemical laser systems to permit operation at higher powers. Identify inputs required to model chemically reacting flows in rocket plumes. Develop theoretical methods to predict properties of structural materials.
(U)	$9,204	Conduct polymer chemistry research to improve fundamental understanding of chemical structures and processing conditions to develop advanced polymeric materials for significantly improved Air Force systems performance and life-spans. Explore chemistry concepts based on

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

organic materials that will enable protection of Air Force personnel and sensors from agile lasers. Investigate nanocomposites to improve thermal and mechanical properties of polymers for lightweight aerospace structures. Devise controls of nanostructure assembly to attain new photonic and electronic functions.

(U) $5,958 Study the chemistry of surface and interfacial processes for accurate detection and prevention of corrosion and degradation of air and space systems, and development and design of novel lubricants. Develop new long-life, low-friction surface structures and coatings for terrestrial and space environments. Examine environmentally compliant nanostructured coating systems for corrosion protection of aluminum aircraft. Investigate novel three-dimensional surface nanostructures for sensor, optical, and power applications. Examine nanoscale surface structures with enhanced energy densities for significantly improved weapon system energy storage and delivery. Develop theoretical and predictive methods for surface and interfacial chemical processes.

(U) $2,000 Conduct research in chemical synthesis and detection techniques, chemical theory, and modeling and simulation that will lead to breakthroughs in new fuels and rocket propellants that are environmentally benign, have reduced signatures, and are less sensitive to accidental detonations. Investigate applications of these potential fuels in flight vehicles to study the benefits of increasing mass of payloads put into space and increasing the lifetime of satellites on orbit. Study application of any potential fuels breakthroughs to the development of hydrocarbon-fueled scramjets and combined-cycle engines for space applications.

(U) $29,072 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 0602203F, Aerospace Propulsion.
(U) PE 0602601F, Space Technology.
(U) PE 0602602F, Conventional Munitions.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

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

(U) E. Schedule Profile Continued

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 01 - Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences							PROJECT 2304
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2304	Mathematical and Computer Sciences	31,601	32,849	35,404	33,051	32,880	32,670	33,413	34,170	Continuing	TBD

(U) A. Mission Description

The Mathematical and Computer Sciences project will develop techniques for modeling and simulation, algorithm development, and control of complex systems. The program will also develop innovative analytical and high-performance computing methods for aerospace systems. The research will improve the performance of aerospace systems through the creation of accurate models and computational tools, enhanced artificial intelligence, and better programming techniques and theories. The primary research areas of 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 hypersonic flows.

(U) FY 2000 ($ in Thousands)

(U) $6,510 Performed dynamics and control research to develop new techniques for design and analysis of control systems to significantly enhance capabilities and performance of aerospace vehicles. Developed modeling, identification, and control capabilities necessary for the integrated control of vehicle aerodynamics and jet engine performance. Created control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition by deployable laser platforms. Formulated algorithms incorporating active control procedures to provide more efficient flow through jet engines.

(U) $6,483 Conducted 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. Expanded automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Formulated distributed, automatic resource management approaches for new methods of mobile agent resource allocation and protection.

(U) $6,369 Conducted physical mathematics and applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Predicted nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Modeled detonation shock dynamics to support reconfigurable conventional warhead design. Identified optimal electromagnetic wave propagation and scattering codes to provide accurate and timely target recognition. Refined physical mathematics, control and signal processing techniques, and modeled advanced electromagnetic materials, composites, and smart skins for air and space weapons.

(U) $4,608 Studied optimization and discrete mathematics to devise advanced mathematical methods for solving complex problems in logistics, engineering design, and strategic planning for battlespace information management. Expanded transportable agent technology to support defensive information warfare applications. Integrated new multidisciplinary optimization design strategies with higher order, time accurate flow solvers

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BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2304**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

for improved design of jet engines, aircraft wings, and other aerospace components.

(U) $3,444 Performed computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Integrated new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Invented methods to reduce computation time for chemical laser simulations. Identified failure modes of bonded composite materials by inserting novel computational methods into mission-support software tools.

(U) $2,571 Studied signals communication and surveillance to expand quantitative methodologies that extended the capability of critical mobile, wireless, and networked communications systems, and strengthened performance of surveillance and targeting functions through autonomous and human-assisted sensing/response platforms. Analyzed irreducible expansions of signals, soft thresholding, and efficient source-channel coding in wireless communication to improve cost versus performance trade offs.

(U) $1,616 Researched the mathematical foundations of external aerodynamics flows 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. Devised accurate computational flow solvers for optimal design of aircraft wings and novel aerospace components. Refined plasma-aerodynamic optimization algorithms to enable design of superior scramjets.

(U) $31,601 Total

(U) FY 2001 ($ in Thousands)

(U) $6,765 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 by deployable laser platforms. Expand active and adaptive control algorithms to enable autonomous air, space, and ground operations.

(U) $6,738 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) $6,620 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

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

applications in laser beam control and stability. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Devise methods to penetrate tree cover and recognize targets.

(U) $4,790 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) $3,579 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) $2,673 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 thresholding, 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) $1,684 Research the mathematical foundations of external aerodynamics to develop fundamental knowledge of basic fluid dynamics and plasma-aerodynamics to predict and control supersonic and hypersonic flows over combat maneuvering flight vehicles. Devise accurate flow solvers for optimal design of aircraft wings and novel aerospace components. Refine plasma-aerodynamic optimization techniques to enable design of superior aerospace vehicles.

(U) $32,849 Total

(U) FY 2002 ($ in Thousands)

(U) $7,014 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. Expand program on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned vehicles, and constellations of small satellites. Develop new techniques for the control of nonequilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion and materials processing.

(U) $7,014 Conduct research in complex systems and software, artificial intelligence, automatic knowledge acquisition; study high performance knowledge bases to allow rigorous construction of highly complex battlefield information systems. Identify advanced techniques in intelligent and mobile

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BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2304

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

agents for next generation information systems. Conduct research in information operations, including support for language-based security, mobile code security, protected execution, and dynamic, adaptive intrusion detection for protection of future battlespace and infosphere systems and networks.

(U) $6,679 Conduct physical mathematics/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 with wide band radar. Investigate feasibility of incorporating virtual time-reversal methodology onboard a formation of small satellites to enhance imaging of radar-acquired moving targets.

(U) $4,677 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 algorithmic research which produces a feasible solution within the time constraint of military operations. Develop techniques for hierarchical model building to accommodate multiple levels of aggregation and complexity, to reflect time and computational constraints.

(U) $3,674 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, munitions, and other aerospace components. Investigate efficient methods to quantify uncertainty in non-linear multidisciplinary design models. Continue devising methods to reduce computation time for chemical simulations from months to days. Improve algorithms for plasma dynamics simulations, munition penetration simulations, and ground-based image reconstruction.

(U) $2,674 Study signals communication and surveillance to expand quantitative methodologies that extend the capability of critical mobile, networked communications systems, and strengthen the performance of surveillance and targeting functions. Improve the efficiency of source-channel coding in wireless communication through technical advances such as optical transmission. Continue research in probabilistic and analytic theory to achieve higher information rates and greater reliability under stringent military covertness constraints. Develop promising areas such as super-resolution imaging and trellis-coded modulation.

(U) $2,000 Construct quantum computer devices that enable atomic level computing a million times faster than today's silicon chip. Design, implement, and test quantum computing algorithms and architectures enabling fast, accurate solutions of complex fluid dynamics problems eliminating the need for multiple design iterations and prototype testing. Develop scalable quantum computers for automatic target recognition and target characterization.

(U) $1,672 Explore mathematical and computational methods of external aerodynamics associated with hypersonic weapon release. Expand plasma

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BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2304**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

aerodynamics algorithms to include magneto hydrodynamic (MHD) augmentation of complete scramjet engines. Computationally investigate the effects of dynamic aero structural tailoring during combat maneuvers on end-game targeting. Computationally explore hypersonic boundary layer transition on transatmospheric vehicles to reduce heat transfer and viscous drag to enable long-range, high-payload hypersonic vehicles.

(U) $35,404 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 0602602F, Conventional Munitions.
(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 June 2001

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

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2305 Electronics	23,603	24,023	26,453	24,477	24,496	24,378	24,925	25,488	Continuing	TBD

(U) A. Mission Description

The Electronics project furthers the fundamental understanding of electronic materials, devices, and systems. This knowledge will enhance Air Force operational capabilities in the areas of directed energy weapons, stealth technologies, electronic countermeasures, information and signal processing, and communications. The research will focus on developing electronic processes to model and predict performance of electronic materials, devices, and systems for power generation. The program also will focus on optical signal processing, radiation effects, and high-speed signal processing. The goals of this research are to minimize the complexity and maximize the 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 investigative research are space electronics, optoelectronic materials, optoelectronic information processing, and quantum electronic solids.

(U) FY 2000 ($ in Thousands)

(U) $7,709 Performed space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Characterized surface and interface states to prevent electronic device degradation in Air Force systems. Explored wide bandgap semiconductor materials ideal for radio frequency power sources and high-temperature operations for air and space weapon systems.

(U) $7,623 Conducted optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Developed unique materials to protect critical optical systems from enemy attack. Devised laser materials to detect, degrade, or blind an adversary's detection capabilities. Created models of new detectors for characterization of the battlespace and surveillance.

(U) $4,487 Studied optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Formulated high bandwidth, multi-wavelength modulators and detectors for Air Force imaging and communication systems. Created optical materials for high-bandwidth communication and parallel signal processing for enabling the increased data transfer speeds required for military operations.

(U) $3,784 Performed 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. Created high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms. Investigated measurement of corrosion in aircraft structures to extend performance life span.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2305**

(U) <u>A. Mission Description Continued</u>

(U) <u>FY 2000 ($ in Thousands) Continued</u>

(U) $23,603 Total

(U) <u>FY 2001 ($ in Thousands)</u>

(U) $7,847 Performed space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Continued characterizing surface and interface states to prevent electronic device degradation. Explored wide bandgap semiconductor materials ideal for radio frequency (RF) power sources and high-temperature operations. Identified fundamental radiation effects on electronic and semiconductor materials and devised methods to prevent space system degradation or destruction.

(U) $7,759 Conducted optoelectronic materials research to investigate detection of optical radiation from far infrared to the ultraviolet spectral range to achieve surveillance dominance of the battlespace. Invented unique materials to protect critical optical systems from enemy attack. Devised laser materials to detect, degrade, or blind an adversary's detection capabilities. Created new detectors for characterization of the battlespace, surveillance, and to obtain target signatures in spectral ranges appropriate for quick target recognition.

(U) $4,567 Studied optoelectronic information processing to explore development and application of optoelectronic materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigated high bandwidth, multi-wavelength modulators and detectors to refine complex semiconductor structures for imaging and communication systems. Created 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) $3,850 Performed 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. Created high-current, high-temperature superconducting tapes and cables for enhanced power generation and storage on Air Force space platforms and directed energy weapons. Formulated innovative approaches to measure active corrosion in aircraft structures to extend performance lifespan.

(U) $24,023 Total

(U) <u>FY 2002 ($ in Thousands)</u>

(U) $8,069 Perform space electronics research to examine military unique low-power and complementary electronic circuits to greatly reduce the size and weight of space platforms. Study the effects of intense RF pulses on electronic circuits and systems. Devise means to prevent surface and interface states from degrading electronic device performance. Explore wide bandgap semiconductor materials as promising candidates for RF 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) $7,824 Conduct optoelectronic materials research for detection and emission of optical radiation from far infrared to the ultraviolet spectral range to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2305

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

achieve spectral dominance of the battlespace. Investigate new non-linear optical materials to protect critical optical systems from laser fire, and access laser wavelengths and power not available with solid state or semiconductor lasers. Study basic mechanisms that limit the efficiency and uncooled operation of lasers and detectors. Formulate laser materials to degrade or blind an adversary's detection and tracking capabilities. Investigate fast multiband detectors for characterization of the battlespace, surveillance, target tracking, and target signatures. Study unique properties available from nanoscale combinations of optoelectronic materials.

(U) $4,647 Study optoelectronic information processing to explore development and application of electro-optical materials and devices to enhance critical communication system accuracy, speed, and data storage. Investigate high bandwidth, multi-wavelength modulators and detectors to develop and refine complex semiconductor structures for imaging and communication systems. Create optical materials for maximum high-bandwidth communication and parallel signal processing. Investigate the use of new optical materials for enabling secure satellite communications and increased data transfer speeds required for military operations.

(U) $3,913 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. Improve high-temperature, high-current superconducting tapes and cables for enhanced storage and power generation on Air Force space platforms and directed energy weapons. Develop new techniques to quantify active corrosion in aircraft structures to increase lifespan. Investigate new high-temperature magnetic materials with sufficient mechanical strength for utilization in aircraft with higher electric workloads.

(U) $2,000 Conduct research addressing the scientific barriers to miniaturization of components enabling much lighter, more compact, highly capable microsatellites and nanosatellites. Research nanopropulsion and power schemes, smart skins, radiation hardening and quantum effect electronics to reduce satellite cost, weight, and size each by a factor of ten. Investigate nanosatellite benefits for improving access to space, mission flexibility, ease of augmentation and upgrade, and graceful degradation during end of service life.

(U) $26,453 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 0602702F, Command, Control, and Communications.

(U) PE 0603203F, Advanced Aerospace Sensors.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE **June 2001**
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2305**

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

(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 June 2001

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

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2306 Materials	12,808	13,952	16,506	14,950	15,575	16,515	16,877	17,254	Continuing	TBD

(U) A. Mission Description

The Materials project seeks to significantly reduce the cost of structural materials while enhancing their performance and reliability. A key goal is to eliminate material reliability issues related to high-temperature strength, toughness, fatigue, and environmental conditions. The program's examination of material strength, toughness, fatigue resistance, and corrosion resistance will serve to enable novel materials for airframe, turbine engine, and spacecraft structures. The research will emphasize refractory alloys, intermetallics, polymer composites, and metal and ceramic matrix composites. The research also will focus on advanced ceramics, such as alumina, silicon carbide, silicon nitride, and carbon/carbon. The research will improve aerospace vehicle structural materials and increase the thrust-to-weight ratio of engines by increasing the operating temperature of engine materials. Research on new processing methods will complement research on materials properties. The program's primary areas of research will be ceramic and nonmetallic materials, metallic materials, and organic matrix composites.

(U) FY 2000 ($ in Thousands)

(U) $4,165 Performed 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. Investigated coupled thermal and mechanical stability of very-high temperature oxide composites and eutectics for jet engine blade applications.

(U) $6,781 Conducted metallic materials research to evaluate novel metallic systems for propulsion and airframe applications. Expanded investigations of thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Identified tailorable transition-phase materials for superior thermal barrier coatings.

(U) $1,862 Studied organic matrix composites to expand knowledge of polymer matrix composites for increasing the strength and life-span of air and space vehicle structures. Explored novel ring-opening chemistry to develop resins with controlled volume shrinkage to improve mechanical properties of high performance adhesives and matrix resins. Investigated moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $12,808 Total

(U) FY 2001 ($ in Thousands)

(U) $4,537 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2306

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $7,386 Conduct metallic materials research to evaluate novel metallic systems for propulsion and airframe applications. Explore thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Evaluate tailorable transition-phase materials for superior thermal barrier coatings.

(U) $2,029 Study organic matrix composites to expand knowledge of polymer matrix composites and 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) $13,952 Total

(U) FY 2002 ($ in Thousands)

(U) $4,787 Perform ceramic and non-metallic materials research to understand optimum strength of very-high temperature, non-metallic materials for airbreathing and rocket engines, and space vehicle applications. Study thermal and mechanical stability interaction of very-high temperature oxide and non-oxide composites for jet engine blade applications. Advance fundamental materials knowledge to develop ultra-high temperature material systems based on carbides for rocket propulsion applications.

(U) $7,542 Conduct metallic materials research to develop affordable and durable metallic systems for advanced engines and aerospace structural applications. Expand investigations of thermal and mechanical stability of metal refractory alloys, intermetallics, and composites for very-high temperature aircraft applications. Research tailorable transition-phase materials for superior thermal barrier coatings and develop advanced metals for multifunctional space systems.

(U) $2,177 Perform organic matrix composites research to advance polymer matrix composite knowledge and increase the life-span and strength of aerospace structures. Study thermal cycling effects of polymer matrix composites at cryogenic temperatures to improve material durability in liquid fuel tank environments. Research novel fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $2,000 Develop new mathematical and computational strategies to reduce maturity time for new materials by ~50% and to minimize the costs of new structural materials for aerospace systems. Explore scientific basis for computational design to reduce amount of costly experimentation required. Develop high performance materials more affordably through synchronization of material development and engineering system design.

(U) $16,506 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2306**

(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 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 June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2307**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2307 Fluid Mechanics	9,637	9,623	10,046	10,561	11,275	12,180	12,440	12,717	Continuing	TBD

(U) A. Mission Description

The Fluid Mechanics project supports research to achieve substantial improvements in the efficacy, reliability, and cost-effectiveness of aerospace vehicles. The goal is to obtain major advances in understanding complex unsteady flows, hypersonic aerodynamics, turbulence, active flow control, and turbomachinery flows that will lead to superior new aerospace vehicles and their subcomponents. The research will lead to techniques to minimize drag and heat transfer, reduce flow separation, and create flow-control techniques to greatly expand current combat envelopes. The primary areas of research will be unsteady aerodynamics, hypersonic aerodynamics, turbulence and flow control, and rotating flows.

(U) FY 2000 ($ in Thousands)

(U) $2,890 Researched unsteady aerodynamics to provide fundamental knowledge of high-speed air flow to optimize current Air Force air vehicle designs and enable revolutionary future weapon systems. Investigated unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Devised flow control design tools used to minimize flow separation and air vehicle drag. Developed fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $2,409 Conducted hypersonic aerodynamics research to investigate complex flowfield phenomena for enabling the design of future Air Force trans-atmospheric vehicles and their flight control systems. Formulated concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques to enable new high-speed weapon systems. Developed high-speed flow prediction codes to quantify thermal stresses in high performance air and space weapon systems.

(U) $2,410 Sought fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in high performance air vehicles. Created novel micro-electromechanical systems (MEMS) actuators, and investigated actuation coupling mechanisms in turbulent flows to enable agile flight vehicles with significantly reduced power requirements. Evaluated the use of MEMS devices for flow control on swept wing air vehicles to substantially reduce drag.

(U) $1,928 Studied rotating flows to evaluate internal flow characteristics for enabling significant enhancement of performance and reliability/ maintainability of airbreathing propulsion systems. Fabricated promising MEMS devices for turbine engine control and Large Eddy Simulation methodology for affordable, high fidelity predictions of gas turbine engine flow fields.

(U) $9,637 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2307

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $2,406 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. Investigated 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) $2,886 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) $2,407 Seek fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in air vehicles. Evaluate 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 with a goal of substantial drag reduction.

(U) $1,924 Study rotating flows to evaluate internal flow characteristics for enhancing the performance and reliability/maintainability of airbreathing 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) $9,623 Total

(U) FY 2002 ($ in Thousands)

(U) $2,513 Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize future 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. Complete the development of design tools for flow control to minimize flow separation and air vehicle drag. Complete the development of fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $3,015 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. Research advanced concepts for hypersonic flow control such as plasma or magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses. Investigate high temperature mitigation techniques for hypersonic flight vehicles.

(U) $2,510 Seek fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts. Investigate flow control concepts to enhance the performance, controllability, and stability in air vehicles. Develop new predictive tools for the air vehicle design process. Evaluate promising flow control actuation concepts and investigate flow control coupling mechanisms in turbulent flows to enable agile flight vehicles

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2307

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

with significantly reduced power requirements.

(U) $2,008 Study complex rotating flow phenomena as they relate to turbomachinery and jet engine applications. Evaluate unsteady flow phenomena for enhancing the performance and reliability/maintainability of airbreathing propulsion systems. Continue development of Large Eddy Simulation methodology for affordable high fidelity predictions of gas turbine engine flow fields and heat transfer effects. Develop understanding of high cycle fatigue aerodynamic forcing. Evaluate possible flow control applications in turbine engines.

(U) $10,046 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 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0603211F, Aerospace Structures.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 01 - Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences							PROJECT 2308
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2308	Propulsion	19,577	21,449	20,819	19,121	19,636	20,162	20,608	21,073	Continuing	TBD

(U) A. Mission Description

Propulsion research seeks to increase the efficiency of energy usage in airbreathing engines, chemical and non-chemical rockets, and combined-cycle propulsion systems. The research will emphasize airbreathing propulsion, space power and propulsion, high-altitude signature characterization and contamination, propulsion diagnostics, and thermal management of space-based power and propulsion systems. Research will investigate chemically reacting flows that involve the complex coupling between energy release through chemical reactions and the flow processes that transport chemical reactants, products, and energy. Research on non-chemical energetic systems will include plasma and beamed energy propulsion for orbit-raising space missions and efficient ultrahigh-energy techniques for space-based energy use. The primary areas of research involved in this project will be space power and propulsion, combustion, and diagnostics.

(U) FY 2000 ($ in Thousands)

(U) $6,486 Performed research on space power and propulsion to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Modeled satellite propulsion characteristics for high-precision clusters of cooperating autonomous micro-satellites. Examined self-consuming satellites to increase payload and thrust capabilities. Created new concepts, such as pulsed detonation rocket and hybrid rocket engines, for optimal rocket propulsion. Identified experimental and numerical characteristics of high-altitude ultraviolet and infrared light satellite contamination to develop techniques to protect space assets.

(U) $6,062 Studied combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Developed computer models to increase weapon system efficiency by predicting unsteady behavior such as combustion instability. Examined 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) $4,041 Investigated advanced diagnostic systems for data reduction and interpretation to create concepts for novel propulsion system applications. Extended diode-laser spectroscopic technique for on-board control of propulsion system operation and performance.

(U) $2,988 Continued 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) $19,577 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2308**

(U) <u>A. Mission Description Continued</u>

(U) <u>FY 2001 ($ in Thousands)</u>

(U)	$7,220	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)	$6,738	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)	$4,491	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)	$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. Produce small quantities (50 gallons) of coal-derived fuel for large-scale combustion, fuel system fouling, and ignition experiments.
(U)	$21,449	Total

(U) <u>FY 2002 ($ in Thousands)</u>

(U)	$7,339	Perform space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Enable clusters of cooperating autonomous micro-satellites by improving thrust and control of micro- and nano-satellite propulsion systems. Research mechanical-electric energy conversion and self-consuming satellites to increase payload and thrust. Explore supercritical combustion for optimal rocket propulsion using hybrid rockets and/or combined cycle engines. Perform research on digital propulsion and pulsed detonation rocket engines. Exploit experimental university satellites to measure thrust and cross-contamination in microsatellite constellations. Develop novel space diagnostic techniques and 100 gram class sensors for accurate measurements on micro- and nano-satellites.
(U)	$6,963	Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Increase combustion efficiency and reduce fuel consumption through enhanced computer models that can predict unsteady behavior such as combustion instability. Advance the state of turbulent combustion simulation methods by incorporating refined models for chemistry and fuel droplets. Investigate enhancements to ignition and flame stabilization by weakly ionized flows.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2308

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $4,517 Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Apply picosecond spectroscopic techniques to characterize turbulent combustion statistical behavior and supercritical fuel properties.

(U) $2,000 Research methods for improving aerodynamics for next generation aerospace vehicles for long range strike. Expand research to develop sound scientific basis for how plasmas are used to improve aerodynamic characteristics and propulsive efficiencies enabling hypersonic vehicles by reducing drag and improving range by more than 10%. Perform demonstrations to prove plasma control effects and to determine how to engineer them into operational systems. Investigate plasma effects on lowering fuel consumption, improving propulsion system performance, providing on-board power generation, and alleviating sonic boom and engine noise.

(U) $20,819 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 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 June 2001										
BUDGET ACTIVITY 01 - Basic Research				PE NUMBER AND TITLE 0601102F Defense Research Sciences					PROJECT 2310	
COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2310 Atmospheric Sciences	5,469	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, effort was eliminated as a separate project with the space sciences efforts moved into Project 2311, Space Sciences.

(U) A. Mission Description

The Atmospheric Sciences project supports research on the Earth's upper atmospheric characteristics to better predict and control the effects the upper atmosphere has on Air Force tactical and strategic operations. The goal is to accurately model ionospheric irregularities and thermospheric dynamics to provide reliable and continuous command, control, and communications. The program will use innovative techniques to evaluate the structure and chemistry of the mesosphere and thermosphere. By modeling the physics and dynamics of the ionosphere, the program will create enhanced global surveillance, geolocation, and communication capabilities. Research activities will include the observation and modeling of atmospheric tides and gravity waves, geomagnetic disturbances, auroral and airglow emissions, and plasma turbulence and dynamics. The research focus will be space weather, optical and auroral emission, and ionospheric scintillation and turbulence.

(U) FY 2000 ($ in Thousands)

(U) $2,187 Performed space weather research to refine space phenomena prediction models to enable optimal design and protection of Air Force space assets. Developed 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. Supported the space weather Coordinated Community Modeling Center to transition information directly to the Air Force Space Forecast Center.

(U) $1,367 Conducted 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. Investigated atmospheric gravity wave interactions from high-latitude observation sites, using powerful new Light Detection and Ranging (LIDAR) techniques, to enable accurate interpretation of optical emissions and refined modeling of the operational space environment.

(U) $1,915 Studied ionospheric scintillation and turbulence to formulate prediction models to enhance global surveillance, geolocation, and communication capability. Investigated ionosphere plasma phenomena created by man-made radio waves, to enable active control of the operational space environment. Analyzed and interpreted signatures of solar activity to provide fundamental knowledge to design techniques to prevent disruption of global radio communications, geolocation, and space surveillance.

(U) $5,469 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 2311.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2310**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Effort moved to Project 2311.
(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 June 2001
BUDGET ACTIVITY 01 - Basic Research		PE NUMBER AND TITLE 0601102F Defense Research Sciences									PROJECT 2311
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2311	Space Sciences	8,334	14,758	15,095	15,475	16,066	16,650	17,015	17,397	Continuing	TBD

Note: In FY 2001, efforts moved from Project 2310, Atmospheric Sciences.

(U) **A. Mission Description**

The Space Sciences project seeks to increase the understanding of the space environment and to optimize the design of future Air Force systems operating in near-Earth orbit, geosynchronous orbit, and deep-space. The goal is to enhance the protection of space assets against threats of space debris, solar wind, solar flares, cosmic rays, and geomagnetic storms. The focus will be 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. The project will develop methods to forecast turbulent plasma phenomena that mediate the energy flow through space in order to improve the Air Force's ability to operate in space. The research will focus on astrophysical observation techniques; solar physics; solar wind transport; magnetospheric physics; magnetosphere-ionosphere coupling; ionospheric physics and scintillation; and the energization processes in the Earth's radiation belts.

(U) FY 2000 ($ in Thousands)

(U) $3,334 Analyzed 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. Investigated sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar eruptions.

(U) $2,083 Studied 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. Evaluated effects of solar wind, interplanetary magnetic field, and Earth’s magnetosphere to enhance space weather specification and forecast models.

(U) $2,917 Studied 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. Examined charged particle dynamics for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth’s satellite environment. Investigated turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $8,334 Total

(U) FY 2001 ($ in Thousands)

(U) $5,902 Continue support to Sacramento Peak Solar Observatory to 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2311**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

eruptions, and predict risk to critical Air Force space operations.

(U) $4,427 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) $4,429 Study 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) $14,758 Total

(U) FY 2002 ($ in Thousands)

(U) $3,773 Analyze, characterize, and model solar phenomena for much better prediction of large-scale solar disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Obtain high-resolution observations 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 field spin states to enable forecasting of solar eruptions and predict environmental risks to critical Air Force space operations. Develop solar vector magnetographs using adaptive optics.

(U) $3,774 Study solar wind effects on the Earth's magnetospheric and radiation belt energization processes and morphology. Enhance space systems performance degradation models. Develop models that provide realistic coupling of the magnetosphere - ionosphere system. Conceive magnetohydrodynamic (MHD) models to develop a theoretical understanding of magnetic reconnection and self-organized criticality in the magnetosphere.

(U) $4,528 Study ionospheric scintillation and turbulence to enhance global surveillance, geolocation, and communication. Observe atmospheric gravity wave interactions from high-latitude and tropical observation sites using light detection and ranging (LIDAR) techniques. Conduct airglow and auroral emission observations and characterize the chemical and physical dynamics of the mesosphere, thermosphere, and ionosphere to develop comprehensive seasonal and climatic maps of high-altitude phenomena.

(U) $3,020 Characterize the populations of space debris particles derived from comets and asteroids to predict threats to Air Force spacecraft. Provide a test bed for advanced deep space surveillance techniques through new astronomical instrumentation and observational methods. Expand laser guide-star development and observations of space backgrounds and optical signatures of orbital targets over the tropics. Research the variable

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2311

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

energy deposited in near-Earth space by cosmic rays and energetic particles from deep space to identify risks to Air Force systems.

(U) $15,095 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.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2312**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2312 Biological Sciences	12,850	14,432	13,972	14,331	14,732	15,066	15,394	15,737	Continuing	TBD

In FY 2001, Congress added $1M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for the detection of nosocomial infections. In FY 2001, the funding was realigned to PE 0602202F, Human Effectiveness Applied Research, project 7757, to align funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312. However, this effort is described in PE 0602202F, Project 7757.

(U) A. Mission Description

The Biological Sciences project investigates biological processes important to Air Force applications. Research will explore the interaction of Air Force chemical and physical agents (lasers and microwaves) with human tissues and consequent potential hazardous effects. This research will generate safety strategies to ensure the hazard-free development of future aerospace materials and directed energy systems. Research in biomimetic sensors will study the biological detection systems of organisms at the molecular level and apply this knowledge to develop novel man-made sensors. Biocatalysis research will attempt to discover and characterize cellular enzymes that catalyze the synthesis of chemical feedstocks used in the safe production of aerospace materials. The research in neuroscience and chronobiology will create new strategies to prevent impaired performance due to jet lag, shift-work, and night operations. This research will create new strategies to prevent the loss of life and/or aircraft due to stress, inattention, or lack of vigilance. The primary areas of research will be bioenvironmental sciences, biocatalysis, chronobiology and neural adaptation, and biomimetic sensors.

(U) FY 2000 ($ in Thousands)

(U) $7,454 Studied 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. Evaluated underlying biochemical alterations related to the adverse effects of JP-8 jet fuel. Explored 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. Examined 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 energy.

(U) $1,285 Researched 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. Identified and isolated bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of aerospace materials synthesis.

(U) $2,570 Performed chronobiology and neural adaptation research to examine the biological mechanisms responsible for crew fatigue, adaptation to the

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2312

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

environment, and individual performance capabilities to improve skilled human performance. Devised and tested new preventative countermeasures for human errors induced by fatigue and jet lag, and performed fundamental research on the biophysical basis of alert cognitive performance.

(U) $1,541 Investigated biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identified methods to enhance them. Investigated, predicted, and modeled biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Devised techniques to model alternate mechanisms of near ambient infrared sensing systems in snakes and beetles to enable room-temperature, compact infrared sensors.

(U) $12,850 Total

(U) FY 2001 ($ in Thousands)

(U) $6,584 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 began 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 computational design of new, safer, aerospace materials. Examine the effects of novel forms of directed energy (microwaves and lasers) on gene expression and identify the specific sub-cellular targets of directed energy.

(U) $3,358 Research biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety for synthesizing chemical feedstocks for manufacturing aerospace materials. Sub-clone various bacterial enzymes to enhance the level of gene expression so 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 aerospace materials synthesis.

(U) $1,882 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 combination of countermeasures such as optimally-timed rest periods and wake promoting compounds.

(U) $1,610 Investigated biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identify methods to enhance these systems. 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2312**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

		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)	$998	The activity for this effort is described in PE 0602202F, Project 7757.
(U)	$14,432	Total

(U) FY 2002 ($ in Thousands)

(U)	$6,846	Study bioenvironmental sciences to investigate the biological effects of exposure to military aerospace chemicals and directed energy systems used by the military to assure the safety, health, and high performance of personnel before, during, and after mission-directed activities. Explore the molecular and cellular effects of JP-8 jet fuel on the lung, brain, skin, and immune system and continue to identify specific molecular pathways involved in eliciting and blocking toxic responses. Continue to develop reliable in vitro simulators of in vivo toxic responses and learn to use them to rapidly acquire and predict toxic profiles at a sub-cellular level. Continue to identify and quantify subtle, gene-induced effects of directed energy (microwaves and lasers) on cellular targets and determine the approximate exposure levels at which these effects are significant.
(U)	$3,494	Research biocatalysis to discover and characterize enzymes from living cells for use as biocatalysts to reduce cost, increase efficiency, and assure safety in chemical feedstocks synthesis for aerospace materials. Discover, isolate, clone, and sequence genes of novel enzymes of use to the military. Biochemically characterize the enzymes and investigate their mechanisms of reaction, kinetics, substrate range, and specificity.
(U)	$1,955	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. Continue to analyze the mechanism by which serotonin regulates the circadian clock. Continue researching the effect of modafinil on preventing adverse performance effects without disrupting sleep. Optimize the combination of fatigue countermeasures such as optimally-timed rest periods and alertness promoting compounds.
(U)	$1,677	Conduct biomimetic research to enable the development of novel sensors, engineering processes, and mechanisms. Investigate fundamental biological properties and processes of infrared sensitive biosystems at the cellular, sub-cellular, and molecular levels to enable the development of novel infrared materials and devices with enhanced structural and functional capabilities. Identify, isolate, and model alternate mechanisms of near ambient infrared sensing in biosystems to enable and/or enhance compact, room-temperature infrared sensors. Probe the functionality of alternative sensors for time-response characteristics. Investigate biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for application to military sensors.
(U)	$13,972	Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2312

(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 0602602F, Conventional Munitions.

(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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
01 - Basic Research	0601102F Defense Research Sciences	2313

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2313 Human Performance	12,403	14,081	13,004	12,997	13,113	12,504	12,764	13,054	Continuing	TBD

(U) A. Mission Description

Human Performance research examines aspects of human information processing critical to Air Force operations. The objective is to develop useful quantitative models of the way humans perceive, navigate, and manipulate their environment; make decisions when performing complex tasks under stress or uncertainty; and adapt to extreme sensory, biophysical, or cognitive workloads. The sensory component of the research will emphasize visual, auditory, vestibular, and kinesthetic systems and their optimal integration. The research will contribute to 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 will be sensory and perceptual systems, cognition, and cognitive workload.

(U) FY 2000 ($ in Thousands)

(U) $3,349 Performed sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Expanded theories of visual search and scene analysis and control of attention for optimal cockpit performance. Investigated the perceptual and cognitive requirements for accurate simulation of virtual environments.

(U) $4,713 Conducted cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Formulated models of intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations.

(U) $4,341 Studied 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. Devised innovative approaches to understanding individual skill differences, and identify new training and selection system models relevant to modern, technology-dependent environments.

(U) $12,403 Total

(U) FY 2001 ($ in Thousands)

(U) $3,533 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. Gain understanding of human multisensory integration to enable the design of automated sensing devices.

(U) $4,971 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **2313**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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) $4,577 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) $1,000 Support basic research and educational outreach projects at the Chabot Observatory and Science Center to assure the Air Force access to superior scientific and engineering talent in future years. Efforts include research to increase the fundamental understanding of the upper atmosphere.

(U) $14,081 Total

(U) FY 2002 ($ in Thousands)

(U) $3,512 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Develop theories for models of human-machine interaction in Air Force weapon systems. Critically test theories of visual search and scene analysis, and control of attention using measures of performance identified in several task domains. Create models for perceptual and cognitive requirements for accurate simulation and for effective design of informative displays. Develop laboratory apparatus to test theories of sensory integration for image understanding.

(U) $4,940 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Develop models of enhanced human performance aided or augmented by intelligent systems. Discover and evaluate theories of training for operator and team effectiveness under stress and sustained operation.

(U) $4,552 Study cognitive workload to validate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance. Model relationships between individual skill differences and interactions with new training methodologies. Study behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $13,004 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 2313

(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: June 2001

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 4113

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4113 External Research Programs Interface	4,713	4,344	6,645	6,788	6,918	7,074	7,232	7,392	Continuing	TBD

(U) A. Mission Description

The External Research Programs Interface project promotes the interaction between the international and domestic civilian research community and Air Force researchers. The research will stimulate scientific and engineering education that will benefit the Air Force and increase the awareness of basic Air Force research priorities. These activities will help to attract talented scientists and engineers to address Air Force needs. The primary elements of this research will emphasize international strategy, international technology liaison, and scientist and engineer research interchange.

(U) FY 2000 ($ in Thousands)

(U) $1,554 Supported 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. Provided 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 United States Department of Defense organizations.

(U) $1,848 Supported international technology liaison missions to identify unique international research capabilities, and make them available to the Air Force. Used 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. Sustained and funded Air Force commitment to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,311 Supported 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 relationships between premiere scientists and the Air Force Research Laboratory. Improved awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent to participate in critical Air Force research.

(U) $4,713 Total

(U) FY 2001 ($ in Thousands)

(U) $1,434 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 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) $1,704 Support international technology liaison missions to identify unique international research capabilities, and make them available to the Air Force.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **01 - Basic Research**	PE NUMBER AND TITLE **0601102F Defense Research Sciences**	PROJECT **4113**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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) $1,206 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 relationships 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) $4,344 Total

(U) FY 2002 ($ in Thousands)

(U) $2,190 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) $2,593 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) $1,862 Support scientist and engineer exchange efforts to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging relationships 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) $6,645 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 01 - Basic Research	PE NUMBER AND TITLE 0601102F Defense Research Sciences	PROJECT 4113

(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.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE **June 2001**

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602102F Materials

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	75,541	96,422	77,164	78,037	78,253	79,204	80,098	82,377	Continuing	TBD
4347	Materials for Structures, Propulsion, and Subsystems	50,451	63,539	46,749	46,106	46,628	47,269	48,595	49,978	Continuing	TBD
4348	Materials for Electronics, Optics, and Survivability	4,655	12,408	9,051	9,444	9,157	8,802	7,734	7,955	Continuing	TBD
4349	Materials Technology for Sustainment	20,435	20,475	19,945	20,238	20,326	20,716	21,283	21,888	Continuing	TBD
4915	Deployed Air Base Technology	0	0	1,419	2,249	2,142	2,417	2,486	2,556	0	0
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, the deployed air base technology efforts in PE 0602201F, Aerospace Flight Dynamics, Project 4397, Air Base Technology, are transferred into this PE in Project 4915, Deployed Air Base Technology. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) **A. Mission Description**

The Materials program develops advanced materials and processing technologies to reduce life cycle costs and improve performance, affordability, supportability, reliability, and survivability of current and future Air Force systems. The program has four projects: (1) develops structural, propulsion, and sub-systems materials and processes technologies; (2) develops electronic, optical, and survivability materials and processes technologies; (3) develops sustainment materials and processes technologies; and (4) develops air base operations technologies including power generation, deployable shelters, and fire fighting. Note: In FY 2001, Congress added $4.5 million for special aerospace materials and manufacturing processes, $3.0 million for advanced physical vapor transport growth process for silicon carbide components, $2.2 million for aircraft structural integrity, $4.0 million for carbon foam development for aircraft and spacecraft, $2.0 million for ceramic matrix composites, $3.2 million for laser processing tools, $1.3 million for resin systems for engine applications, $1.0 million for thermal protection systems for hypervelocity vehicles, $1.0 million for weathering and corrosion on aircraft surfaces and parts, $0.5 million for infrared (IR) detectors, radio frequency (RF), and power electronics, and $1.8 million for thermal management for space structures. This explains the perceived overall decrease in the Materials program in FY 2002.

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

DATE
June 2001

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602102F Materials

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	78,103	72,815	70,719	
(U)	Appropriated Value	78,811	97,315		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-45			
	b. Small Business Innovative Research	-1,735			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-871			
	e. Rescissions	-619	-893		
(U)	Adjustments to Budget Years Since FY 2001 PBR			6,445	
(U)	Current Budget Submit/FY 2002 PBR	75,541	96,422	77,164	TBD

(U) Significant Program Changes:

In FY 2002, the increase in this program is due to realignment of efforts to align with Air Force Research Laboratory organizational structure.

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BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT **4347**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4347 Materials for Structures, Propulsion, and Subsystems	50,451	63,539	46,749	46,106	46,628	47,269	48,595	49,978	Continuing	TBD

(U) <u>A. Mission Description</u>

Develops materials and processing technology base for aircraft, spacecraft, and missiles to improve affordability, maintainability, and performance of current and future Air Force systems. Advanced thermal protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet aircraft, spacecraft, and missile requirements. 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. Develop high temperature turbine engine materials that will enable engine designs to double the turbine engine thrust to weight ratio. Spacecraft material technologies are being developed that are lightweight, thermally conductive, dimensionally stable, noncontaminating, and resistant to the space environment. Alternative or replacement materials are developed to maintain the performance of aging operational systems. Friction and wear resistant materials, 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. Concurrent development of advanced processing methods to enable 'adaptive' processing of aerospace materials. Note: In FY 2001, Congress added $4.5 million for special aerospace materials and manufacturing processes, $2.2 million for aircraft structural integrity, $4.0 million for carbon foam development for aircraft and spacecraft, $2.0 million for ceramic matrix composites, $3.2 million for laser processing tools, $1.3 million for resin systems for engine applications, $1.0 million for thermal protection systems for hypervelocity vehicles, and $1.8 million for thermal management for space structures which explains the perceived decrease in FY 2002.

(U) <u>FY 2000 ($ in Thousands)</u>

(U) $9,029 Developed enabling polymeric and carbon-carbon materials technologies for diverse, high-payoff Air Force system needs including structural and thermal applications. Evaluated carbon matrix composites degradation mechanisms to enhance life prediction of advanced aircraft environmental control systems and hot, exhaust-washed structures and engine components. Identifed suitable polymers and conductive elastomers as base materials for low-observable gap sealants, thin wires, and electrostatic discharge coatings. Identified and evaluated toughened and nanostructured polymers for thin films to enable inflatable membrane structures such as deployable mirrors for surveillance and space counterforce applications.

(U) $7,260 Developed 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. Evaluated 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.

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

(U) FY 2000 ($ in Thousands) Continued

Demonstrated the feasibility of electrically conductive elastomers for use in low-observable gap treatments and established baseline analytical capability to predict the optical properties of specialty coatings. Evaluated permanent corrosion resistant primer resins and environmentally safe corrosion protection with a 30-year life.

(U) $8,946 Developed 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. Developed 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. Developed non-autoclave processes for large structural, cryogenics tanks, and substructures for future Air Force space platforms. Identified materials and processes for low-cost, multifunction composites to enable small, highly tailorable space platforms. Identified and developed novel product forms (foams, nanomaterials) for lightweight, tough, and affordable structural materials.

(U) $20,487 Developed and transitioned 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. Optimized wrought gamma titanium aluminides with a 200°F higher temperature capability for advanced gas turbine engine critical components and characterized advanced intermetallic alloys with the potential of achieving a 300°F temperature increase over current turbine blade materials. Developed life prediction and design methods to better predict the impact of high cycle fatigue (HCF) on critical engine components and identified critical components and inspection requirements for turbine engine rotor life extension, retirement for cause criteria, and enable repair processes. Developed and optimized 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. Developed process technology for lower tier materials suppliers to improve quality and affordability of components for weapon systems. Developed metallic materials, such as discontinuously reinforced aluminum, nanocrystalline aluminum, and high temperature metallic sheets for lighter weight and higher strength components for space systems and thermal protection for space vehicles.

(U) $4,729 Developed ceramics and ceramic matrix composites technology base for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures, and determined the durability of ceramics under service life conditions to guide further materials development and to assess useable life. Conducted rocket engine rig tests of vanes, thrusters, and nozzle ramp subelements, developed integrally woven ceramic composite structures for actively cooled space vehicle applications, and developed thermal protection materials for emerging reusable space vehicles. Identified optimum constituents for 2400°F capable ceramic matrix composite for turbine engine combustors and airfoils, performed subscale dynamometer testing of multiple ceramic composites for next generation aircraft brake friction materials, and initiated extended durability testing of ceramic composites for exhaust components. Developed repair techniques for radar

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

absorbing material (RAM) coatings and engine tested a repaired ceramic matrix composite exhaust nozzle seal. Developed advanced constituents such as oxidation resistant interface coatings for longest life, highest performance ceramic composites.

(U) $50,451 Total

(U) FY 2001 ($ in Thousands)

(U) $5,014 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) $10,244 Develop and transition 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. 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 for aircraft platforms.

(U) $18,884 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 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) $23,450 Develop and transition affordable lightweight metallic materials, behavior and life prediction technology, higher temperature intermetallic alloys, and metals processing technology to enhance performance, lower acquisition cost, increase durability, and improve reliability of Air Force weapon systems. Transition wrought gamma titanium aluminides with a 200°F higher temperature capability for demonstration in advanced gas

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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 turbine blade materials. Develop life prediction and design methods to better predict the 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) $5,947 Develop ceramics and ceramic matrix composites technologies for enhanced 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) $63,539 Total

(U) FY 2002 ($ in Thousands)

(U) $8,126 Develop enabling polymeric materials for diverse aerospace structural applications including spacecraft mirror applications, enhanced aircraft canopies, micromechanical devices, and advanced wiring concepts. Evaluate toughened and nanostructured polymers as temperature resistant in Air Force aircraft and space applications. Demonstrate and verify new methods for rapid fabrication of micron three-dimensional structures for Air Force micromechanical devices. Demonstrate use of hybrid thin wires for aircraft and spacecraft applications. Investigate feasibility of flexible, higher efficiency polymeric fibers for photvoltaic advanced solar cells. Optimize light-absorbing polymeric materials for incorporation into paint formulations for corrosion characterization applications.

(U) $10,728 Develop affordable, advanced organic matrix composite structural materials and technologies for Air Force systems applications including lightweight structures requiring thermal and/or structural management for environmental control. Scale-up and publish demonstrated processing and/or mechanics models which predict component dimensions improving low-observable and affordability for large integrated structures for future Air Force air platforms. Investigate specific composite material degradation mechanisms to improve life prediction for aircraft

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

environmental control systems and hot, exhaust-washed structures and engine components. Evaluate next generation high temperature organic matrix composites for air and space platforms. Evaluate non-autoclave materials and processes for composite cryogenic tank structures for future space platforms. Process and fabricate novel product foams such as nanomaterials, nanotubes, and carbon foams for lightweight, tough, and affordable structural materials.

(U) $7,975 Develop and transition nonstructural materials for fluids, lubricants, aircraft topcoat, and corrosion resistant coatings and specialty treatments to improve system performance and reduce life cycle costs. Test optically tailorable thermal control coatings with controlled heat dissipation for spacecraft thermal control. Evaluate effects of the space environment on polymer and thermal control coatings. Explore electrically conductive elastomers for use in low-observable gap treatments. Establish baseline analytical techniques to predict the optical properties of specialty coatings. Process permanent corrosion resistant primer resins and environmentally safe corrosion protection with a 30-year life for aircraft surfaces. Identify nanostructured multifunctional coatings to control friction and wear in extreme operating environments. Evaluate surface treatments for friction, stiction, and wear control in micro-scale devices and micromechanical applications.

(U) $15,778 Develop and transition affordable lightweight metallic materials, behavior and life prediction technologies, higher temperature intermetallic alloys, and metals processing technology to enhance performance, lower acquisition cost, increase durability, and improve reliability for weapon systems. Demonstrate life prediction methodology and surface treatments needed to prevent High-Cycle Fatigue damage in integrally bladed rotors. Characterize high temperature metallic alloys with the potential of achieving a 300°F temperature capability increase over current turbine blade materials. Refine damage-tolerant life prediction methodologies for high temperature resistant titanium alloy for their use in fracture-critical turbine engine applications. Develop advanced affordable process technologies to enable more affordable production of complex structural metal components for air and space vehicles. Develop processing methods for the metallic materials for lightweight, high-strength components in future space vehicles.

(U) $4,142 Develop ceramics and ceramic matrix composite technologies for enhanced performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures. Evaluate ceramic composites for exhaust and hot section components under real and simulated service life conditions, with a focus toward life prediction and durability assessment. Develop highly durable thermal protection materials for aerospace vehicles with aircraft-like operability. Develop ceramic composites for lightweight space mirror applications. Identify best performing aircraft brake material and perform full-scale dynamometer tests. Optimize radar absorbing material coating repair for superalloy and/or titanium alloy substrates. Evaluate advanced oxidation-resistant interface coatings in severe applications. Initiate development of more durable ceramic composites based on these new coatings.

(U) $46,749 Total

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(U) B. Project Change Summary
Not Applicable.

(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 June 2001
BUDGET ACTIVITY 02 - Applied Research					PE NUMBER AND TITLE 0602102F Materials						PROJECT 4348
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4348	Materials for Electronics, Optics, and Survivability	4,655	12,408	9,051	9,444	9,157	8,802	7,734	7,955	Continuing	TBD

(U) A. Mission Description

Develops materials technologies for surveillance and terrestrial situational awareness systems and subsystems for aircraft, missile, and space applications. Develops materials for protection of aircrews, sensors, aircraft, and space systems from laser and high power microwave directed energy threats. Develops sensor modules, microwave devices, infrared detectors, and infrared countermeasures (IRCM) devices are used in target detection, weapons targeting, electronic warfare, and active aircraft protection. Electronic and optical materials are being developed to enable surveillance and terrestrial situational awareness with higher operating speeds, greater tunability, higher output power, improved thermal management (including higher operating temperatures), greater sensitivity, and extended dynamic range. Materials are being developed to counter the most prominent threat laser wavelengths and new materials are being developed to respond to emerging threat wavelengths and ultimately to reject the directed energy independent of agile threat wavelengths, without impairing mission effectiveness. Note: In FY 2001, Congress added $3.0 million for advanced physical vapor transport growth process for silicon carbide components and $0.5 million for infrared (IR) detectors, radio frequency (RF), and power electronics which explains the perceived decrease in FY 2002.

(U) FY 2000 ($ in Thousands)

(U) $98 Developed and transitioned materials technology base to enhance the safety and survivability of aircrews against heat seeking IR missile threats. Determined viability of new ferroelectric nonlinear-optical 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) $3,696 Developed and transitioned materials technology base to enhance the safety and survivability of aircrews against laser threats. Developed second generation, nonlinear absorbers as infrared materials. Validated stepped limiter device. Demonstrated damage tolerant, biological limiter host materials for protection of personnel eyes, viewing systems, and night vision goggles.

(U) $861 Developed and transitioned enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensor systems against laser threats. Identified 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) $4,655 Total

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $5,558 Develop materials and process technologies for power control and microwave devices to provide improved performance, affordability, and operational capability of 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 materials with improved performance at and above the X-band wavelength region to enable improved power control devices. Evaluate sensor materials for defect density, doping, and stoichiometry through advanced process control techniques.

(U) $3,268 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) $2,870 Develop materials technology to enhance the safety and survivability of aircrews against heat seeking IR missile and laser threats. Develop new nonlinear-optical materials to replace state-of-the-art lithium niobate for infrared countermeasure 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) $712 Develop 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 for laser eye protection.

(U) $12,408 Total

(U) FY 2002 ($ in Thousands)

(U) $2,264 Develop and demonstrate materials and process technologies for power generation, power control, and for microwave components to provide improved performance, affordability, and operational capability for surveillance, targeting/tracking, situational awareness, and lethal and non-lethal weapon systems. Develop and demonstrate materials and materials processing technologies to enable increased power generation and power control components reliability and temperature capability while reducing power consumption, weight, cost, cooling, complexity, and size. Develop and demonstrate materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic counter measures systems. Develop materials and materials process technologies for ultra-lightweight, ultra-high power aircraft electrical generators enabling airborne lethal and non-lethal directed energy weapons in fighter-sized aircraft.

(U) $2,408 Develop and demonstrate IR detector materials and materials processing technologies to enable improved performance, affordability, and

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

operational capability of surveillance, tracking, targeting, and situational awareness systems. Develop alternative infrared (IR) detector materials for space applications capable of detecting very long wavelengths. Develop the process control required for growth of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Validate new processing techniques to improve IR detector materials yield and affordability in small lots.

(U) $3,714 Develop and demonstrate materials technology to enhance the safety and survivability of aircrews and related assets against heat seeking missiles and laser threats. Demonstrate improved growth and processing techniques for large nonlinear crystals for generating higher power far-IR laser radiation for advanced infrared countermeasures. Develop and validate materials processing techniques and materials that will enable high performance optical control of phased array radar and satellite to satellite data links. Identify and characterize organic materials with large nonlinear absorption properties for the protection of personnel eyes, viewing systems, and night vision goggles.

(U) $665 Develop enabling materials technologies to enhance the survivability and mission effectiveness of aerospace sensors, viewing systems, and night vision goggles against laser threats. Develop liquid crystal materials for autonomous tunable filters to block agile laser wavelengths. Evaluate high optical density, multiple wavelength switchable filter stacks on curved substrates for agile laser wavelength eye protection.

(U) $9,051 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 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

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(U) <u>E. Schedule Profile Continued</u>

(U) Not Applicable.

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COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4349 Materials Technology for Sustainment	20,435	20,475	19,945	20,238	20,326	20,716	21,283	21,888	Continuing	TBD

(U) A. Mission Description

Develops and transitions materials and materials processing technologies to support operational Air Force mission areas by providing the ability to inspect the quality of delivered systems, transitioning more reliable and maintainable materials, establishing capability to detect and characterize performance threatening defects, characterizing materials processes and properties necessary for materials transition, and providing quick reaction support and failure analysis to the operational commands and repair centers. Develops repair techniques and nondestructive inspection/evaluation (NDI/E) methods that are needed for metallic and non-metallic structures, coatings, corrosion control processes, and to support integration of composite structures for space and aircraft systems. Various NDI/E methods are essential to ensure optimum quality in the design and production of aircraft, spacecraft, propulsion, and missile systems. These NDI/E methods are also essential to monitor and detect the onset of any service-initiated damage and/or deterioration due to aging of operational systems. Note: In FY 2001, Congress added $1.0 million for weathering and corrosion on aircraft surfaces and parts.

(U) FY 2000 ($ in Thousands)

(U) $7,055 Developed and transitioned 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. Demonstrated enhanced laser generated ultrasound capabilities to detect the onset of hidden corrosion between metallic structural elements for aging aircraft structures. Established design and laboratory scale baseline feasibility capability to evaluate remote inspection capabilities for crack detection within complex structures. Identified 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) $2,454 Developed 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. Identified NDI/E point inspection device requirements to verify repair quality. Established the baseline criteria for an integrated low-observable repair kit. Fabricated high temperature and/or ultraviolet (UV) gap sealants and conductive elastomers. Evaluated 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) $10,926 Developed and transitioned 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. Provided failure analysis and materials investigations for field, acquisition, and depot organizations. Developed alternative wiring and connector technologies and investigate new techniques for analyzing structural failures of replacement materials for aging Air Force systems. Measured and characterized high cycle

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

fatigue (HCF) foreign object damage (FOD) propagation values for turbine engine blade materials and transitioned to industry military handbook 5 (MIL-HDBK 5), the primary source of static design allowables for metallic materials and structural elements (fasteners). Developed 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. Tested 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) $20,435 Total

(U) FY 2001 ($ in Thousands)

(U) $4,401 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) $2,979 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 gap sealants and conductive elastomers. Develop ultrasonically applied and/or removed thermoplastic radar absorbing material (RAM) repairs, high temperature RAM coating repairs, and radar absorbing structure field level repairs.

(U) $4,727 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 protection materials technologies for space and low-observable applications. Evaluate testing techniques needed for analyzing structural failures of replacement materials for aging Air Force systems.

(U) $8,368 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 HCF and 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

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

emerging materials used in operationally fielded Air Force systems. Validate technical understanding of corrosion.

(U) $20,475 Total

(U) FY 2002 ($ in Thousands)

(U) $4,473 Develop non-destructive inspection/evaluation (NDI/E) technology to identify and characterize damage in complex, low-observable materials and structures. Develop inspection technology for aging aerospace structures and propulsion systems. Identify methods to rapidly detect and characterize multi-site damage and cracks in large area, aging structures. Identify computer simulations and models of NDI/E technique response which will enable the development of improved inspections in a virtual environment to permit the depots to rapidly assess the potential of new corrosion and crack detection NDI/E methods. Develop transition methods to measure residual stress to allow depots to safely extend the service life of turbine engine rotors. Identify and develop methods to detect and characterize the severity of fretting fatigue in engine components. Identify NDI/E methods to characterize the low-observable properties of paints and coatings during and after application.

(U) $3,128 Develop enabling technologies to reduce the Air Force maintenance burden due to low-observable requirements. Develop capability for NDI/E point inspection devices and verify repair quality. Evaluate an integrated low-observable repair kit. Validate high temperature and/or ultraviolet gap sealants and conductive elastomers. Demonstrate ultrasonically applied and/or removed thermoplastic radar absorbing material (RAM) repairs, high temperature RAM coating repairs, and radar absorbing structure field level repairs.

(U) $4,803 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. Continue certification and transition of emerging electrostatic discharge protection materials technologies and techniques for space and low-observable applications. Continue experimental evaluation of testing techniques needed for analyzing structural failures of replacement materials for aging Air Force systems.

(U) $7,541 Develop support capabilities, information, and processes to resolve problems in the use of materials, in the repair of aircraft structures and to reduce aircraft corrosion. Validate residual stresses baseline criteria of high cycle fatigue foreign object damage in turbine engine blade materials. Demonstrate advanced composite materials compatibility with laser effluents as an alternative to metallic materials for high energy chemical oxygen-iodine laser devices. Evaluate improved gap-filler materials for low-observable platforms and test on-aircraft processed adhesive and patch repair of high-temperature composite aircraft structures. Demonstrate capabilities to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Establish baseline for improved corrosion management procedures.

(U) $19,945 Total

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(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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DATE **June 2001**

BUDGET ACTIVITY **02 - Applied Research**

PE NUMBER AND TITLE **0602102F Materials**

PROJECT **4915**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4915 Deployed Air Base Technology	0	0	1,419	2,249	2,142	2,417	2,486	2,556	0	0

Note: In FY 2002, the deployed air base technology efforts in PE 0602201F, Aerospace Flight Dynamics, Project 4397, Air Base Technology, are transferred into this PE in Project 4915, Deployed Air Base Technology.

(U) A. Mission Description

Supports the air expeditionary forces (AEF) through development of new technologies for deployable airbase systems to reduce airlift, setup times, manpower requirements, and sustainment costs. Develops efficient and cost-effective technologies to provide force protection and survivability, including fire fighting, to AEF deployed warfighters. Develops affordable, deployable technologies that ensure military readiness, maintain aerospace missions, support weapon systems sustainment, and ensure deployability.

(U) FY 2000 ($ in Thousands)
(U) $0 This effort was performed in PE 0602201F, Aerospace Flight Dynamics, Project 4397, Air Base Technology, ($1.441 million).
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 This effort was performed in PE 0602201F, Aerospace Flight Dynamics, Project 4397, Air Base Technology, ($4.157 million).
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $892 Develop new deployable airbase systems to reduce airlift, setup times, manpower requirements, and sustainment costs in support of AEF technologies. Develop lightweight, flexible solar cell technologies that improve operating efficiency and reduce sustainment costs of airmobile systems. Develop lightweight, rapidly assembled matting systems to enable rapid expansion of aircraft parking at deployment locations. Develop effective advanced fire fighting agents and equipment to protect deployed warfighters.
(U) $110 Develop affordable, deployable technologies that ensure military readiness, maintain aerospace missions, support weapons systems sustainment, and ensure deployablity. Develop safe, cost-effective disposal of problem AEF wastes for low-observable (LO) material waste treatment.
(U) $417 Develop efficient and cost-effective technologies to provide force protection and survivability to AEF deployed warfighters and materials. Develop atmospheric threat prediction models and deployable sensors systems to protect AEF forces from toxic industrial materials.
(U) $1,419 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602102F Materials**	PROJECT **4915**

(U) B. Project Change Summary
Not Applicable.

(U) C. Other Program Funding Summary ($ in Thousands)
(U) Related Activities:
(U) PE 0603112F, Advanced Materials for Weapon Systems
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy
Not Applicable.

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

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

DATE
June 2001

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602201F Aerospace Flight Dynamics

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	48,870	53,183	97,465	64,274	67,114	66,933	68,931	70,921	Continuing	TBD
2401	Structures	22,635	49,035	32,998	23,329	24,433	24,411	25,170	25,905	Continuing	TBD
2402	Vehicle Equipment	3,744	0	0	0	0	0	0	0	Continuing	TBD
2403	Flight Controls and Pilot-Vehicle Interface	12,213	0	34,711	21,190	22,221	22,132	22,775	23,429	Continuing	TBD
2404	Aeromechanics and Integration	8,837	0	29,756	19,755	20,460	20,390	20,986	21,587	Continuing	TBD
4397	Air Base Technology	1,441	4,148	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, Projects 2402, 2403, and 2404 were combined into Project 2401. Beginning in FY 2002, selected efforts from Project 2401 have moved into Projects 2403 and 2404. Beginning in FY 2002, Project 4397 has moved into PE 0602102F, Project 4915. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

This program investigates, develops, and analyzes aerospace vehicle technologies in the three primary areas of structures, controls, and aeromechanics. First, advanced structures concepts are explored and developed to exploit new materials, fabrication processes, and design techniques. Second, flight control technologies are developed and simulated for both manned and unmanned aerospace vehicles. Third, the aeromechanics of advanced aerodynamic vehicle configurations are developed and analyzed through simulations, experiments, and multidisciplinary analysis. Resulting technologies reduce life cycle costs and improve the performance of existing and future manned and unmanned aerospace vehicles. Note: In FY 2001, Congress added $2.0 million for aeronautical research, and $2.9 million for weapon systems logistics, deployed base systems technology, and force protection.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics

(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.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	45,594	48,775	55,436	
(U)	Appropriated Value	45,718	53,675		
(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	3,360			
	e. Rescissions	-208	-492		
(U)	Adjustments to Budget Years Since FY 2001 PBR			42,029	
(U)	Current Budget Submit/FY 2002 PBR	48,870	53,183	97,465	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to the recent DoD strategy review which increased funding for technologies in space lift and next generation aerospace vehicles for long range strike.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics	PROJECT 2401

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2401	Structures	22,635	49,035	32,998	23,329	24,433	24,411	25,170	25,905	Continuing	TBD

Note: In FY 2001, Projects 2402, 2403, and 2404 were combined into Project 2401. Beginning in FY 2002, selected efforts from Project 2401 have moved into Projects 2403 and 2404.

(U) A. Mission Description

This project develops advanced structures concepts to exploit new materials and fabrication processes and investigates new structural concepts and design techniques. Resulting technologies strengthen and extend the life of current and future manned and unmanned aerospace vehicle structures. Payoffs to the warfighter include reduced weight and cost, as well as improved operability and maintainability of aerospace vehicles. Note: In FY 2001, Congress added $2.0 million for aeronautical research.

(U) FY 2000 ($ in Thousands)

(U) $1,566 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 aerospace vehicle performance. Continued 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) $2,091 Developed unitized composite and metallic concepts that reduce manufacturing costs of future aerospace vehicles. Verified design criteria for translaminar reinforced composites to reduce inspection and repair costs. Developed integrated multidisciplinary design methods to reduce design time.

(U) $1,579 Continued development of multifunctional structures that tailor structural response, and integrated subsystem functionality to reduce system level manufacturing costs and increase tactical performance of future aerospace vehicles. Tested advanced airframe structural integration concepts to detect widespread fatigue and corrosion.

(U) $3,393 Continued 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. Developed turbine engine nozzles that are structurally integrated with the airframe for future aerospace operating vehicles.

(U) $12,302 Extended usable structural lives and/or reduced costs of aging aircraft and unmanned aerospace vehicles with technologies that account for structural life, risk assessment, repairs, and dynamic loads. Structural lives can be extended by development of bonded composite repairs of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2401**

(U) A. Mission Description Continued

(U)	FY 2000 ($ in Thousands) Continued	
		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	Developed an advanced technology assessment capability which serves Air Force leadership in identifying, prioritizing, developing, and demonstrating next-generation aerospace vehicle concepts. Facilitated web-based design environment process by bringing the best ideas to a design without the constraint of time and space.
(U)	$22,635	Total
(U)	FY 2001 ($ in Thousands)	
(U)	$3,742	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 structural 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 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2401**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(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 unmanned air vehicles.
(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 life of aerospace vehicle structures. Concepts under development consist of design, fabrication, and assessment of high temperature composite and metallic aerospace vehicle structures.
(U)	$8,890	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 structural 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)	$2,000	Expand aeronautical research efforts to focus on developing technologies for integrated design solutions for optimal signature, aerodynamics, and sensor performance of future aircraft.
(U)	$49,035	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2401**

(U) A. Mission Description Continued

(U)	FY 2002 ($ in Thousands)	
(U)	$2,859	Develop economic service life analysis for current and future aircraft, enhancing capability, component replacement, and technology direction. Continue development of unitized structural concepts and multidisciplinary optimization methodologies that enhance affordability and decrease vulnerability for current and future aerospace vehicles. Incorporate newly developed analysis tools into life prediction and failure analysis software.
(U)	$5,080	Develop analytical certification methodologies for the incorporation of advanced methods, concepts, and manufacturing technologies into legacy aircraft components and future airframe designs. Improve the air-worthiness certification process for aircraft subjected to dynamic aeroelastic loads with high fidelity models.
(U)	$6,941	Continue development of structural concepts and design and analysis methods that enable the integration of structure with other airframe functions to reduce cost and increase the survivability of future systems. Concepts include adaptive structures for varying moldline, subsystems hardware, and antennae contained within loadbearing structure.
(U)	$18,118	Develop technologies that incorporate advanced materials as well as passive and active cooling to withstand extreme flight environments. Technologies will improve durability of existing and future aerospace vehicle structures resulting in reduced cost and increased life. Concepts include advanced, durable, all-weather thermal protection systems, attachment techniques, vehicle health monitoring and health management, integrated thermal protection systems, hot primary structures, hybrid structures, unitized structures, joining concepts, and cryogenic/non-cryogenic tank structures.
(U)	$32,998	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 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics	PROJECT 2401

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics	PROJECT 2402

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2402 Vehicle Equipment	3,744	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, Project 2402 was moved to Project 2401.

(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 2000 ($ in Thousands)

(U) $1,035 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 model hydrodynamic ram effects on composite fuel tanks.

(U) $767 Developed and evaluated 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) $158 Developed and assessed affordable subsystem technologies that enhance aerospace vehicle safety and reliability, and reduce cost. Continued to develop and assess technologies required to apply electric actuation to manned and unmanned aerospace vehicles.

(U) $1,784 Developed and assessed technologies for aerospace vehicle energy management systems and components to reduce vehicle size and weight by developing high efficiency, lightweight thermal energy components and advanced heat transport techniques.

(U) $3,744 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 2401.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort moved to Project 2401.

(U) $0 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE **June 2001**
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2402**

(U) **C. Other Program Funding Summary ($ in Thousands)**
(U) Related Activities:
(U) PE 0603106F, Logistics Systems 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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602201F Aerospace Flight Dynamics	2403

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2403 Flight Controls and Pilot-Vehicle Interface	12,213	0	34,711	21,190	22,221	22,132	22,775	23,429	Continuing	TBD

Note: In FY 2001, Projects 2402, 2403, and 2404 were combined into Project 2401. Beginning in FY 2002, selected efforts from Project 622401 have been moved into Projects 2403 and 2404.

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)

(U) $3,197 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. Completed flight demonstration of optical air data system and transitioned the capability to the user. Continued development of advanced vehicle management system architecture concepts and identified key component demonstrations.

(U) $2,813 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 on-board pilot-induced oscillation prevention.

(U) $2,470 Developed capabilities to evaluate technologies for increased aerospace vehicle performance and decreased vulnerability and cost, and improved probability of mission success. Conducted mission technology assessments for manned vehicles and unmanned aerospace vehicles; determined design guides for effective mission management systems. Conducted aerospace vehicle technology simulations and identified controllability boundaries for safe aerospace vehicles flight.

(U) $3,733 Continued to develop control technology for the autonomous maneuvering of unmanned aerospace vehicles in the terminal area to improve flight safety and combat effectiveness. Developed and integrated high integrity, four-dimensional precision trajectory generation and control algorithms. Continued 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) $12,213 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2403**

(U) A. Mission Description Continued

(U)	FY 2001 ($ in Thousands)	
(U)	$0	Effort moved to Project 2401.
(U)	$0	Total
(U)	FY 2002 ($ in Thousands)	
(U)	$3,982	Develop and assess advanced control mechanization technologies to provide highly reliable operation for manned and unmanned systems at significantly reduced size, weight, and cost. Complete laboratory demonstrations of fiber optic-based vehicle management system and optical air data system components. Develop validation and verification techniques for complex, adaptive, and autonomous control software. Assess control mechanization technologies for extending the effective life of legacy aircraft.
(U)	$8,938	Develop and assess control automation techniques and algorithms to enable the safe and interoperable application for formations of manned and unmanned vehicle systems. Concepts will also provide mission responsiveness and adaptability for improved operational effectiveness of manned and unmanned systems. Continue development and test of intelligent-agent software providing package-level coordination and health monitoring and management for aerospace vehicles. Continue the simulation analysis of automated aerial refueling system technologies. Complete analysis and specification of on-board sensor suite for safe operation of unmanned vehicles in proximity of other manned and unmanned air vehicles.
(U)	$6,657	Develop new flight control design methods and criteria that provide air combat advantage by increasing performance and decreasing vulnerability and cost. Continue development of new intelligent/learning reconfigurable controller to enable continued air vehicle operation in the event of damage or failure. Integrate with on-line route planner and systems diagnostics for unmanned vehicle fault tolerant, autonomous operations. Develop integrated adaptive guidance and control systems for high and ultra-high speed aerospace vehicles.
(U)	$6,199	Develop advanced flight control technology to enable aircraft-like operations for affordable on-demand military access to space. Continue development and analysis of affordable, lightweight vehicle/health monitoring and management systems, integrated with critical guidance and navigation algorithms for high and ultra-high speed aerospace vehicles. Develop parameters for health monitoring and management data collection, and develop prognostic algorithms.
(U)	$8,935	Assess the value of air vehicle technologies to future aerospace systems through the development and utilization of in-house tools, systems, and processes for simulation-based research and development. Continue development of virtual simulations for unmanned air vehicles (UAVs) used in validating autonomous control algorithms for mixed manned and UAV operations. Enhance simulation and analysis capabilities to project life cycle cost impacts. Develop the capability to virtually simulate mission utility of next generation aerospace vehicles for long range strike.
(U)	$34,711	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2403**

(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 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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602201F Aerospace Flight Dynamics	2404

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2404	Aeromechanics and Integration	8,837	0	29,756	19,755	20,460	20,390	20,986	21,587	Continuing	TBD

Note: In FY 2001, Projects 2402, 2403, and 2404 were combined into Project 2401. Beginning in FY 2002, selected efforts from Project 2401 have moved into Projects 2403 and 2404.

(U) **A. Mission Description**

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

(U) FY 2000 ($ in Thousands)

(U) $1,344 Conducted aerodynamic design, analysis, test, and performance assessments of advanced tactical transport aircraft and aerospace vehicles consistent with signature and cost constraints.

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

(U) $4,107 Developed and demonstrated affordable fixed-wing vehicle aerodynamic technologies to increase aerospace performance and decrease vulnerability. Continued development of aerodynamic and structural integration including flow control in payload bays.

(U) $8,837 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moved to Project 2401.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **2404**

(U) A. Mission Description Continued

(U)	FY 2002 ($ in Thousands)	
(U)	$11,137	Develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions to reduce life cycle cost and decrease human risk. Complete development of tools and techniques for predicting and optimizing aerodynamic performance and survivability of long duration unmanned aerospace vehicles. Continue preliminary development of conformal inlet designs that improve airflow to engines while providing low signature for increased survivability. Continue development of signature compatible, high lift wings for long duration surveillance missions.
(U)	$3,794	Develop design tools that permit quicker and more affordable certification of aerodynamic enhancements to extend the operational life of the current fleet. Continue development of analysis tools to accelerate the aerodynamic integration of new and existing weapons with current aircraft to enhance their warfighting ability. Continue to enhance computer design and analysis code that reduces the need for expensive flight-testing.
(U)	$10,231	Develop and assess aerospace technologies that enable ultra-high speed flight and low-cost access to orbit to permit global reach. Complete comparative analyses of aerospace vehicle configurations for next generation long range strike to project global power from CONUS bases. Explore integrated airframe concepts for high-speed aerospace vehicles. Continue investigation into techniques to generate and control plasma flow field over high-speed vehicles to significantly reduce drag. Develop computational, multidisciplinary, experimental and analytical tools to simulate and control the flow fields around advanced concepts for ultra-high speed aerospace vehicles in extreme flight environments. Continue development of complex configurations that mitigate the extreme thermal environment under which high speed aerospace vehicles operate. Develop techniques to carry and deploy weapons from high speed aerospace vehicles.
(U)	$4,594	Develop and evaluate critical aeronautical technologies that enable directed energy weapons to be carried on future air vehicles to improve combat effectiveness. Complete analyses of integration of directed energy weapons on the total air vehicle system identifying impacts to the flight control system, secondary power subsystem, and aerodynamic configuration. Complete development of tools that establish the military impact of directed energy weapons when installed on viable air platforms on future engagements. Develop aircraft techniques to enhance energy beam transmission through the complex, turbulent aerodynamic environment surrounding aircraft enabling the use of directed energy weapons from high-speed, maneuvering aircraft.
(U)	$29,756	Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics	PROJECT 2404

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

(U) Related Activities:

(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 June 2001
BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602201F Aerospace Flight Dynamics						PROJECT 4397
COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4397 Air Base Technology	1,441	4,148	0	0	0	0	0	0	Continuing	TBD

Note: Beginning in FY 2002, Project 4397 has moved into PE 0602102F, Project 4915.

(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. Note: In FY 2001, Congress added $2.9 million for weapon systems logistics, deployed base systems technology, and force protection.

(U) FY 2000 ($ in Thousands)

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

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

(U) $120 Evaluated air transportable shelters that are lightweight and suitable for AEF operations. Developed air transportable shelter technologies for aircraft and flightline personnel.

(U) $1,441 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) $634 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.

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

(U) $2,900 Initiate Congressionally-directed effort in weapon systems logistics, deployed base systems technology, and force protection.

(U) $4,148 Total

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BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602201F Aerospace Flight Dynamics**	PROJECT **4397**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Effort moved into PE 0602102F, Project 4915
(U) $0 Total

(U) B. Project Change Summary
Not Applicable.

(U) C. Other Program Funding Summary ($ in Thousands)
(U) Related Activities:
(U) PE 0603211F, Aerospace Structures.
(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
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BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	68,642	66,404	69,080	63,945	69,011	72,252	73,426	75,576	Continuing	TBD
1123	Warfighter Training	16,385	11,846	14,594	11,182	12,722	13,531	14,525	14,957	Continuing	TBD
1710	Deployment and Sustainment	5,651	6,308	8,052	7,468	7,345	7,507	7,708	7,930	Continuing	TBD
1900	Environmental Quality Technology	2,704	0	0	0	0	0	0	0	0	TBD
7184	Crew System Interface & Protection	35,624	37,708	34,124	32,954	37,226	39,194	39,671	40,826	Continuing	TBD
7757	Directed Energy Bioeffects	8,278	10,542	12,310	12,341	11,718	12,020	11,522	11,863	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2000, studies in support of Distributed Mission Training moved from Project 7184 to Project 1123, and the Toxicology Hazards Research program moved from Project 7757 to Project 1710. In FY 2001, efforts in Project 1900 were terminated due to higher Air Force priorities. In FY 2001, Congress added $1.0M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for detection of nosocomial infections. The funding was realigned to PE 0602202F, Project 7757, to align the funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312, Defense Research Sciences. However, the effort is described in PE 0602202F, Project 7757.
FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

This program establishes technical feasibility and develops the technology base for protecting and enhancing human effectiveness for Air Force weapon systems and for operational readiness. The program addresses crew systems interface, crew protection, warfighter training, and deployment and sustainment of forces. The Warfighter Training project focuses on the development and evaluation of new methods and technologies to enhance Air Force training and education. The Deployment and Sustainment project develops and evaluates technologies that will increase weapon systems and force supportability. The Environmental Quality Technology 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. The Crew System Interface and Protection project develops and evaluates technologies that will increase the performance

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BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

(U) A. Mission Description Continued

of humans. The Directed Energy Bioeffects project develops technologies to protect humans from, and enable the military use of, electromagnetic radiation. Note: In FY 2001, Congress added $4.0 million for Solid Electrolyte Oxygen Separator research and $0.4 million for Altitude Protection.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	70,494	62,619	60,301	
(U)	Appropriated Value	71,012	67,019		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-13			
	b. Small Business Innovative Research	-1,674			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-155			
	e. Rescissions	-528	-615		
(U)	Adjustments to Budget Years Since FY 2001 PBR			8,779	
(U)	Current Budget Submit/FY 2002 PBR	68,642	66,404	69,080	TBD

(U) Significant Program Changes:

Increase in FY 2002 is due to increased emphasis on agile laser eye protection.

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BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

PROJECT
1123

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1123 Warfighter Training	16,385	11,846	14,594	11,182	12,722	13,531	14,525	14,957	Continuing	TBD

Note: In FY 2000, studies in support of Distributed Mission Training (DMT) moved from Project 7184 to Project 1123.

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)

(U) $4,927 Researched 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. Developed cockpit sensors, which replicate real world responses to outside stimuli. Explored 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. Completed the development of the threat library, which covers all known threats.

(U) $10,599 Developed 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. Began to develop an internet-based integrated team decision support system. Performed 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. Identified key training and operational knowledge, skills, and tasks, and developed specifications for competency-based training and rehearsal for both DMT and operational flight training.

(U) $859 Developed concepts 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. Implemented a deployable personal agent into an existing distributed

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

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

command and control simulation for training, assessment, and aiding the warfighter.

(U) $16,385 Total

(U) FY 2001 ($ in Thousands)

(U) $5,933 Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. 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) $5,125 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. Begin feasibility study of integrated intelligence, surveillance, and reconnaissance (ISR) data utility for aircrew mission planning, mission operations, and evaluation. Conduct knowledge engineering for ground-based satellite controller training and develop recommendations and a satellite control station exemplar for space-system operator training and performance support, and continue studies to validate integrated command and control aerospace operations centers with the DMT environment.

(U) $788 Develop Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. Develop and implement tools and simulation for training and assessment of performance in two separate command and control information systems. Develop new training and team dynamic protocols to operational users.

(U) $11,846 Total

(U) FY 2002 ($ in Thousands)

(U) $5,028 Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Explore federation connectivity options for training systems operating at different levels of security classification. Develop behavioral models to simulate the threat operators in the command and control chain. Explore PC-based, high-resolution, real-time image generator and ultra-high resolution laser projector concept for DMT simulators.

(U) $6,566 Develop tools and strategies for identifying and improving combat mission training, rehearsal, and operations for distributing training and performance support methods and technology exemplars to operational forces. Research will produce the empirical and analytical basis for better training guidelines when warfighters train in DMT environments. Complete development of methods to identify and validate mission essential competencies for air superiority and global attack, and begin extending methods to new domains of space operations, information warfare,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 1123

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

information operations, and command and control. Develop and validate curriculum for Air Superiority Distributed Mission Training implementation at operational mission training centers, and within large-scale exercises at command and control simulation facilities. Conduct usability assessments of enhanced instructor operator station tools to embed instructional principles in DMT simulations, and complete a 'first look' assessment of operational deployment impacts on retention and decay of mission essential competencies and potential contributions of specific curricula for refresher training in pre- and post-deployment applications at mission training centers.

(U) $3,000 Develop training technologies in command and control centers that support theatre air operations centers. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. Develop tools that will provide real-time performance support with automated remediation leading to a reduction in training costs with no reduction in training effectiveness. Integrate command and control systems into the DMT environment. Develop embedded training tools and simulations for command and control information systems.

(U) $14,594 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

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

(U) E. Schedule Profile Continued

(U) Not Applicable.

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BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602202F Human Effectiveness Applied Research

PROJECT
1710

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1710	Deployment and Sustainment	5,651	6,308	8,052	7,468	7,345	7,507	7,708	7,930	Continuing	TBD

Note: In FY 2000, the Toxicology Hazards Research program moved from Project 7757 to Project 1710.

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)

(U) $300 Developed technologies for improved cargo handling and improved support of space assets to better support weapon systems and reduce logistics support costs. Completed 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) $2,926 Developed logistics readiness and sustainment technology options and performed 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. Identified diagnostic strategies and data requirements to support the advanced prognostic and diagnostic program which will reduce aircraft down time. Developed enabling technology for innovative software architectures for more accurate representation of human behavior in synthetic environments.

(U) $2,425 Demonstrated and applied predictive human health assessment models to accurately characterize the human health risk associated with exposure to operational compounds and materials for force protection. Characterized the health hazard to flight operations personnel exposed to jet fuels (JP-8) and various additive compounds. Developed a science-based standard that accurately reflects the human health consequences of widespread contamination by solvent compounds used in maintenance processes.

(U) $5,651 Total

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

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $1,788 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 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) $1,746 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 technologies 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) $2,774 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. Apply predictive tools to assist fuels developers in rapidly screening various additives for toxicity.

(U) $6,308 Total

(U) FY 2002 ($ in Thousands)

(U) $2,020 Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs. Develop software tools to automatically generate maintenance procedures from weapon system design descriptions. Define functional requirements for theater sustainment and distribution decision support tools. Develop artificial intelligence software architectures for improved depot repair forecasting and more timely efficient home-based support for the warfighter. Develop advanced computer models for representing human cognition in simulations.

(U) $2,130 Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for AEF operations. Conduct feasibility studies and devise preliminary plans for presenting various types of information to maintenance and logistics personnel, such as aircraft status, supply status, and diagnostics data. The focus will be on display techniques for the support of the logistics commanders and their staff. Begin investigating the feasibility of developing a distributed logistics training capability to support the logistics community.

(U) $3,902 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Demonstrate and apply methods to quantify skin toxicity risks from fuels and solvents used in flight operations and maintenance processes. Develop a biologically-based model for validation of exposure standards for Air Force

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

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

missile fuel oxidizer.

(U) $8,052 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 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 June 2001

BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 1900

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1900	Environmental Quality Technology	2,704	0	0	0	0	0	0	0	0	TBD

Note: In FY 2001, efforts in Project 1900 were terminated due to higher Air Force priorities.

(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. The objective is 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 2000 ($ in Thousands)

(U) $945 Developed filtration materials and processes to protect U.S. forces from long-term health consequences from exposure to hazardous materials. Developed advanced filter materials and processes to remove and destroy operationally generated hazardous organic materials and particulate contaminants. Defined warfare agent interaction with Air Force unique materials.

(U) $1,086 Developed integrated materials technologies that demonstrate the capability to identify, monitor, and mitigate/neutralize toxic risks. Developed sensor materials for detection, mitigation, avoidance, and warning of operational toxic materials. Identified tracer emissions for detection and modeling of chemically-based atmospheric threats.

(U) $673 Discovered and characterized novel enzymatic reactions for applications in biotransformations and biocatalytic synthesis of high-performance materials. Explored biotransformation and biocatalytic generation of Air Force unique materials.

(U) $2,704 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 No Activity.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602202F Human Effectiveness Applied Research**	PROJECT **1900**

(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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602202F Human Effectiveness Applied Research	7184

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
7184 Crew System Interface & Protection	35,624	37,708	34,124	32,954	37,226	39,194	39,671	40,826	Continuing	TBD

Note: In FY 2000, studies in support of Distributed Mission Training moved from Project 7184 to Project 1123.

(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 crew-systems interface. It develops and assesses technologies for information display, human-centered information warfare, team communications, and crew scheduling and fatigue management. It conducts experiments and evaluations of control interfaces, crew station layout and functional integration, emergency escape, crash protection, aircrew oxygen systems, acceleration protection, and aircrew life support.

(U) FY 2000 ($ in Thousands)

(U) $3,841 Developed 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. Continued 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. Demonstrated improved control station for uninhabited aerial vehicles. Planned validation of inventory cockpit accommodation maps and complete data analysis of U.S. part of multi-national whole-body three-dimensional survey.

(U) $2,913 Developed cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Completed a cognitive task analysis and identified information requirements for an Information Warfare Watch Center. Demonstrated high-accuracy speech recognition in a fighter test aircraft and demonstrated speech countermeasures in an operational exercise. Integrated and demonstrated voice recognition and laser pointer/tracker technologies with large screen interactive display for command center operations.

(U) $3,712 Developed concepts for integrating human computer interface technologies, human performance modeling tools, and real-time simulations to affordably quantify operational benefit from new interface technologies. Explored new human-computer interface options for future unmanned vehicle control stations. Advanced 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. Began drafting a design notebook for tactical re-supply crew stations.

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

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $4,297 Developed visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and developed an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Visual display interface technologies enhance situational awareness, warfighter performance, combat effectiveness, and survivability. Conducted studies to understand the trade off of night vision goggle optical resolution with field-of-view. Identified ways to increase sunlight readable display efficiency. Conducted study of helmet-mounted display contrast requirements for color recognition.

(U) $2,259 Developed advanced audio displays including three-dimensional audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Conducted a feasibility demonstration of an integrated three-dimensional audio headset with noise reduction and CD quality digital audio. Demonstrated the ability to reduce the acoustic signature for special operations aircraft. Began a program to exploit the use of audio signals to add a new capability for remote threat detection in perimeter defense.

(U) $1,538 Conducted 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. Determined risks for aircrews engaged in unpressurized flight at high altitude for extended periods of time. Investigated performance and comfort issues associated with pressure breathing technology for tactical aviators.

(U) $5,528 Developed human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Defined human impact tolerance limits, and used these to design and validate mathematical or physical models of human response to impact environments. Research focused on full aircrew accommodation issues, including definition of ejection seat haulback/retraction criteria and spinal injury criteria to minimize probability of injury. Evaluated multi-axis head and neck response for the development of tolerance and injury criteria to minimize injury risk during ejection with helmet-mounted devices. Evaluated helmet biodynamic properties in the sustained acceleration environment and assessed the physiological effects of multi-axis maneuvering.

(U) $2,596 Conducted 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. Established feasibility of using newly developed alertness enhancing stimulants in Air Force missions and developed fatigue avoidance mission planning technologies. Characterized spatial disorientation problems related to helmet-mounted displays, night vision goggles, and agile aircraft flight profiles.

(U) $1,634 Developed 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. Developed miniaturized distillation column air separation techniques and cryogenic refrigeration technology and combined designs to generate both nitrogen and oxygen in a single integrated package.

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

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $2,884 Developed solid state electrolyte oxygen generation technologies for aircraft on-board oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Pursued improvements to increase oxygen flow rates, reduce power consumption, and decrease operating temperatures of existing ion conducting ceramics technology. Investigated requirements for utilization and integration of solid state electrolyte oxygen generators as on-board systems.

(U) $3,461 Provided 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) $961 Conducted 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. Established common environment between Australia's airborne early warning and control simulator and the Air Force Research Laboratory's synthesized immersion research simulator for joint experiments. Began to develop an integrated multi-sensory crew station to demonstrate the virtual air commander concept.

(U) $35,624 Total

(U) FY 2001 ($ in Thousands)

(U) $4,188 Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Complete multi-sensory control station and operator workload classification algorithm and incorporate into laboratory demonstration of unmanned aerial vehicle control. 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) $3,280 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 interface for all-source intelligence analysts for faster and more accurate decision-making. Continue research on speech signal processing and speech-based countermeasures for information operations.

(U) $4,377 Develop concepts for integrating human computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefit from new interface technologies. Complete a feasibility evaluation of an integrated control interface for unmanned vehicles, demonstrating multi-vehicle per mission operation. Develop integrated flight path and synthetic terrain concept for primary flight reference on heads-up displays.

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 7184

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $4,367 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. 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) $2,618 Develop advanced audio displays including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. 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 preliminary auditory symbology design criteria for improving situational awareness using 3-D audio displays.

(U) $3,448 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) $6,419 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 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 materials to improve pilot performance by reducing the bulk, weight, and thermal burden of existing acceleration protection ensembles.

(U) $3,963 Develop solid state electrolyte oxygen generation technologies for aircraft and ground-based oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Continue research to improve oxygen production efficiency, lower power consumption, lower operating temperature, and improve thermal management concepts. Design, fabricate, and conduct laboratory testing of solid state electrolyte oxygen generator concepts.

(U) $3,165 Provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(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) $1,487 Conduct international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Perform international laboratory experiment in each country using real-time simulators employing 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) $396 Conduct altitude protection 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. Continue studies to quantify altitude decompression sickness risk for special operations and combat search and rescue missions in unpressurized aircraft.

(U) $37,708 Total

(U) FY 2002 ($ in Thousands)

(U) $4,231 Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Determine the feasibility of extending real-time workload classification technology into unmanned combat aerial vehicle operations, and evaluate reduced crew operation in a multi-sensory unmanned aerial vehicle control station. Complete databases for cockpit accommodation and NATO three-dimensional human population as core elements for an intelligent, on-line physical accommodation information system to optimize equipment fit. Perform laboratory experiments using a virtual air command station to determine human interface design requirements for airborne early warning and control.

(U) $5,237 Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Continue to devise user-computer interface concepts for intelligence analysts, investigate a display interface for integrated asset management, analyze decision-support aids for Air Operations Centers, and provide a laboratory demonstration of a rapid shared display for command center situation awareness. Begin analysis and definition of human-machine interfaces and decision support tools for global attack. Begin development of operator interface concepts and descriptive performance metrics in support of the Targets Under Trees program. Continue research on speech signal processing and speech-based countermeasures for information operations, including a concept demonstration of an intelligent voice jammer.

(U) $4,424 Develop concepts for integrating human computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefit from new interface technologies. Produce design guidelines for an integrated control interface for unmanned

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

vehicles. Continue to develop operator-vehicle interface concepts for exploiting real-time, off-board data and demonstrate payoffs for mobility/special operations missions in laboratory simulations. Complete a feasibility evaluation for validating a digital model of human decision-making behavior.

(U) $4,412 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Conduct study on replacing the heads-up display with a helmet-mounted display, establish color contrast guidelines, and develop frames of reference and symbology for attitude displays. Establish design guides for windscreens and night vision displays. Determine resolution and brightness requirements for large flat-panel displays.

(U) $2,837 Develop advanced audio displays including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Plan system integration and laboratory test as initial implementation for an acoustic remote threat detection in perimeter defense. Conduct research on (50 dB) hearing protection technologies for improved performance in high performance aircraft. Develop human performance standards for helmet-mounted cueing systems in vibratory environments.

(U) $1,400 Complete 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) $1,000 Develop integrated human-centered information warfare technologies to assess and predict human performance under information warfare conditions and to influence an adversary's decision-making function. This research will provide information warriors with human perception management tools and the means to evaluate the effectiveness of information warfare strategies on the human target set. Cognitive modeling efforts will model effects of cross-cultural communications on human decision-making behavior. Auditory and visual technologies will be applied to develop perception management tools for offensive counter-information applications.

(U) $3,306 Develop human injury and protective systems design criteria for use against hazards encountered in crash environments and emergency escape. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including crashes, emergency escape, and parachute opening shock. Begin developing injury assessment toolbox to be used in conducting injury risk assessment on personal protection and life support equipment, and seat and cockpit systems. Develop analysis techniques for evaluating data from ejection seat recorder. Conduct laboratory studies on adaptable restraint system technologies for application across Air Force airlift aircraft.

(U) $7,277 Develop aviation safety technologies to alleviate/mitigate 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

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

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

global attack missions. This research will also reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Extend fatigue management technologies to provide operational commanders and mission planners with the capability to evaluate effects of alternative applications of performance enhancing pharmacological agents and non-pharmacological fatigue countermeasures on crew performance and mission effectiveness. Conduct spatial disorientation countermeasures research efforts to improve primary flight displays and reduce pilot workload through development of more intuitive symbology and improve pilot training through development of ground-based and flight-based spatial orientation training practices. Focus acceleration protection research efforts on defining physiological and performance effects of thrust-vectored flight and assessing the effects of pharmaceutical fatigue countermeasures and current and emerging operational biological prophylactic agents on flight safety and pilot effectiveness in the high performance/high demand cockpit of modern fighter aircraft.

(U) $34,124 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.
(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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602202F Human Effectiveness Applied Research	7757

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
7757 Directed Energy Bioeffects	8,278	10,542	12,310	12,341	11,718	12,020	11,522	11,863	Continuing	TBD

Note: In FY 2000, the toxicology hazards research program moved from Project 7757 to project 1710. In FY 2001, Congress added $1.0M to PE 0601102F, Defense Research Sciences, to develop rapid diagnostic and fingerprinting techniques along with molecular monitoring systems for detection of nosocomial infections. The funding was realigned to PE 0602202F, Project 7757, to align the funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0601102F, Project 2312, Defense Research Sciences. However, the effort is described in PE 0602202F, Project 7757.

(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 2000 ($ in Thousands)

(U) $3,136 Conducted laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while researching countermeasures for optical hazards/threats, with and without laser eye protection. Pursued assessments/evaluations of foreign directed energy weapons to better define threats and countermeasures. Initiated 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. Explored optical technologies to achieve information warfare dominance.

(U) $4,611 Conducted radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy weapons, communications, and radar. Provided data on cancer development and birth defects for revised human exposure standard for ultra-wide band pulsed microwaves. Began Air Expeditionary Force Agile Combat Support Initiative for portable High Energy Microwave Active Denial Technology. Conducted wave propagation modeling for information warfare applications.

(U) $531 Evaluated Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collected and analyzed first year post-operative data.

(U) $8,278 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 7757

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$4,123	Conduct laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while researching countermeasures for optical hazards/threats, with and without laser eye protection. 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 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)	$5,923	Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of 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)	$496	Evaluate Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collect and analyze second year post-operative data.
(U)	$0	Develop rapid diagnostic and fingerprintion techniques along with molecular monitoring systems for the detection of noscomial infections.
(U)	$10,542	Total

(U) FY 2002 ($ in Thousands)

(U)	$5,614	Conduct laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while researching countermeasures for optical hazards/threats with and without laser eye protection. Assess bioeffects of agile laser technologies. Provide guidance for non-lethal laser illuminator employment. Demonstrate technologies for safe, active lasing in aircrew simulators, supporting improved engagement tactics, countermeasures, and laser safety training requirements.
(U)	$5,848	Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of electromagnetic energy for directed energy weapons, non-lethal weapons, communications, and radar. Evaluate celluar damage and behavioral/cognitive disruption from pulsed radio frequency emitters. Continue health and safety studies on millimeter waves. Improve technology and models for radio frequency exposure prediction, assessment, and hazard warning.
(U)	$300	Conclude post-operative evaluation and issue interim recommendations on the study of Photorefractive Keratectomy as a surgical method to reduce aircrew need for glasses or contact lenses.
(U)	$548	Develop safety design criteria for portable Active Denial Technology in support of the Air Expeditionary Force/Agile Combat Support initiative,

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

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

enabling safe exploitation of directed energy weapons. Research and resolve human safety, control, and pointing and tracking issues of directed energy. Verify the non-harmful effects of the active denial technology. Develop safety design criteria for directed energy systems using validated computer model.

(U) $12,310 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:
(U) PE 0602720A, Environmental Quality Technology.
(U) PE 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 **June 2001**

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602203F Aerospace Propulsion

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	76,285	123,618	149,211	136,547	138,807	139,478	143,173	146,919	Continuing	TBD
3012	Advanced Propulsion Technology	0	0	21,585	7,041	7,491	7,801	8,002	8,212	Continuing	TBD
3048	Fuels and Lubrication	11,247	8,735	9,645	14,345	14,402	14,637	15,022	15,416	Continuing	TBD
3066	Turbine Engine Technology	38,979	41,705	41,387	40,405	38,528	35,450	36,418	37,370	Continuing	TBD
3145	Aerospace Power Technology	26,059	28,002	21,583	24,113	24,216	24,512	25,162	25,819	Continuing	TBD
4847	Rocket Propulsion Technology	0	45,176	55,011	50,643	54,170	57,078	58,569	60,102	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.
As of FY 2001, all rocket propulsion efforts previously performed in PE 0602601F, Project 1011, Rocket Propulsion Technology, were transferred to Project 4847 in order to align projects with the Air Force Research Laboratory organization.
In FY 2001, efforts formerly in PE 0602269F, Project 1025, Hypersonic Technology Program, were shifted to PE 0602203F, Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B. In FY 2002, the Hypersonic Technology Program work performed in PE 0602203F, Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B will be transferred to Project 3012 in order to align projects with the Air Force Research Laboratory organization.
In FY 2001, Congress added $12.6M and $11.1M to PE 0305182F, Spacelift Range System, to activate Rocket Test Stand 1D and upgrade Rocket Component Test Stand 2A, respectively, at Edwards Air Force Base, California. In FY 2001, the funding was realigned to PE 0602203F, project 4847, to align funding with the appropriate PE for this effort. The funding database has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0305182F, Project 4137, Range Standardization and Automation. However, this effort is described in Project 4847.

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

DATE
June 2001

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602203F Aerospace Propulsion

(U) A. Mission Description

The Aerospace Propulsion program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has five projects, each focusing on a technology area critical to the Air Force: 1) The Turbine Engine Technology project develops enabling capabilities to enhance performance and affordability of existing weapon systems. Turbine Engine Technology project efforts are part of the Integrated High Performance Turbine Engine Technology (IHPTET) program; 2) The Rocket Propulsion Technology project pursues advances in rocket technologies for space access and maneuver, and tactical and strategic missiles. Rocket Propulsion Technology project efforts are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program; 3) The Aerospace Power project develops efficient energy storage and generation techniques for ground, air, and space military applications; 4) The Fuels and Lubrication project develops new concepts and technologies to power, cool, and lubricate new and existing engines; and 5) The Advanced Propulsion Technology project develops combined cycle and advanced airbreathing hypersonic propulsion technologies to enable revolutionary propulsion options for the Air Force. Note: In FY 2001, Congress added $0.8 million for Fuels and Lubricants; $3.8 million for magnetic bearing cooling turbine; $2.6 million for Poly (p-phenylene-2,6-benzobisoxazole) (PBO) Membrane Fuel Cells; $1.8 million for Variable Displacement Vane Pump (VDVP); $3.5 million for Hypersonic Electric Power System; and $1 million for Lithium Ion battery.

(U) B. Budget Activity Justification

This program is in Budget Activity 2, Applied Research.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	77,007	116,262	127,333	
(U)	Appropriated Value	77,712	124,762		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-38			
	b. Small Business Innovative Research	-1,763			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	1,029			
	e. Rescissions	-655	-1,144		
(U)	Adjustments to Budget Years Since FY 2001 PBR			21,878	
(U)	Current Budget Submit/FY 2002 PBR	76,285	123,618	149,211	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**

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

(U) Significant Program Changes:

Note: Changes to this program since the previous Presidents Budget are due to PE realignments to align projects with the Air Force Research Laboratory organization. Fiscal Year 2002 increases are also due to the recent DoD strategy review which increased funding for hypersonic and rocket propulsion technologies to enable fuller dominance of space.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 3012

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3012 Advanced Propulsion Technology	0	0	21,585	7,041	7,491	7,801	8,002	8,212	Continuing	TBD

Note: In FY 2002, the Hypersonic Technology Program work formerly performed in Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B has been transferred to Project 3012 in order to align projects with the Air Force Research Laboratory organization.

(U) A. Mission Description

The Advanced Propulsion Technology project develops combined/advanced cycle airbreathing hypersonic propulsion technologies to enable revolutionary propulsion options for the Air Force. These new engine technologies will enable future high-speed weapons, aircraft, and space launch concepts. The primary focus is on hydrocarbon fueled engines capable of operating over a broad range of flight Mach numbers. Technologies developed under this program enable capabilities of interest to both Department of Defense and National Aeronautical and Space Administration (NASA). Efforts include modeling and simulation, proof of concept demonstrations of critical components, advanced component development, and ground-based demonstrations.

(U) FY 2000 ($ in Thousands)
(U) $0 This work was performed in PE 0602269F, Project 1025.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 This work is performed in PE 0602203F, Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $14,500 Demonstrate advanced hydrocarbon scramjet engine technology to enable fuller dominance of space. Conduct detailed analysis for mating scramjet flight ready engine with flight demonstrator vehicle. Perform trajectory optimization for flight test. Complete design and component development. Initiate fabrication of flight-ready hydrocarbon fueled scramjet engine, including flight weight fuel cooled structures, flight weight fuel control valves, fuel pump, and engine controller. Evaluate options for scramjet start, including gas generator / heat exchanger system, barbotage fuel injection with plasma ignition, and silane injection with a mechanical throat or air throttle. Demonstrate flight weight scramjet start system. Verify operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation.
(U) $1,422 Conduct assessments, system design trades, and simulations to integrate combined and advanced cycle airbreathing hypersonic propulsion technologies into future missiles, manned and unmanned air vehicles, and access to space concepts. The goal is to improve warfighting

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT **3012**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

capability and meet Air Force Global Reach/Power needs. Conduct system trade studies to determine military payoff and establish component technology goals. Define component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and the Defense Advanced Research Projects Agency (DARPA).

(U) $3,050 Conduct proof-of-concept demonstrations of critical components for advanced and combined cycle engines. Design, fabricate, and test sub-scale inlet/combustor/nozzle to identify coupling between engine operating modes and investigate transition between modes. Design and fabricate components capable of withstanding severe temperature and acoustic environments, and demonstrate component structural integrity. Demonstrate flight-type scramjet engine operation and performance over a broad flight speed envelope.

(U) $2,113 Design flowpath for advanced and combined cycle engines to demonstrate operation and performance over a broad flight speed envelope. Initiate design of advanced and combined cycle engines components for incorporation into advanced and combined cycle demonstrator engines.

(U) $500 Develop plasma ignition system coupled with necessary power source, power conditioning, and control system to eliminate need to pre-heat fuel or use silane combustion aid. Investigate magnetohydrodynamic power generation and extraction from a hydrocarbon fueled scramjet flow path to provide energy for directed energy weapons and plasma generation for hypersonic vehicle drag reduction and scramjet combustion enhancement.

(U) $21,585 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 0602201F, Aerospace Flight Dynamics.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702E, Tactical Technology.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0603601F, Conventional Weapons Technology.
(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

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BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT **3012**

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

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT 3048

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3048 Fuels and Lubrication	11,247	8,735	9,645	14,345	14,402	14,637	15,022	15,416	Continuing	TBD

(U) A. Mission Description

The Fuels and Lubrication project develops improved fuels, lubricants, and combustion concepts for advanced turbine engines, scramjets, and combined cycle engines. Systems applications include missiles, aircraft, and hypersonic vehicles for space access. Fuels and lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Analytical and experimental areas of emphasis include fuels and fuels logistics; advanced combustion and propulsion concepts; and lubricants, bearings, electromagnetic rotor, and oil-less engine technology. Note: In FY 2001, Congress added $0.8 million for Fuels and Lubricants.

(U) FY 2000 ($ in Thousands)

(U) $4,176 Developed and tested high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emission and signatures for aerospace systems. This technology results in reduced fuel system fouling/coking (reduced maintenance costs); provides cooling for increased heat load generated by avionics, engines, and other vehicle subsystems; enables reduced fuel consumption (supportability); and reduces vehicle pollutant emissions and signatures (reduced environmental impact and minimized vulnerability). Formulated low-cost fuel additives that increased the thermal stability of jet fuel by 225 degrees Fahrenheit and heat sink by five-fold. In addition, formulated low-cost fuel additives that reduced pollutant emissions (particulates) by 50%. Evaluated additives in small-scale laboratory devices.

(U) $3,551 Designed, evaluated, and matured high-performance, low-emissions, robust combustor concepts for advanced airbreathing engines. Matured Trapped Vortex Combustor technology to provide dramatically improved thrust-to-weight, reduced development, production, and maintenance cost, and lower fuel consumption. Transitioned trapped vortex technology to full-annular combustor design. Conducted breadboard pulse detonation engine testing and model development to quantify actual engine performance and military payoffs. Developed and applied advanced laser diagnostics to fundamental flames and advanced military combustors to determine in situ combustor performance.

(U) $3,520 Developed lubrication and systems diagnostics technologies to permit efficient high-speed rotation of turbine engine components. This technology included 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. Fabricated test rigs for full-scale demonstration of magnetic bearings for Integrated High Performance Turbine Engine Technology (IHPTET) Phase III engines. Continued small prototype diagnostic unit development for engine health monitoring.

(U) $11,247 Total

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $2,361 Develop high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emissions and signatures for aerospace systems. Evaluate a low-cost fuel additive in small-scale laboratory devices and a reduced scale fuel system simulator. This additive could increase JP-8 thermal stability by 225 degrees Fahrenheit and heat sink by five-fold. Evaluate low-cost fuel additives in research scale combustors to reduce pollutant emissions (particulates) by 50% in aircraft engines.

(U) $2,917 Develop revolutionary combustion concepts for combined cycle engines and pulse detonation engines. Continue development of novel gas turbine combustor designs including inter-turbine burner. Complete optimization of Trapped Vortex Combustor for inclusion in high performance, low emissions gas turbine engine demonstrators. Conduct preliminary design of pulse detonation engine for military applications. Develop and test multi-tube, high frequency, demonstrator pulse detonation engine to enable high-performance, low-cost propulsion. Demonstrate the inter-turbine burner concept at representative engine operating conditions. Demonstrate advanced optical diagnostic techniques for health monitoring and control of advanced military combustors.

(U) $2,657 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 such as magnetic levitation and solid and vapor lubrication for advanced engines with operating conditions that exceed the capabilities of conventional approaches. Emphasis is placed on demonstrating full-scale magnetic bearing hardware at engine conditions projected for advanced demonstrator engines. Continue maturation of small prototype diagnostic units for engine health monitoring based on evolving needs of near-term production and demonstrator engines.

(U) $800 Develop, formulate, and evaluate affordable advanced fuel additives using novel synthesis techniques, computational chemistry, and bench scale rigs to reduce particulate emissions (i.e., smoke and soot) by 70%, and increase JP-8 fuel high temperature stability to 900 degrees Fahrenheit and low temperature properties to -70 degrees Fahrenheit. The focus is on enhancing aircraft survivability and operating envelope, and reducing maintenance costs. Develop novel magnetic bearings and vapor phase lubrication concepts for advanced lubrication subsystems. Formulate models to simulate advanced lubrication system behavior.

(U) $8,735 Total

(U) FY 2002 ($ in Thousands)

(U) $1,950 Develop low-cost additive approaches to improve fuel properties needed for manned and unmanned systems. Approaches include flow improving additives for low temperature properties to enable replacement of specialty fuels with JP-8; thermal-oxidative and pyrolytic deposit-reducing additives to increase the temperature limit of JP-8 to 900 degrees Fahrenheit; and particulate reducing additives to reduce soot emissions and infrared signature from propulsion systems. Initiate development of computer model based upon chemical structure-activity relationships for fuel additives design and performance modeling.

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U)	$463	Study low-cost approaches to reduce fuel logistics footprint. Screen candidate technologies for fuel field diagnostic techniques. Define improvements in additive packages to reduce logistics footprint.
(U)	$675	Examine hydrocarbon fuel behavior under conditions encountered in combined and advanced cycle engines for low-cost access to space. Determine fuel ignition and combustion properties deficiencies. Study high energy density fuels for combined cycle engine applications. Perform payoff analyses and configuration trade studies to define, focus, and evaluate research in common fuels for future military air and space vehicles. Develop modeling and simulation capability for thermal management systems for aerospace vehicles.
(U)	$2,741	Develop and evaluate combustor and propulsion concepts for gas turbine, pulse detonation, and combined and advanced cycle engines for manned and unmanned systems. Complete optimization of the trapped vortex combustor for transition to demonstrator engines. Identify combustor designs to reduce emissions from gas turbine engines. Demonstrate a highly-swirled ultra-compact combustor for use as the main combustor of a gas turbine engine. Investigate non-traditional thermodynamic cycles and propulsion systems through modeling, simulation, and experimentation. Perform payoff analyses and configuration trade studies to define, focus, and evaluate propulsion technology research for revolutionary combustor and propulsion concepts. Continue the development of pulse detonation engine technology and evaluate performance using hydrocarbon fuel.
(U)	$288	Develop advanced optical and electromechanical diagnostics techniques and devices for fuel systems. Develop revolutionary combustor and propulsion concepts. Investigate pollutant gaseous emissions and particulate formation mechanisms and mitigation techniques in combusting environments.
(U)	$1,503	Conduct research to provide the Air Force with reliable and economical advanced lubricants. Develop advanced bearing and lubricants concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Perform payoff analyses and configuration trade studies to define, focus, and evaluate research in lubricants and mechanical systems for combined cycle engines.
(U)	$2,025	Develop advanced bearing concepts for small- and intermediate-sized turbine and rocket engine applications. Develop electromagnetic rotor support and power generation concepts, components, and materials for advanced, oil-less engines.
(U)	$9,645	Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0601102F, Defense Research Sciences.

(U) PE 0602805F, Dual Use Science and Technology.

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

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE **June 2001**

BUDGET ACTIVITY **02 - Applied Research**

PE NUMBER AND TITLE **0602203F Aerospace Propulsion**

PROJECT **3066**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3066 Turbine Engine Technology	38,979	41,705	41,387	40,405	38,528	35,450	36,418	37,370	Continuing	TBD

Note: In FY 2001, efforts formerly in PE 0602269F, Project 1025, Hypersonic Technology Program, were shifted to PE 0602203F, Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B. In FY 2002, the Hypersonic Technology Program work will be transferred to PE 0602203F, Project 3012, in order to align projects with the Air Force Research Laboratory organization.

(U) A. Mission Description

The Turbine Engine Technology project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, exhaust systems, and structural design. This project supports the Integrated High Performance Turbine Engine Technology (IHPTET) program, a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus turbine propulsion technology on national needs. The program also supports design activities for the next-generation turbine engine development effort, the Versatile, Affordable, Advanced Turbine Engine (VAATE).

(U) FY 2000 ($ in Thousands)

(U) $27,073 Developed core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Completed fabrication and initiated rig testing of state-of-the-art four-stage compressor through use of three-dimensional aeromechanical blading and endwall contours. Completed fabrication of a high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin. Completed blade damping model development which includes three-dimensional shroud contact capability among a spectrum of other friction constraints. Tested an advanced high-work turbine yielding heat transfer characterization for reduced cooling flow and increased durability.

(U) $6,600 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 to provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Fabricated exhaust nozzle hardware capable of fluidic injection deleting the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricated 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. Completed design of a non-linear control system which simplifies control logic development and provides component performance trend data.

(U) $3,576 Developed components for expendable engines for missile and unmanned air vehicle applications to provide expendable engines with reduced

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles.

(U) $1,730 Developed components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Fabricated a splittered, forward swept compressor rotor with high efficiency and high stage loadings that reduces fuel consumption and production and maintenance costs with fewer parts. Fabricated prototype high response air valve for active stability control capability for increased stage loading, reduced stage count, and increased stall margin.

(U) $38,979 Total

(U) FY 2001 ($ in Thousands)

(U) $27,315 Develop core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Complete rig testing of a 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 and three-dimensional features yielding reduced cooling air at higher design operating temperatures.

(U) $7,021 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 to provide aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Rig test exhaust nozzle hardware capable of fluidic injection to delete the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricate contoured ceramic composite exhaust nozzle hardware. Elevate 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 design of the non-linear control system, which simplifies control logic development and provides component performance trend data.

(U) $3,814 Develop components for expendable engines for missile and unmanned air vehicle applications to 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 need for cooling air and higher performance.

(U) $1,844 Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Begin rig testing splittered, forward swept compressor rotor to validate high efficiency, high stage loading design, leading to engines with reduced fuel consumption, fewer parts, and lower production and maintenance.

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $1,711 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) $41,705 Total

(U) FY 2002 ($ in Thousands)

(U) $28,325 Develop core turbine engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, and transports. These components enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycles costs. Design and fabricate a high-pressure ratio compressor including an active stability control system for reduced fuel burn, and high reaction blading and engine stall avoidance techniques for reduced maintenance costs. Develop improved performance, reduced emissions combustor technologies. Conduct analytical and experimental evaluations of combustor aerodynamics, fuel-air mixing, and liner cooling techniques. Develop affordable, robust, lightweight, and compact combustors such as the Integrated Lightweight Combustor or Trapped Vortex Combustor configurations. Conduct environmental and structural evaluation of spar/shell turbine blade with enhanced internal convection, limited transpiration cooling technologies, and three-dimensional features to reduce cooling air at high design operating temperatures. Rig test a non-contacting stress measurement system allowing durable measurement of vibratory response of rotating blades. This technology enables replacements for limited life strain gages, reducing core engine components development and maintenance costs.

(U) $6,967 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 enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Validate the contoured ceramic composite exhaust nozzle hardware in a high temperature environment. Evaluate temperature, pressure, and vibration of integrated components in a demonstrator engine. Complete reliability testing of variable displacement vane pump system to eliminate fuel recirculation to tanks, reduce thermal loading, and increase weapon system thermal capacity. Complete fabrication of the non-linear control system to simplify control logic development and provide component performance trend data.

(U) $3,784 Develop components for limited life engines for missile and unmanned air vehicle applications. These components enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, greatly expanding the operating envelopes of cruise missiles and unmanned vehicles. Rig test a composite forward swept fan for reduced weight, improved efficiency, and lower cost. Rig test low-cost ceramic turbine blades to reduce cooling air and enhance performance.

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $2,311 Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Complete rig testing the splittered, forward swept compressor rotor to validate high efficiency, high stage loading design. The components enable engines with reduced fuel consumption and lower production and maintenance costs.

(U) $41,387 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Materials:
(U) PE 0601102F, Defense Research Sciences.
(U) PE 0602102F, Materials.
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0602122N, Aircraft Technology.
(U) PE 0603210N, Aircraft Propulsion.
(U) PE 0603003A, Aviation Advanced Technology.
(U) This project has been 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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BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602203F Aerospace Propulsion

PROJECT
3145

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3145	Aerospace Power Technology	26,059	28,002	21,583	24,113	24,216	24,512	25,162	25,819	Continuing	TBD

(U) A. Mission Description

The Aerospace Power Technology project develops techniques for efficient energy generation and storage for military ground, air, and space applications. Power component technologies are developed to increase reliability, maintainability, commonality, and supportability of aircraft and flight line equipment. Research in power storage technologies enables the 10-20 year long-term energy storage goals of Air Force unmanned vehicles. Electrical power generation and thermal management technologies are enabling for all future military directed energy weapon systems. This project supports development of very high output power systems suitable for applications to air moving target indication (AMTI) radar, high power lasers for space platforms, and orbiting/maneuvering vehicles. Lightweight power systems suitable for other space applications are also developed. Note: In FY 2001, Congress added $3.8 million for magnetic bearing cooling turbine; $2.6 million for Poly (p-phenylene-2,6-benzobisoxazole) (PBO) Membrane Fuel Cells; $1.8 million for Variable Displacement Vane Pump (VDVP); $3.5 million for Hypersonic Electric Power System; and $1 million for Lithium Ion battery.

(U) FY 2000 ($ in Thousands)

(U) $9,472 Developed power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems to improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. Designed Inverter Converter Controller (ICC) for starter/generator systems that doubles power density, thus enabling the use of these systems on manned and unmanned aircraft. Developed 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) $6,858 Developed thermal management, energy storage and power conditioning components and subsystem technologies for AMTI radar, space-based laser, and orbiting/maneuvering vehicles. Specifically, developed 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. Developed small-scale heat pipes for passive power electronics cooling for improved power density. Designed space mission enabling high energy density lithium ion cells and batteries.

(U) $592 Developed 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. Conducted a feasibility study of high temperature superconducting (HTSC) high power generator technology to develop Yttrium Barium Copper Oxide (YBCO) coated conductors. This HTSC technology is enabling for ground mobile, airborne, and space-based directed energy power sources.

(U) $2,921 Developed alternative energy conversion techniques for ground and space applications. These techniques included such technologies as thermal

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PROJECT **3145**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

photovoltaics and thermionic energy converters, which could either be powered by energy from the sun or traditional combustion techniques.

(U) $6,216 Developed alternative secondary power system related technologies that will help transition more electric technology to current and future aircraft. Specific development efforts focused on air-driven power generation, magnetic bearing coolers, and variable displacement fuel pumps.

(U) $26,059 Total

(U) FY 2001 ($ in Thousands)

(U) $5,730 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These technologies improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. 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) $9,080 Develop thermal management, energy storage, and power conditioning components, and subsystem technologies for air moving target indication (AMTI) radar, high power lasers for space platforms, and orbiting/maneuvering vehicles. Design an integrated Power Management and Distribution (PMAD) for space-based distributed power systems with 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 high power lasers on space platforms. Develop small-scale heat pipes for passive power electronics cooling for improved power density. Evaluate cycle life for long-term space applications of high energy density lithium ion cells and batteries.

(U) $492 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. Expand development of Yttrium Barium Copper Oxide (YBCO) coated conductors to include coils for high temperature superconducting high power generator development.

(U) $1,000 Design, fabricate, and evaluate lithium ion cells for battery applications for high power military requirements such as pulse power weapons for space and aircraft, burst communication devices, and on-the-soldier weapons and communications equipment.

(U) $3,800 Continue development of turbomachine incorporating magnetic bearings to provide augmented cooling and electrical power to Air Force systems. Design and fabricate ground test turbomachine equipment for aircraft application. Evaluate feasibility of magnetic bearings to meet directed energy weapon and Expeditionary Air Force ground support power applications.

(U) $2,600 Develop the Poly(p-phenylene-2, 6-benzobisoxazole) (PBO) membrane for use in Proton Exchange Membrane (PEM) direct methanol fuel cells. Characterize physical and electrochemical properties of the membranes. Evaluate the performance of a PBO membrane in a direct methanol fuel cell.

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $1,800 Modify the Variable Displacement Vane Pump (VDVP) design for test on an engine with commercial applications. Fabricate a VDVP design for advanced tactical aircraft applications and evaluate initial endurance and damage tolerance.

(U) $3,500 Conceptualize integrated vehicle-power-generation-weapon system. Simulate and design electrical components for magneto-hydrodynamic (MHD) and electro-magneto-hydrodynamic (EMHD) power systems to provide high power sources for hypersonic systems and directed energy weapons. Enable MHD pressure control of hypersonic engine inlet.

(U) $28,002 Total

(U) FY 2002 ($ in Thousands)

(U) $9,763 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These technologies improve aircraft self-sufficiency, reliability, maintainability, and supportability while reducing life cycle costs and enabling new capabilities. Fabricate and begin evaluation of advanced switched reluctance machine controllers. Continue development of high energy density lithium ion cell and maintenance free battery technology by testing cells and batteries to load profiles requirements for aircraft. Initiate development of lithium polymer cells. Complete design of low-cost, long duration fuel cells for unmanned air vehicle systems. Develop and test magnetic materials for high temperature generator and magnetic bearing aircraft applications.

(U) $6,261 Develop thermal management, energy storage and power conditioning components, and subsystem technologies for space applications. Fabricate an integrated Power Management and Distribution system for space-based distributed power systems that are half the weight and volume of conventional approaches. Demonstrate radiation-hardened power semiconductor device. 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. Test cycle life of high energy density lithium ion cells and batteries for long-term space applications. Evaluate mechanical pumped-loop for higher power spacecraft. Continue work on active two-phase thermal management technologies.

(U) $5,559 Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement. These technologies enable delivery of high power for operation of directed energy weapons. Complete designing high density power conditioning for directed energy weapon systems. Develop high rate (pulse power) Lithium Ion batteries. Begin development of a thermal management system for cryogenic generator applications.

(U) $21,583 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0601102F, Defense Research Sciences.

(U) PE 0602102F, Aerospace Flight Dynamics.

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0602805F, Dual Use Science and Technology.

(U) PE 0603205, Flight Vehicle Technology.

(U) PE 0603605F, Advanced Weapon Technology.

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

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion — PROJECT 4847

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4847 Rocket Propulsion Technology	0	45,176	55,011	50,643	54,170	57,078	58,569	60,102	Continuing	TBD

Note: As of FY 2001, all rocket propulsion efforts previously performed in PE 0602601F, Project 1011, Rocket Propulsion Technology, were transferred to Project 4847 in order to align projects with the Air Force Research Laboratory organization.
In FY 2001, Congress added $12.6M and $11.1M to PE 0305182F, Spacelift Range System, to activate Rocket Test Stand 1D and upgrade Rocket Component Test Stand 2A, respectively, at Edwards Air Force Base, California. IN FY 2001, the funding was realigned to PE 0602203F, Project 4847, to align the funding with the appropriate PE for this effort. The funding data base has not yet been updated to reflect this realignment. Funding for this effort is found in PE 0305182F, Project 4137, Range Standardization and Automation. However, the effort is described in Project 4847.

(U) A. Mission Description

The Rocket Propulsion Technology project develops advances in rocket technologies for space access, maneuver, and for tactical and strategic missiles. Analytical and experimental areas of emphasis are propellants, combustion, rocket materials, strategic sustainment, and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of future space and missile launch sub-systems. Technologies are developed to reduce the weight and cost of components using new materials, and improved designs and manufacturing techniques. All efforts in this project are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus rocket propulsion technology on national needs.

(U) FY 2000 ($ in Thousands)
(U) $0 Previously accomplished in PE 0602601F, Project 1011.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $4,426 Develop high-energy density and non-toxic propellants for increased space launch payload capability. 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 impulse (Isp) 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, study, and 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 continued use of

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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

energetic chemical rocket propellants in existing rocket propulsion systems.

(U) $2,788 Develop advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engines used in heavy lift space vehicles. Continue to characterize, study/evaluate injector performance with application to combustor 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 measuring 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.

(U) $5,103 Continue to 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) $2,089 Complete the development of 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) $18,695 Continue to 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. 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. Verify performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. 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.

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

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

		Continue to develop and characterize components applicable to liquid propulsion (cryogenic and storable). Initiate feasibility studies concerning rocket based combined cycle engines.
(U)	$6,964	Continue development of 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 Post Boost Control Systems (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)	$5,111	Continue developing solar electric and solar thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites and satellite constellations. Continue Hall thruster development efforts to meet Air Force need for 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 orbital transfer vehicles. Perform preliminary characterization of concentrator surface roughness. Fabricate an advanced solar thermal thruster and integrate with an inflatable concentrator. Begin development of an electrically controlled solid propellant.
(U)	$0	Upgrade and activate rocket engine test stand to enable system level research and test capabilities for new and existing rocket engines. Upgrade test stand for liquid oxygen/kerosene engine research. Prepare test stand to support Integrated High Payoff Rocket Propulsion Technology (IHPRPT) hydrocarbon boost engine test.
(U)	$0	Upgrade and activate rocket component test stand 2A at Edwards Air Force Base, California, to support component level research of advanced rocket propulsion systems. Install high-pressure piping and data acquisition system components.
(U)	$45,176	Total

(U) FY 2002 ($ in Thousands)

(U)	$5,147	Develop, characterize, and test strained-ring, unsaturated hydrocarbons and energetic, reduced-toxicity monopropellants to increase space launch payload capability. Refine synthesis methods of new propellants to facilitate the transition from producing lab-scale quantities to producing sufficient material to meet operational requirements. Continue scale up of selected propellants for laboratory and demonstrator engine evaluations. Develop high-energy-density oxidizers and polymeric binders (i.e., linked heterocyclic compounds), and optimize paths for incorporating these materials into propellants with significantly enhanced performance. Continue evaluating the potential of monopropellants

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT **4847**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

comprised of reduced-toxicity ionic salts to reduce the cost of space access and space operations. The goal is monopropellants with performance equivalent to bipropellants. Continue to evaluate selected propellants in advanced combustion devices to determine materials compatibility and performance.

(U) $2,514 Develop advanced liquid engine combustion technology to improve performance while preserving chamber lifetime and reliability in heavy lift space vehicle engines. Continue to characterize, study, and evaluate injector performance to ensure chamber/injector compatibility and prevent damage to test and operational combustion devices. Complete the development of rocket motor 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. Continue to develop, analyze, and model advanced combustion devices and injectors compatible with new energetic propellants. Continue to model and analyze advanced propulsion concepts with enhanced performance and reliability such as laser-propelled lightcraft and rocket-based combined cycle engines.

(U) $3,036 Develop advanced technologies and material property enhancements for lightweight components for use in launch and space systems. Develop advanced ablative components using hybrid polymers for use in current and future launch systems Continue to characterize and develop new high temperature polymers and carbon-carbon materials for use in advanced combustion devices and propulsion systems to meet lower weight and increased strength requirements. Continue to develop advanced materials for use with high-energy propellants. Complete and transition advanced high temperature materials to Air Force systems to reduce system weight and cost, and increase performance.

(U) $12,753 Develop propulsion component technology for reliable, safe, and low-cost boost and orbit transfer systems. Complete development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Continue development of a low-cost, high discharge pressure turbopump for advanced cryogenic engines. Develop components for hybrid propulsion for space boosters and air-launched missiles. Continue to develop turbomachinery, combustion, and propellant management devices for solid and liquid rockets. Continue developing high temperature turbine materials for oxidizer rich applications. Continue developing advanced lightweight rocket engine nozzles 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 demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Develop new fuels and oxidizers for advanced solid propulsion.

(U) $7,088 Develop missile propulsion technology, aging and surveillance technology, and Post Boost Control Systems for sustainment of current Intercontinental Ballistic Missile fleet. Continue to develop an advanced lightweight solid rocket motor. Complete development of tools to enhance the capability to determine the service life of strategic systems and other solid rocket motors. Begin full-scale testing of the advanced Post Boost Control Systems. Complete efforts for prediction of solid motor life and transition into damage assessment models.

(U) $7,423 Develop solar electric and thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

and satellite constellations. Continue Hall thruster development efforts to achieve Air Force orbit transfers using electric propulsion. Continue development of micro satellites (< 25 kg) propulsion systems (e.g., plasma thrusters) for advanced imaging missions. Continue developing solar thrusters and concentrators for future orbital transfer vehicles. Evaluate electrically controlled solid propellant. Design high power solar thermal components

(U) $12,050 Develop materials and processes to dramatically improve performance, durability, and cost of rocket propulsion systems. Evaluate new candidate materials for rocket engines such as Metal Matrix Composites, Discontinually Reinforced Materials, Ceramics, Ceramic Metallics, and Advanced Composites for use in liquid oxygen, liquid hydrogen, high-temperature, and high-pressure environments. Identify and evaluate the applications of these materials to turbopump housings, ducts, valves, solid rocket casings, insulation, and nozzle throats. Develop material property databases and initiate demonstration of suitability for application using representative geometry and processing conditions for the intended rocket engine components.

(U) $5,000 Develop rocket component of a hydrocarbon fueled rocket based combined/combination cycle engine for rapid acess to space. Initiate studies to establish optimum propulsion cycle and operating conditions. Initiate detailed design of high pressure turbopumps for hydrocarbon propellants. Initiate hydrocarbon thrust chamber design, focusing on affordable, lightweight materials and propellants to provide optimal heat transfer. Evaluate rocket engine health management and prognostic systems. Initiate scale-up and testing of new high density strained-ring hydrocarbon propellants. Evaluate combustion and thermal stability properties of select new hydrocarbon propellants. Produce sufficient quantities of propellants for 100-200 lb thrust level rocket engine demonstrations.

(U) $55,011 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 0602114N, Power Projection Applied Research.
(U) PE 0602303A, Missile Technology.
(U) PE 0602805F, Dual Use Science and Technology.
(U) PE 0603302F, Space and Missile Launch Technology.
(U) PE 0603311F, Ballistic Missile Technology.

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

(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 June 2001

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	59,653	67,024	84,149	81,697	83,482	86,248	88,921	91,475	Continuing	TBD
2000	Electronic Countermeasures Technology	14,339	0	0	0	0	0	0	0	Continuing	TBD
2002	Electronic Component Technology	6,562	19,228	19,984	18,854	19,196	19,573	20,062	20,567	Continuing	TBD
2003	EO Sensors & Countermeasures Tech	8,883	11,746	14,217	14,210	15,423	15,493	15,997	16,515	Continuing	TBD
4916	Electromagnetic Tech	0	0	7,327	7,031	7,205	7,320	7,528	7,744	Continuing	TBD
6095	Sensor Fusion Technology	11,258	13,190	14,582	14,942	15,575	15,879	16,327	16,791	Continuing	TBD
6096	Microelectronics Technology	10,155	0	0	0	0	0	0	0	Continuing	TBD
7622	RF Sensors & Countermeasures Tech	8,456	22,860	28,039	26,660	26,083	27,983	29,007	29,858	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, work performed under this PE, Project 2000, moved to this PE, Projects 2002, 2003, and 7622. Additionally in FY 2001, work performed under this PE, Project 6096, moved to this PE, Project 2002. In FY 2002, work performed under PE 0602702F, Project 4600, moves to this PE, Project 4916. 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. FY 2003 - FY 2007 budget numbers do not reflect the DOD Strategy Review results.

(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. To achieve this progress, this program pursues simultaneous advances in: 1) generating, controlling, receiving, and processing electronic and photonic signals for radio frequency (RF) sensor aerospace applications; 2) electro-optical (EO) aerospace sensor technologies for a variety of offensive and defensive uses; 3) RF antennas and associated electronics for airborne and space-based

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

DATE **June 2001**

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602204F Aerospace Sensors

(U) A. Mission Description Continued

surveillance, together with active and passive electro-optical (EO) sensors; 4) technologies to manage and fuse on-board sensor information for timely, comprehensive situational awareness; and 5) technology for reliable, all-weather surveillance, reconnaissance, and precision strike radio frequency (RF) sensors and electronic combat systems. Note: In FY 2001, Congress added $2.0 million for Three-Dimensional (3-D) Non-Volatile Memory interconnects and packaging.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	63,922	65,644	69,294	
(U)	Appropriated Value	64,331	67,644		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-42			
	b. Small Business Innovative Research	-1,516			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-2,726			
	e. Rescissions	-394	-620		
(U)	Adjustments to Budget Years Since FY 2001 PBR			14,855	
(U)	Current Budget Submit/FY 2002 PBR	59,653	67,024	84,149	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 June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 2000

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2000 Electronic Countermeasures Technology	14,339	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, this work transferred to this PE, Projects 2002, 2003, and 7622.

(U) **A. Mission Description**

This project determines the feasibility of active and passive electronic countermeasure technologies. It explores, develops, expands, and refines the most promising and cost-effective candidate technologies. These technologies will 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. The project also develops countermeasure concepts against radar, infrared (IR), and electro-optical (EO) threat weapon systems. In addition, it develops countermeasure concepts against networks for command, control, and communication. The project analyzes links and sensors of threat air defense systems. It generates a database of countermeasure techniques and technologies to support development of specific self-protection or support countermeasures equipment. Specifically, the project exploits emerging technologies to provide increased capability for: 1) radar warning, radio frequency (RF) electronic warfare (EW), 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 (e.g., chaff, decoys, etc.); and 5) hardware and software for associated processing and technology integration needs. The project advances countermeasure capabilities that are vital to the survival of operational aerospace platforms facing future threats in hostile environments.

(U) FY 2000 ($ in Thousands)

(U) $3,201 Developed countermeasure technologies against IR-guided missiles and EO threats. Continued evaluating techniques against imaging missile seekers and demonstrated cooperative jammer and decoy concepts. Developed optical transmitter technology capable of sensing multiple target characteristics to provide robust non-cooperative combat identification. (In FY 2001, this work transferred to Project 2003.)

(U) $2,687 Developed affordable RF jamming technology and concepts that enhance aircraft survivability by degrading enemy radar, missile, and command and control systems. Completed evaluation of alternative methods for covert featureless waveform detection. Optimized advanced deceptive countermeasure techniques. Continued to develop techniques for degrading enemy modern communication networks. (In FY 2001, this work transferred to Project 7622.)

(U) $475 Developed off-board (expendable) RF and combined IR/RF countermeasure concepts for affordable survivability. Demonstrated countermeasure effectiveness of advanced decoys against dual-mode missile seekers. (In FY 2001, this work transferred to Project 2003.)

(U) $2,021 Developed technology for generic software modules to enable low-cost block upgrades to EW receivers. Completed tests of combined de-interleaving correlation and threat identification software modules for aerospace EW receivers. (In FY 2001, this work transferred to Project 7622.)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **2000**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U)	$2,725	Developed affordable radio frequency (RF) receiver technology for use in operational and future electronic warfare (EW) receivers. Continued to demonstrate a wideband digital receiver brassboard. Evaluated narrowband receiver technology. Developed wideband analog-to-digital circuits. (In FY 2001, this work transferred to Project 2002.)
(U)	$1,738	Developed affordable antenna technology for use in operational and future aerospace platform electronic receivers and apertures. Developed low-frequency direction-finding antennas. Demonstrated advanced pattern control of multimode/multifunction antennas. Demonstrated phase shifters and transmit/receive module technology. (In FY 2001, this work transferred to Project 7622.)
(U)	$1,492	Developed aerospace missile and laser warning technologies to accurately cue countermeasures. Devised laser warning discrimination methods. Assessed hyperspectral imaging technology for missile warning. Demonstrated infrared clutter rejection techniques. (In FY 2001, this work transferred to Project 2003.)
(U)	$14,339	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Efforts transferred to this PE, Projects 2002, 2003, and 7622.
(U)	$0	Total

(U) FY 2002 ($ in Thousands)

(U)	$0	Effort conducted in this PE, Projects 2002, 2003, and 7622.
(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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **2000**

(U) E. Schedule Profile Continued

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602204F Aerospace Sensors	2002

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2002	Electronic Component Technology	6,562	19,228	19,984	18,854	19,196	19,573	20,062	20,567	Continuing	TBD

Note: In FY 2001, work previously performed under this PE, Projects 2000 and 6096, transferred into Project 2002.

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)

(U) $4,122 Developed compact, affordable, mixed-mode, multi-function receiver and phased array components for radar and EW. Fabricated miniature digital receiver components, direct digital waveform transmitters, and very low-power (<0.5W) analog-to-digital converters for air- and space-based sensors. Refined advanced RF component evaluation, modeling, and simulation methods.

(U) $332 Developed microwave technologies to enable high operating temperature, solid state microwave transmitters used in military ground-based and airborne radar applications. Developed robust high-speed, high-power III-nitride transistors.

(U) $318 Demonstrated 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 Developed 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. Developed advanced packaging and interconnect processes for phased array antennas and EW transmitters. (In FY 2000, this work moved from Project 6096.)

(U) $887 Developed 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. Fabricated advanced microwave tube components.

(U) $6,562 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 2002

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$5,076	Develop compact, affordable, multi-function receiver and phased array components for radar, electronic warfare (EW), and other intelligence, surveillance, and reconnaissance (ISR) sensors. Demonstrate miniature airborne digital receiver components. Design and fabricate direct digital waveform transmitters and high-resolution (10-16 bit), ultra-low power (<3.0W) analog-to-digital converters. Demonstrate and refine advanced component evaluation methods. (In FY 2000, portions of this work were performed in Project 6096.)
(U)	$4,523	Develop microwave technologies for advanced radio frequency (RF) 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 2000.)
(U)	$3,854	Develop packaging and integration technologies for high performance aerospace 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 6096.)
(U)	$1,114	Develop signal control components and techniques to meet RF loss levels required for future radar, EW, and ISR sensors. Design micro-electro-mechanical phase shifters with a 300% improvement in RF loss performance. Develop miniature filters for high performance channelized radar and EW 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 signal processors. (Prior to FY 2001, this work was performed in Project 6096.)
(U)	$2,000	Develop three-dimensional (3-D) interconnects and packaging technologies for 3-D non-volatile memory.
(U)	$19,228	Total

(U) FY 2002 ($ in Thousands)

(U)	$5,851	Develop compact, affordable, multi-function receiver and phased array components for radar, EW, and other ISR sensors. Demonstrate Gallium Arsenide (GaAs), Indium Phosphide (InP), and silicon-on-insulator (SOI) RF components for bench-level evaluation of radar and EW digital receiver modules. Develop a brassboard low-power (< 1.0W) analog-to-digital converter and deliver for testing in a space-qualified silicon package. Complete study and design phase of a multi-mode/multi-function digital receiver prototype module, and complete a feasibility trade study on performing wideband direct digital synthesis from space platforms.
(U)	$4,686	Develop microwave technologies for advanced radio frequency (RF) apertures and phased array antennas used in military intelligence,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 2002

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

surveillance, and reconnaissance (ISR) sensors. Develop and demonstrate robust components for L-band and X-band transmitters and receivers that operate with limited environmental controls. The components will be greater than 60% efficient with no active cooling, provide 20 Watts of output power, designed for radiation tolerance to 1 Mrad and greater than 200 degrees Celsius operating temperature.

(U) $4,499 Develop packaging and integration technologies for high performance aerospace RF sensor components. Demonstrate ten-fold cost reduction in an aerospace 20 GHz transmitter and a Ku-to -X-Band down-converter using low-cost packaging techniques. Develop a novel, flexible membrane to enable an ultra lightweight transmit/receive subarray. Develop mixed signal multichip modules, and evaluate three-dimensional interconnects, chip coatings, and advanced design techniques to enable high density micro-electro-mechanical systems and flexible assemblies for aerospace applications.

(U) $1,499 Develop signal control components and techniques to meet RF loss levels required for future radar, electronic warfare, and ISR sensors. Fabricate and characterize micro-electro-mechanical systems phase shifters for 300% improvement in RF loss performance operating over a 3:1 bandwidth.

(U) $2,249 Develop RF photonic technologies to demonstrate compact, affordable, wide bandwidth, high data rate aerospace sensors. Develop low-loss, low-voltage broadband modulators for compact digital receiver applications. Design high-performance components for wideband phased array antennas. Investigate the integration of photonic solutions for long time delays with the micro-electro-mechanical phase shifters for short delays to increase bandwidth.

(U) $1,200 Develop innovative transmitter and receiver concepts along with the associated component technology alternatives required for an affordable space-based RF surveillance sensor system. Design architectures that maximize predicted transmitter and receiver technology payoffs, and identify long lead-time RF sub-components required for space-based moving target indication.

(U) $19,984 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **2002**

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602204F Aerospace Sensors	2003

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2003 EO Sensors & Countermeasures Tech	8,883	11,746	14,217	14,210	15,423	15,493	15,997	16,515	Continuing	TBD

Note: In FY 2001, portions of this effort transferred into this project from this PE, Projects 2000 and 2001.

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)

(U) $2,068 Developed software engineering technologies to promote assured performance and affordability of complex existing and next-generation air and space platform software. Continued to demonstrate automated means to ensure correctness of cockpit display and console software. Developed and applied capability for performing in-flight self-checking of mission critical weapons and information systems software. Continued to develop new techniques for rapidly incorporating new hardware/software functions into scaleable, plug-and-play systems.

(U) $2,337 Developed sensor component technologies to detect, locate, and identify low-contrast ground and aerospace targets from high altitude and space. Developed aerospace infrared hyperspectral sensor components and fusion algorithms. Validated sensor target models.

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

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

(U) $445 Developed military-unique optical transmission components to enable information dominance. Fabricated high-speed optical communication subsystem in the laboratory.

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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **2003**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

		existing systems.
(U)	$8,883	Total

(U) FY 2001 ($ in Thousands)

(U)	$2,209	Develop day/night electro-optical (EO) 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)	$1,766	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 EO threats. Design components and refine techniques to defeat imaging missile seekers. (Prior to FY 2001, this work was conducted in Project 2000.)
(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 conducted in Project 2000.)
(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. (In FY 2001, this effort transferred from this PE, Project 2000.)
(U)	$11,746	Total

(U) FY 2002 ($ in Thousands)

(U)	$4,995	Develop technology for non-cooperative identification of airborne and ground-based platforms. Conduct ground-to-air demonstration of long-range combat identification (CID) sensors. Test coherent image processing/extraction algorithms including three-dimensional (3-D) block registration algorithms. Conduct measurements and evaluate advanced 3-D focal planes for CID application. Continue passive hyperspectral model development, validation, and performance predictions. Continue analysis and evaluation of multifunction ladar flight demonstration data for CID.

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U)	$1,419	Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification. Continue development of a pulsed vibration/imaging sensing system for long-range combat identification. Investigate and demonstrate critical components of a monolithic, solid state coherent ladar architecture.
(U)	$2,412	Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions. Begin utility analysis of high altitude active sensors. Test components for active multispectral imaging. Demonstrate electro-optical (EO) imaging through weather and obscurants. Develop concepts based on high precision pointing, range gating, and image processing. Evaluate non-mechanical EO beam steering devices. Investigate component designs for ladar apertures.
(U)	$2,128	Develop countermeasure technologies for use against infrared-guided missiles and EO. Continue to design components and refine techniques to defeat imaging missile seekers. Continue exploitation of advanced infrared missile technology.
(U)	$3,263	Develop aerospace missile and laser warning technologies to accurately cue countermeasures. Laboratory test temporal and spectral tracking algorithms focused on multi-spectral imaging techniques. Evaluate advanced laser warning sensor component hardware for application in a space environment.
(U)	$14,217	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 June 2001

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

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4916 Electromagnetic Tech	0	0	7,327	7,031	7,205	7,320	7,528	7,744	Continuing	TBD

Note: In FY 2002, this work transferred from PE 0602702F, Project 4600.

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)
(U) $0 Effort conducted in PE 0602702F, Project 4600.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 Effort conducted in PE 0602702F, Project 4600.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $1,800 Develop experimental and theoretical techniques for the characterization of electromagnetic scattering from targets and terrain as applied to the detection of difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms.
(U) $1,948 Design and develop antennas for airborne and space-based surveillance. Design, analyze, and build advanced large lightweight antenna arrays. Develop new algorithms for digital beam-formed multi-beam antennas. Develop antenna front-end high-speed electronics.
(U) $1,679 Design and develop next generation electro-optical techniques and advanced components for use in detection and identification of concealed targets. Design and fabricate multifunction sensor arrays and innovative materials and device technologies for optical beamsteering. Design and develop active components and advanced integration techniques for autonomous ladar-guided munitions and other imaging applications. Develop optical processing techniques for optical aberration in aircraft-generated turbulence.
(U) $1,900 Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates. Establish the viability of tomographic hyperspectral sensing techniques for missions that have not been able to capitalize on the power of spectral

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	**0602204F Aerospace Sensors**	**4916**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

target identification tools. Evaluate the applicability of these and new tomographic hyperspectral sensor concepts to the characterization of explosions and missile launches, and to the development of techniques for real-time bomb damage assessment.

(U) $7,327 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

(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 June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 6095

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
6095 Sensor Fusion Technology	11,258	13,190	14,582	14,942	15,575	15,879	16,327	16,791	Continuing	TBD

(U) A. Mission Description

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

(U) FY 2000 ($ in Thousands)

(U) $4,059 Developed, evaluated, and demonstrated single and multi-sensor lethality algorithms to dramatically improve air combat capability. Performed a ground station emulation. Simulated targeting with real-time information-into-the-cockpit. Developed adaptive resource allocation.

(U) $3,860 Developed, evaluated, and demonstrated air-to-ground single and multi-sensor radar target signature models to support ATR in strike operations. Investigated computational electromagnetics techniques. Generated geometric target models. Characterized clutter.

(U) $1,999 Developed, evaluated, and demonstrated feasibility of multi-sensor ATR algorithms for on- and off-board sensor-to-shooter image and data fusion to rapidly attack time-critical targets. Completed evaluation of a sensor-to-shooter algorithm. Devised multi-sensor performance metrics. Evaluated multisensor ATR algorithms.

(U) $1,340 Developed 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 sensors as the key to the next generation jam resistant technology.

(U) $11,258 Total

(U) FY 2001 ($ in Thousands)

(U) $4,029 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 ATR and information fusion using live threat emitter data.

(U) $3,875 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **6095**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

intelligence community.

(U) $2,144 Develop, evaluate, and demonstrate feasibility of multi-sensor automatic target recognition (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) $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) $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) $13,190 Total

(U) FY 2002 ($ in Thousands)

(U) $4,345 Develop and evaluate single and multi-sensor lethality algorithms to dramatically improve air combat capability. Perform laboratory demonstration of adaptive resource allocation methods for ATR. On embedded high-performance computing systems, develop real-time ATR algorithms for time-critical targets. Develop and evaluate algorithms and concepts for detecting and targeting targets under trees.

(U) $4,151 Develop and evaluate single and multi-sensor radar target signature models to support ATR in strike operations. Develop target signature models for multi-sensor fusion of synthetic aperture radar (SAR), electro-optical (EO) multispectral systems, and signals intelligence in reconnaissance ground stations. Sensor fusion will provide the ability to maintain tracks of vehicle groupings through multiple platforms and missions with a high probability of detection and a less than 1% false alarm rate.

(U) $2,297 Develop and evaluate the feasibility of multi-sensor ATR algorithms for on- and off-board sensor-to-shooter image and data fusion to rapidly attack time-critical targets. Validate multi-sensor performance metrics utilizing measured and synthetic data. Continue evaluating multi-sensor ATR algorithms.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **6095**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U)	$679	Develop precision time, position, and velocity sensors capable of operating in jamming environments enabling multiple platform sensor-to-shooter operations. Continue development of Global Positioning System specific jamming mitigation techniques for operation in hostile radio frequency environments.
(U)	$2,687	Develop and demonstrate enabling automatic target recognition (ATR) technologies for intelligence, surveillance, and reconnaissance applications. Continue evaluating physics-based and adaptive learning techniques.
(U)	$423	Develop ATR and Sensor Fusion performance assessment technology. Conduct ATR performance evaluation theory research.
(U)	$14,582	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 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 June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 6096

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
6096 Microelectronics Technology	10,155	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, this effort transferred to this PE, Project 2002.

(U) A. Mission Description

This project focuses on military unique aspects of microelectronics and radio frequency (RF) photonics, as applied to military sensors. This technology includes photonic subsystems and components for controlling and distributing RF signals; high-speed devices and circuits; packaging and power distribution; design tools; and 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. These components and subsystems will use electronic and photonic analog-to-digital converter circuits; fiber optic signal control and distribution subsystems; high-temperature electronics; multi-function monolithic integrated circuits; high density photonic interconnects; and RF distributions and radar beamforming. Computer-aided engineering technology is a key component of the project and will assist in addressing the low-cost, very high performance, low power, tough environmental, multi-organization development, and high complexity challenges of our warfighting electronics. The technology this project develops is unavailable through commercial sources.

(U) FY 2000 ($ in Thousands)

(U) $2,240 Developed advanced high-speed device technologies to enable affordable, compact space-based sensors. Designed RF components and analog-to-digital converters for high dynamic range, high sensitivity micro-receivers. (In FY 2001, this work transferred to this PE, Project 2002.)

(U) $1,752 Developed advanced design tools to reduce the cost and time required to create complex Air Force electronic systems such as mixed analog and digital systems. Demonstrated tools for reconfigurable computers and for describing hardware behavior. (In FY 2001, this work transferred to this PE, Project 2002.)

(U) $3,527 Developed 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. Specified required representations. Developed advanced techniques for analyzing life cycle cost/performance trade offs.

(U) $2,251 Developed RF technologies to demonstrate compact, affordable, wide bandwidth, high data rate sensors. Designed photonic interconnect architectures for high performance digital receivers and processors. (Prior to FY 2000, this work was performed under PE 0602702F, Project 4600. In FY 2001, this work transferred to this PE, Project 2002.)

(U) $385 Developed, as part of an international cooperative effort, the three-dimensional multilayer microwave packaging and interconnect multichip

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **6096**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

assembly technologies needed for next-generation airborne moving target indicator radars. (In FY 2001, this work transferred to this PE, Project 2002.)

(U) $10,155 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort transferred to this PE, Project 2002.

(U) $0 Total

(U) FY 2002 ($ 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 0603203F, Advanced Aerospace Sensors.

(U) PE 0603270F, Electronic Combat Technology.

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

(U) PE 0602705A, Electronics and Electronic Devices.

(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 **June 2001**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	**0602204F Aerospace Sensors**	**7622**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
7622 RF Sensors & Countermeasures Tech	8,456	22,860	28,039	26,660	26,083	27,983	29,007	29,858	Continuing	TBD

(U) A. Mission Description

This project develops and assesses technology for reliable, all-weather surveillance, reconnaissance, and precision strike radio frequency (RF) sensors and electronic combat systems. It emphasizes the detection and tracking of surface and airborne targets that have RF signatures that are difficult to detect 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 develops techniques and technologies to detect and counter the links and sensors of threat air defense systems and command and control networks. The project also exploits emerging technologies and components to provide increased capability for offensive and defensive RF sensors, including radar warning, RF electronic combat, and electronic intelligence applications.

(U) FY 2000 ($ in Thousands)

(U) $1,174 Developed aerospace microwave sensor technologies for air-to-air radar and target detection that support surveillance, reconnaissance, protection, targeting, attack, and electronic warfare. Designed electromagnetic interference mitigation techniques. Validated advanced radar performance/cost analysis tools.

(U) $1,665 Developed adaptive microwave processing algorithms for detecting and locating advanced cruise missiles and slow airborne and ground targets. Designed techniques to mitigate clutter and jamming on airborne monostatic and bistatic radars.

(U) $1,484 Developed advanced aerospace sensors for air-to-ground targeting and attack, providing synthetic aperture radar targeting solutions for maneuvering tactical aircraft in a hostile environment. Performed an independent assessment of various current and future airborne and space surveillance sensors.

(U) $732 Developed technology for detecting and attacking concealed targets. Developed innovative foliage- and ground-penetrating radar waveforms and targeting algorithms.

(U) $980 Developed technology to accurately determine algorithm and sensor performance from airborne and space-based platforms in realistic airborne surveillance and combat scenarios. Tested bistatic adjuncts on unmanned aerial vehicles. (In FY 2000, this work transferred from PE 0602702F, Project 4506.)

(U) $1,108 Developed 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 4600.)

(U) $1,313 Developed RF space protection technology. Investigated techniques to provide warning and countermeasures against RF interference with

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **7622**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

satellite operations.

(U) $8,456 Total

(U) FY 2001 ($ in Thousands)

(U) $4,144 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 4506.)

(U) $3,519 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 radio frequency 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 this PE, Project 2000.)

(U) $2,555 Develop technology for generic software modules to enable low-cost block upgrades to electronic warfare receivers. Design threat identification software modules for next-generation threat warning receivers. (Prior to FY 2001, this work was conducted in this PE, Project 2000.)

(U) $5,823 Develop affordable antenna technology for use in operational and future aerospace platform electronic receivers and apertures. Demonstrate, in the laboratory, 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 this PE, Project 2000.)

(U) $22,860 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602204F Aerospace Sensors**	PROJECT **7622**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $6,535 Develop aerospace microwave sensor technologies for detecting, locating, and engaging airborne and ground targets. Conduct airborne radar target and clutter phenomenology data collections used to evaluate, validate, and improve engineering tools supporting intelligence, surveillance, and reconnaissance (ISR) and multi-intelligence sensor concept studies and system analyses. Evaluate sensor performance through in-flight experiments and simulations.

(U) $3,733 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. Develop multi-mission adaptive radar algorithms to support various operational modes including air and ground target detection, ground target imaging, electronic protection, and passive radio frequency (RF) emission detection. Develop advanced waveforms to achieve transmit adaptivity and simultaneous multi-mode operation. Improve interference rejection, self-protection, and target identification by exploiting diversity in frequency, delay, polarization, modulation, and coding.

(U) $3,981 Develop technology for detecting and precisely locating concealed targets using standoff aerospace platforms. Develop and evaluate technology for airborne ground-penetrating radar. Develop and evaluate signal processing algorithms for improving detection and false alarm performance in foliage-penetrating radar.

(U) $3,484 Develop affordable RF jamming technology and concepts that enhance aerospace vehicle survivability by degrading enemy radar, missile, and command and control systems. Develop multifunction electronic warfare (EW) technique waveforms. Evaluate exploitations of advanced RF threats. Develop optimized EW techniques to degrade modern radar, communication, and missile threat systems.

(U) $2,488 Develop technology to enable low-cost upgrades to RF signal receivers. Model threat identification algorithms for next-generation threat warning receivers. Evaluate state-of-the-art digital receiver subsystems. Design advanced very-high frequency receiver improvements for detecting targets under trees. Design novel RF photonic analog-to-digital converter circuitry for order-of-magnitude gains in performance accuracy versus current state-of-the-art.

(U) $5,723 Develop affordable antenna technology for use in operational and future aerospace platform electronic receivers and apertures. Evaluate wideband, high precision, interferometric, multimode, direction-finding antennas in the laboratory. Develop design tools to predict antenna performance installed on host platform models. Develop robust ultra-wideband front end electronics to handle large signals.

(U) $1,100 Develop and validate, via a global infosphere experiment, the radar architectures, aperture technology, and signal processing to support a space-based moving target indication sensor. Use the collaborative engineering environment to model and assess RF architectures and signal processing techniques. Analyze the utility of a space-based sensor architecture.

(U) $995 Design and validate multi-intelligence sensor technologies for total battlefield awareness. Evaluate single platform technologies for common waveform utilization, knowledge-based function scheduling, and superior difficult target detection for both in-the-clear and concealed targets. Develop and evaluate hybrid sensor systems, including space/air/ground combinations delivering improved location accuracies and tracking

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602204F Aerospace Sensors	PROJECT 7622

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

strategies.

(U) $28,039 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.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602269F Hypersonic Technology Program	PROJECT 1025

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1025	Hypersonic Technology Program	15,455	0	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2000, funding for this program was zeroed by the Air Force; however, Congress added $16.0 million for Hypersonic Technology. In FY 2001, the Air Force provided funding for this program in PEs 0602203F, Aerospace Propulsion; 0603202F, Aerospace Propulsion Subsystems Integration; and 0603216F, Aerospace Propulsion and Power Technology. Beginning in FY 2002, all funding for this program will be shifted to PE 0602203F, Aerospace Propulsion, Project 3012, in order to align projects with the Air Force Research Laboratory organization.

(U) A. Mission Description

This program develops advanced hypersonic technologies that will provide revolutionary propulsion options to provide the Air Force with new hypersonic weapons and space launch capabilities. This program will focus on hydrocarbon fueled hypersonic vehicle technologies and demonstrate their feasibility. Technologies developed under this program will be applicable to both Department of Defense and National Aeronautical and Space Administration requirements. Planned efforts include analyses, hypersonic materials/structures, airbreathing propulsion, hydrocarbon fuels, and integrated technology test demonstrations.

(U) FY 2000 ($ in Thousands)

(U) $14,688 Designed, developed, and tested propulsion components, structures, and integrated propulsion devices for advanced hypersonic propulsion concepts. Continued 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. Completed demonstration of heavyweight scramjet engine in freejet. Initiated fabrication and testing of flight type scramjet combustor and inlet.

(U) $398 Developed technologies for instrumentation and test in realistic hypersonic conditions. Continued application of hypersonic test instrumentation to freejet engine configurations and establishment of test instrumentation protocol for freejet testing.

(U) $269 Developed and extended computational technologies from low-speed and supersonic flight to the hypersonic environment. Continued validation of computational methods in instrumented engine flowpath test rigs.

(U) $100 Conducted 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. Continued mission analyses to characterize user requirements and technology maturity. Updated 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602269F Hypersonic Technology Program**	PROJECT **1025**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued
(U) $15,455 Total

(U) FY 2001 ($ in Thousands)
(U) $0 Efforts moved to PE 0602203F, PE 0603202F, and PE 0603216F.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $0 Efforts moved to PE 0602203F, Project 3012.
(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	15,808	0	0	
(U)	Appropriated Value	16,000			
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-377			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram				
	e. Rescissions	-168			
(U)	Adjustments to Budget Years Since FY 2001 PBR	0	0	0	
(U)	Current Budget Submit/FY 2002 PBR	15,455	0	0	TBD

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602269F Hypersonic Technology Program**	PROJECT **1025**

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

(U) Significant Program Changes:
Note: In FY 2000, funding for this program was zeroed by the Air Force; however, Congress added $16.0 million for Hypersonic Technology. In FY 2001, the Air Force provided funding for this program in PEs 0602203F, Aerospace Propulsion; 0603202F, Aerospace Propulsion Subsystems Integration; and 0603216F, Aerospace Propulsion and Power Technology. Beginning in FY 2002, all funding for this program will be shifted to PE 0602203F, Aerospace Propulsion, in order to align projects with the Air Force Research Laboratory organization.

(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
June 2001

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602601F Space Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	141,083	68,850	61,086	56,479	62,222	69,153	71,107	73,263	Continuing	TBD
1010	Space Systems Protection Technology	27,284	28,031	18,430	13,186	16,284	17,818	18,322	18,878	Continuing	TBD
1011	Rocket Propulsion Technology	40,553	0	0	0	0	0	0	0	Continuing	TBD
3326	Lasers and Imaging Technology	17,279	0	0	0	0	0	0	0	Continuing	TBD
4846	Spacecraft Payload Technologies	0	8,318	11,734	10,308	9,752	13,830	14,217	14,651	Continuing	TBD
5797	Advanced Weapons and Survivability Technology	18,110	0	0	0	0	0	0	0	Continuing	TBD
8809	Spacecraft Vehicle Technologies	37,857	32,501	30,922	32,985	36,186	37,505	38,568	39,734	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, spectral sensing (intelligent satellite systems and hyperspectral technology) efforts in Project 3326 move into Project 8809. In FY 2001, in order to align projects within the Air Force Research Laboratory organization, all rocket propulsion efforts performed in Project 1011 were transferred to PE 0602203F, Project 4847, and all lasers and imaging efforts in Project 3326 and all advanced weapons and survivability technology efforts in Project 5797 were transferred to PE 0602605F, Projects 4866 and 4867. In FY 2001, Project 8809 has been split with spacecraft payload technology being moved into Project 4846. In FY 2001, the satellite protection related work currently in Project 8809 moved into Project 1010. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) **A. Mission Description**

This PE focuses on three major areas. First, space systems protection develops technologies to understand, mitigate, and exploit effects of weather and geophysics environments on the design and operation of Air Force systems. Second, spacecraft payload technologies improve satellite payload operation by investigating advanced component and subsystem capabilities. The last major area, spacecraft vehicles, focuses on spacecraft platform, payload, and control technologies, and their interactions. Note: In FY 2001, Congress added $16.8 million ($7.0 million for the High-frequency Active Auroral Research Program, $3.0 million for S&T Space Survivability, $1.8 million for Advanced Aluminum Aerostructures, $1.0 million for Composite Cryogenic Fuel Tanks, and $4.0 million for Terabit).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	146,021	57,687	54,495	
(U)	Appropriated Value	147,118	69,487		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-73			
	b. Small Business Innovative Research	-3,467			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-1,442			
	e. Rescissions	-1,053	-637		
(U)	Adjustments to Budget Years Since FY 2001 PBR			6,591	
(U)	Current Budget Submit/FY 2002 PBR	141,083	68,850	61,086	TBD

(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 June 2001
BUDGET ACTIVITY 02 - Applied Research					PE NUMBER AND TITLE 0602601F Space Technology						PROJECT 1010
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1010	Space Systems Protection Technology	27,284	28,031	18,430	13,186	16,284	17,818	18,322	18,878	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 from '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. Note: In FY 2001, Congress added $10.0 million ($3.0 million for S&T Space Survivability and $7.0 million for the High-frequency Active Auroral Research Program (HAARP)).

(U) FY 2000 ($ in Thousands)

(U) $2,110 Developed technologies to monitor, predict, and control space environmental conditions hazardous to DoD operational space systems. Leads to improved space system design, lifetime, and operational capabilities and aids in anomaly resolution. Demonstrated on-orbit hazardous radiation monitoring using miniaturized radiation sensing technology. Completed analysis of interaction of transmitted radio waves with radiation belts to assess potential for mitigation of hazardous radiation levels.

(U) $8,521 Developed 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. Completed all-altitude background clutter prediction code to extend capability to all lines-of-sight for space-based sensors to support design of next generation surveillance satellites. Completed measurements of the visibility of surrogate missile target signatures through clouds to support earliest warning of missile launches. Performed measurements of atmospheric optical turbulence in theaters of interest, and developed deployment aids and performance prediction models to minimize operational impacts of optical turbulence on laser weapons. Validated atmospheric turbulence effects on operational laser systems.

(U) $3,365 Developed capability of forecasting 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. Designed, fabricated, and began testing of Communications/Navigation Outage Forecasting System (C/NOFS) planar Langmuir probe sensor for measuring ionospheric plasma levels. Began design and fabrication of neutral wind sensor for C/NOFS.

(U) $9,699 Expanded experimental research capabilities to characterize and control the physical processes produced in space via interactions with very high power radio waves at the HAARP Alaska facility. Focused 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. Transferred the operations center at HAARP facility from a temporary to a

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT **1010**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

modern control center. Installed additional on- and off-site diagnostic instruments. Developed software to provide real-time access to diagnostic data via the internet. Supported basic and applied research and related applications.

(U) $2,425 Developed software that predicts the impact of weather on precision-guided munitions (PGMs) and navigation and surveillance systems and that predicts weather effects uniquely impacting DoD military operations. Developed and transitioned: 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) $582 Developed algorithms that 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. Developed and validated atmospheric compensation and image analysis algorithms needed to exploit data collected by space-based hyperspectral sensors. Included background models into 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) $582 Performed measurements to quantify the effects of current solar cycle maximum on Global Positioning System (GPS) navigation links, developed associated algorithm for specifying GPS link outages, and upgraded and validated 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 accuracy, communications outages, high frequency communications connectivity, errors and clutter on surveillance radars, and geolocation accuracy. Developed GPS outage nowcasting system using ground-based sensors and advanced algorithms that include effect of solar cycle. Developed assimilation model for ionospheric specification that uses real-time data from ground and space sensors and is upgradeable to a forecasting capability.

(U) $27,284 Total

(U) FY 2001 ($ in Thousands)

(U) $2,424 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 that 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 the feasibility of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 1010

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

space-based mitigation technologies.

(U) $9,783 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 through the use of space-based sensor data. Complete deployment aids and performance prediction models that minimize the operational impacts of atmospheric optical turbulence on laser weapons. Complete an assessment of advanced missile detection technologies that provide for the earliest detection of theater ballistic missiles in boost phase.

(U) $3,862 Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting and space-based geolocation 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 geolocation accuracy.

(U) $2,054 Develop key satellite threat warning technologies and tools for on-board satellite use that detect, geolocate, and characterize acquired intentional and unintentional ground-based radio frequency and laser signals. Satellite threat warning technologies enable the warfighter to have increased knowledge of possible hostile acts directed at mission critical satellites and aid in satellite anomaly resolution. Design key satellite protection technologies, such as geolocation algorithms, radio frequency antennas, and miniaturized sensor and processing electronics, for advanced satellite threat warning/attack reporting capabilities.

(U) $6,936 Expand experimental research capabilities to characterize and control the physical processes produced in space with very high power radio waves at the High Frequency Active Auroral Research Program (HAARP) Alaska facility. Continue to further develop and test concepts for imaging underground structures and provide new radio-wave propagation modes via the generation of irregularities in the ionosphere. Continue the collection of diagnostic data to characterize the space weather environment. Investigate ionospheric Extremely Low Frequency/Very Low Frequency (ELF/VLF) virtual antenna properties. Expand the high frequency radio transmitter capability from 8-MHz to 10-MHz. Extend roads and install additional diagnostic pads and instruments that reduce interference problems and enhance radio science capabilities.

(U) $2,972 Develop technologies that improve the survivability of space systems by specifying, forecasting, and mitigating the effects of the ionosphere and space radiation environment. Expand the coverage of the Scintillation Network Decision Aid (SCINDA), which is a component of a global system for predicting the effects of ionospheric scintillation on communication and navigation systems. Develop advanced, space-borne sensors to detect hazards to spacecraft from space particles and chemical contamination. Develop advanced instrumentation and analysis techniques for real-time monitoring of solar activity and improved prediction of space environmental hazards.

(U) $28,031 Total

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

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $2,475 Develop technologies for monitoring, predicting, and controlling space environmental conditions hazardous to DoD operational space systems. These technologies lead to improved space system design, lifetime, and operational capabilities and aid in anomaly resolution. Use simulations to assess technologies that control hazardous space particle populations in extreme environments resulting from natural or adversarial actions. Use all-sky images from space-based detector system to develop advanced algorithms for tracking system-impacting solar eruptions en route to Earth. Develop algorithms for short-term forecasting of solar flares, based on observations of plasma flow in solar active regions. Validate time-dose probability codes for space system design using data from compact environment anomaly sensors. Complete design of space particle control experiment and make the transition to Advanced Technology Development. Construct dynamic radiation belt data assimilation and forecast models to predict energetic electron spacecraft hazards.

(U) $8,270 Develop real-time infrared backgrounds clutter code, spectral signature libraries, target detection techniques, and decision aids for application to space-based surveillance, laser weapons, and countermeasure systems, including detection of low-observable targets. Technologies lead to increased surveillance capability and to more effective operation of laser weapons and countermeasures systems. Develop global clutter specification model and dim-target detection techniques for advanced space-based surveillance systems. Incorporate global clutter model into all-altitude background prediction code and validate model with space-based data. Conduct field measurements to validate candidate concepts for earliest detection of theater ballistic missiles in boost phase. Test and validate decision aids and performance prediction tools for turbulence effects on laser weapon system performance. Validate global spectral signature libraries created from Warfighter-1 data, and develop a modeling and simulation capability to predict the performance of surveillance functions under specified scene and atmospheric conditions.

(U) $6,295 Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting and space-based geolocation demonstrations. This forecasting capability will support the warfighter through situational awareness, allowing operators to use alternate links or systems in times of outages. Integrate and validate the suite of ionospheric specification and forecast models for the Communications/Navigation Outage Forecast System (C/NOFS) Advanced Concept Technology Demonstration (ACTD). Assemble the models with data-handling systems to construct the C/NOFS data center. Provide reliable error maps for geolocation requirements. Expand the ground-based network of ultra high frequency and L-band satellite links to provide worldwide outage specification and enhance the ground-based component of C/NOFS. Establish high latitude sites to monitor formation and motion of polar ionospheric patches.

(U) $1,390 Develop key satellite threat warning technologies and tools for on-board satellite use that 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. Complete miniaturization of radio frequency attack reporting receiver. Incorporate results of risk reduction space flight test into attack reporting system hardware and software and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT **1010**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

begin system integration for year-long space flight demonstration. Investigate integrated attack reporting approaches.

(U) $18,430 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: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 1011

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1011 Rocket Propulsion Technology	40,553	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, efforts in this project were transferred to PE 0602203F, Project 4847.

(U) A. Mission Description

The Rocket Propulsion Technology project pursues advances in rocket technologies for space access, maneuver, and for tactical and strategic missiles. Analytical and experimental areas of emphasis are propellants, combustion, rocket materials, strategic sustainment, and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of future space and missile subsystems. Technologies are developed to reduce the weight and cost of components using new materials, and improved designs and manufacturing techniques. All efforts in this project are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program; a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus rocket propulsion technology on national needs.

(U) FY 2000 ($ in Thousands)

(U) $4,815 Continued to develop high-energy density and non-toxic propellants for increased payload capability. Continued to develop promising propellants to transition into future high-performance boost and orbit transfer propulsion systems. Optimized source for producing high-energy density additives and developed techniques to accurately measure concentrations of these additives. The goal is to achieve cryogenic propellants that maximize future propulsion system performance. Continued preparation for demonstrations and transitioned additives into system-ready applications.

(U) $2,731 Developed 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 were accomplished by full-scale single element cold flow injector testing in windowed pressure vessels, using laser diagnostics. Characterized injector performance and reliability at high pressures. Developed a sub-scale 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 of injector development to industry and government by two times. Continued to characterize, study, and evaluate injector performance with application to combustor chamber/injector compatibility to prevent damage to test and operational combustion.

(U) $3,450 Continued to develop advanced material technology for lightweight components and material property enhancements for use in launch and space systems. Completed 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. Developed 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT **1011**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

components (metal and non-metal).

(U) $13,818 Continued to develop propulsion component technology for reliable, safe, and low-cost boost and orbit transfer systems. Continued developing and demonstrating advanced materials for rocket engine components and continued to develop turbomachinery, combustion devices, and propellant management devices for solid and liquid rockets. Began development of high temperature oxygen rich turbine materials for applications to oxidizer rich turbomachinery. Began application of advanced Aluminum Metal Matrix Composite Materials to rocket turbomachinery housings and rocket structural hardware. Completed testing of a high-performance, low-cost cryogenic upper stage combustion chamber for an expander cycle application. Completed the testing of a high performance hydrostatically supported liquid hydrogen. Continued characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions. Continued to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Initiated development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Verified performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continued to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles.

(U) $3,748 Continued developing solar electric propulsion technologies for stationkeeping, repositioning, and orbit transfer appropriate for large communication satellites and satellite constellations. Continued Hall thruster development to higher powers to meet Air Force need for Low Earth Orbit/Geosynchronous Orbit orbit transfers using electric propulsion. Completed development of propulsion for Air Force small satellites (~100 kg). Continued development of propulsion systems for micro-satellites (<25 kg) needed for advanced Air Force imaging missions. Continued the design and test of solar thrusters and concentrators for future orbit transfer systems and satellite propulsion systems with longer life.

(U) $2,242 Continued the development of analytical tools for prediction of propellant life. Completed development of tools to increase the capability to determine the age life of strategic systems and other solid rocket motors.

(U) $1,950 Continued development of Post Boost Control Systems for sustainment of current Intercontinental Ballistic Missile (ICBM) fleet. Continued development of compatible case/liner, insulator, and case systems for higher combustion temperature propellants. Completed design and began fabrication of solid rocket motor test hardware. Fabricated and tested gas generator with non-refractory materials capable of withstanding high heat loads. Developed 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) $1,170 Continued development of missile propulsion technology for sustainment of current ICBM fleet. Completed design solid rocket motor test hardware.

(U) $2,730 Continued the development of propulsion technologies for the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 1011

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

Completed the design efforts to minimize weight while significantly improving the heat transfer capability of a high pressure thrust chamber assembly.

(U) $2,242 Continued development of tactical missile propulsion systems. Completed fabrication of hybrid tactical oxider system for integration into test hardware. The fuel system was developed in coordination with Japan.

(U) $1,657 Continued the development of advanced upperstage and orbit transfer propulsion. Completed the design and fabrication of advanced solar thermal propulsion test hardware. Integrated propulsion components with system level components in preparation for space flight.

(U) $40,553 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Efforts transferred to PE 0602203F, Project 4847.

(U) $0 Total

(U) FY 2002 ($ 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 Activities:

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

(U) PE 0602303A, Missile Technology.

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

(U) PE 0603311F, Ballistic Missile Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 1011

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)										DATE June 2001
BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602601F Space Technology						PROJECT 3326
COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3326 Lasers and Imaging Technology	17,279	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, this project was transferred to PE 0602605F, Project 4866.

(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 are 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 2000 ($ in Thousands)

(U) $1,602 Developed long-range optical technologies for increased resolution characterization and data fusion applications. Lightweight deployable mirrors that are the critical basis for these applications were 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 were addressed.

(U) $449 Continued 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 concentrated 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 were performed.

(U) $3,458 Developed high power chemical and all-gas phase iodine laser technologies for applications such as directed energy weapons and illuminators. Demonstrated high energy, frequency conversion of chemical oxygen iodine laser (COIL) for potential airborne laser illuminator applications. Completed parallel technology efforts for the repetitively pulsed COIL illuminator. Evaluated these results and assess the potential of this technology for an alternate, scalable airborne laser illuminator. Improved efficiency and reduce weight of COIL devices for airborne laser missions. Developed with proof of principle experiments advanced COIL technologies which include iodine atom production with electric discharges and iodine atom production through chemical reactions. Evaluated, theoretically and experimentally, advanced ejector nozzle concepts which improve the pressure recovery potential of COIL devices. Demonstrated a 100-watt subsonic all-gas phase chemical iodine laser.

(U) $4,070 Developed 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. Developed compact, reliable, high-power, solid state laser technologies at mid-infrared wavelengths. Investigated new laser materials needed to reduce the size and weight (currently 40 pounds, one cubic foot) of solid state laser-based infrared countermeasure

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602601F Space Technology**	PROJECT **3326**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

demonstrator. Developed a mid-infrared laser with the beam brightness needed for platforms with high infrared signatures. Investigated novel materials effects associated with plasma/spark and ultra-fast lasers for countering focal plane array seekers. Investigated propagation, beam control, and imaging technologies related to ultra-fast lasers.

(U) $5,773 Developed 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. Developed 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. Developed integration technologies necessary for demonstration of power at 100s of Watts.

(U) $770 Developed relay mirror concepts and pursued development of large optics and their optical compensation for large mirror space-based applications.

(U) $1,157 Developed 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, and reconnaissance. Completed Phase I experiments for frequency agile heterodyne receiver development. Established transmitter/receiver requirements for unmanned aerial vehicle applications.

(U) $17,279 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Program transferred to PE 0602605, Project 4866.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Program transferred to PE 0602605, Project 624866.

(U) $0 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 3326

(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 June 2001

BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 4846

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4846 Spacecraft Payload Technologies	0	8,318	11,734	10,308	9,752	13,830	14,217	14,651	Continuing	TBD

Note: In FY 2001, spacecraft payload technology efforts have been split from Project 8809 and moved into Project 4846.

(U) **A. Mission Description**

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on three primary areas: (1) the development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; (2) development of advanced space data generation and exploitation technologies, including infrared, Fourier Transform hyperspectral imaging, polarimetric sensing, and satellite antenna subsystem technologies; and (3) development of high-fidelity space simulation models that support space-based surveillance and space asset protection research and development for the warfighter.

(U) FY 2000 ($ in Thousands)
(U) $0 Previously accomplished in Project 8809.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $2,846 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 multi-color and low background infrared detectors and QWIPs, higher temperature infrared detectors, and higher performance radiation-hardened detectors. Continue experimental investigation of two-, three-, and multi-color detectors, and tunable and broadband gratings. Investigate future concepts for 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, and space backgrounds.
(U) $806 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) $3,841 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.

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

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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, Fast Fourier Transform (FFT) processors, optical sensors, and analog devices. Fabricate ultra-high density, low-power micro-electro-mechanical system (MEMS) device for evaluation in space environment. Fabricate smaller, lighter, lower power electronics packaging.

(U) $825 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 to validate research and development systems engineering level technology trade off decisions for space-based missions/campaign level assessments and for intelligent satellite system test beds. 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 test bed.

(U) $8,318 Total

(U) FY 2002 ($ in Thousands)

(U) $4,397 Develop advanced infrared device technologies for space applications that support hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of targets such as decoys, satellites, and warheads, throughout their trajectory. Develop cryogenic detector and read-out devices that will perform for extended periods of time under adverse natural and enhanced space environments. Develop and evaluate both broadband and narrow band detector devices and the appropriate low-noise, cryogenic read-out device and device architectures necessary for multi-band (2- and 3-color) detection. Enhance device architectures for future space sensor concepts that include the need for radiation-hardness, radiation tolerance, longer wavelengths, higher operating temperatures and higher frame rates. Study next generation detection requirements for space, and explore and exploit potential infrared device solutions.

(U) $987 Develop hyperspectral imaging data exploitation methodologies for military imaging and remote sensing applications. Fourier Transform HyperSpectral Imager (FTHSI) and polarimetric sensing technologies will provide enhanced surveillance capability for future space-based sensor systems by improving the ability of the systems to discriminate military targets in various scenarios. Complete evaluation of the hyperspectral imaging system performance based on data received from the Fourier FTHSI payload. Develop technology and modeling for understanding the electro-optical/infrared (EO/IR) polarimetric phenomenology.

(U) $4,398 Develop technologies for space-based payload components such as low power, high performance, radiation-hardened electronic devices,

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

micro-electro-mechanical system (MEMS) devices, and advanced electronics packaging for next generation high performance space electronics. Expand microelectronic material characterization to silicon-on-insulator (SOI) and chalcogenide materials and apply radiation research and material defect analysis to improve device design. Fabricate and test monolithically integrated low power, silicon-based quantum-sized devices. Characterize new radiation-hardened nonvolatile digital memories, Fast Fourier Transform (FFT) processors, and optical sensors. Investigate design enhancements for ten-fold performance improvement for the memories and FFT processors. Fabricate nonvolatile analog memories. Establish a MEMS reliability test device for ground and space experiments. Investigate a chip-scale packaging system with optimized confinement features and coating for MEMS devices. Establish a non-volatile analog reconfigurable packaging architecture.

(U) $965 Develop modeling, simulation, and analysis (MS&A) tools for space-based surveillance systems, rendezvous and proximity operations, optical/infrared imaging space systems, large deployable space optics, and distributed satellite architecture payloads. Complete connection of satellite toolkit and spacecraft simulation toolkit. Extend simulation architecture to support flight software development and definition and conduct near-term flight test experiment.

(U) $987 Develop advanced satellite antenna architectures and performance characterization tools for large, lightweight, modular space antennas. The advanced antenna architectures will improve the affordability and capability of antennas for space-based payload subsystems for Air Force surveillance and navigation efforts. Develop algorithms for performance characterization of modular phased-array antenna tiles. Build and test engineering models to simulate performance of phased-array antenna tiles and integrated antenna modules to include MEMS time delay units for phase control. Characterize performance of antenna tiles and modules and correlate results to model predictions; update models based on actual performance. Extend engineering models to simulate performance of the antenna tiles and integrated modules in a space environment in preparation for demonstration on a three microsatellite constellation space flight experiment.

(U) $11,734 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.

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

(U) <u>D. Acquisition Strategy</u>
Not Applicable.

(U) <u>E. Schedule Profile</u>
(U) Not Applicable.

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

DATE: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 5797

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
5797 Advanced Weapons and Survivability Technology	18,110	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, this project was transferred to PE 0602605F, Project 4867.

(U) A. Mission Description

This project examines high power microwave (HPM) and other unconventional weapon concepts using innovative technologies. 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 developed hardening technologies and methodologies.

(U) FY 2000 ($ in Thousands)

(U) $1,453 Investigated technologies for developing innovative HPM sources to support multiple Air Force applications such as command and control warfare and suppression of enemy air defenses. Conducted field test for single shot HPM device. Designed, built, and tested candidate repetitive device. Obtained experimental data to improve anchoring of existing computer models.

(U) $1,918 Assessed effects/lethality of directed energy weapon technologies against representative air and ground military systems. Investigated susceptibility of current fighter technologies and provide results to developers. Completed lethality assessment studies on selected military relevant targets. Continued to identify HPM protection requirements on large and small aircraft.

(U) $1,746 Developed wideband HPM technologies that support command and control warfare applications. Researched methods to enhance HPM source technology such as power throughput for solid state switches and high repetition rates for high pressure gas switches. Extended the current capabilities of electromagnetic modeling and simulation codes to better predict the electromagnetic environment induced in more complex geometric structures.

(U) $2,567 Developed narrowband HPM technologies that support suppression of enemy air defenses. Developed models of HPM effects for military electronic targets of interest. Validated and verified the models through measurement and computer simulation. Assessed predictability of models. Determined those HPM effects parameters enhanced through repetitively pulsing. Designed and developed component technologies - prime power, pulsed power, sources, and antennas - for repetitively pulsed systems.

(U) $5,544 Investigated HPM technologies that support offensive and defensive advanced airborne tactical applications made possible based on increased power available on future aircraft. Established 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 5797

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

		technology specification set for each concept. Investigated a wide range of technology alternatives and lethality parameters and used this data in a trade off study to select the most promising concepts that optimizes performance, cost, and schedule.
(U)	$554	Investigated Active Denial Technology applications for Agile Combat Support. Developed high specific power, millimeter-wave sources using computer simulation and experiments.
(U)	$1,919	Assessed the vulnerability of six U.S., NATO, and foreign satellites to the effects of directed energy weapons, primarily high energy lasers and high power microwaves (HPMs). Previous assessments were updated, as required, based on new intelligence information. Other directed energy effects were included as appropriate.
(U)	$2,409	Evaluated radio frequency threats to U.S. infrastructure.
(U)	$18,110	Total

(U) FY 2001 ($ in Thousands)

(U)	$0	Program transferred to PE 0602605, Project 4867.
(U)	$0	Total

(U) FY 2002 ($ in Thousands)

(U)	$0	Program transferred to PE 0602605, Project 4867.
(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.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

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

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 02 - Applied Research					PE NUMBER AND TITLE 0602601F Space Technology						PROJECT 8809
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
8809	Spacecraft Vehicle Technologies	37,857	32,501	30,922	32,985	36,186	37,505	38,568	39,734	Continuing	TBD

(U) **A. Mission Description**

This project focuses on seven major space technology areas: spacecraft platforms (e.g., structures, controls, power, and thermal management); space-based payloads (e.g., survivable electronics); satellite control (e.g., software for autonomous distributed satellite formation flying, signal processing, and control); modeling and simulation of space-based systems; satellite protection technologies (e.g., space environment effects, debris prediction, and threat warning/attack reporting); microsatellite technologies; and integrated experiments of advanced technologies for transition to planned systems (e.g., payload/platform/launch vehicle merging). Note: In FY 2001, Congress added $6.8 million ($1.8 million for Advanced Aluminum Aerostructures, $1.0 million for Composite Cryogenic Fuel Tanks, and $4.0 million for Terabit).

(U) FY 2000 ($ in Thousands)

(U) $4,100 Developed 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. Started development of 35 percent efficient solar cells and polymer batteries. Continued development of thin film solar cells, lithium-ion batteries, and thermal to electric conversion cells. Continued development of non-electrochemical energy storage techniques.

(U) $5,467 Developed technologies for advanced space platform structures such as spacecraft structural controls for vibration suppression, multi-functional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Whole spacecraft launch vibration suppression will enable precision pointing and sensing systems. Multi-functional 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. Designed vibration suppression systems for primary and secondary payloads. Continued development of design and integration techniques for multi-functional structures and integration of multi-chip modules into spacecraft bus. Developed and fabricated component subsystems for deployable large aperture optical arrays.

(U) $2,520 Developed 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. Characterized microelectronic materials and internal structures to improve fabrication processes. Characterized next generation low-power, quantum-sized devices for possible space application. Designed devices such as improved radiation-hardened nonvolatile memories, processors, sensors, and analog devices.

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

Designed ultra-high density, low-power micro-electro-mechanical system (MEMS) device for evaluation in space environment. Designed smaller, lighter, lower power electronics packaging.

(U) $759 Developed 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. Continued to integrate simulation architecture models using visual programming codes and commercial-off-the-shelf software to enhance fidelity of satellite constellation-level modeling.

(U) $2,037 Developed 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. Characterized 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. Developed methodology for determining signal information necessary for source evaluation and nature.

(U) $3,791 Developed 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. Launched the MightySat II.1 vehicle and demonstrated operation of the integrated platform and stand-alone experimental payloads.

(U) $9,969 Developed 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. Completed development of first microsatellite in the series to test autonomous microsatellite operations. Initiated design of microsatellite for a three-unit flight constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing.

(U) $4,365 Developed hyperspectral imaging technologies for space-borne assets to provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Developed Warfighter-1 target detection and terrain classification algorithms and perform on-orbit evaluation of the hyperspectral sensor and ground operations. Completed integration and testing of data processing and exploitation algorithms for the Fourier Transform Hyperspectral Imaging sensor and validate results with baseline data. Developed an advanced

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

		hyperspectral processing and data exploitation center for developing and validating hyperspectral imaging algorithms.
(U)	$4,849	Continued the terabit technology program, focusing on increasing the channel capability and improving the bit error rate. Extended the range of the wireless 28GHz link.
(U)	$37,857	Total

(U) FY 2001 ($ in Thousands)

(U)	$3,559	Continue to develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells, lightweight batteries, and innovative power generation and storage concepts. Continue development of 35 percent efficient solar cells and thin film solar cells. Complete development of power cells using thermal to electric conversion technology and lithium ion and polymer batteries. Improve accuracy of cryocooler modeling tools, and identify mechanisms that limit operational life and degrade cryocooler subsystem performance.
(U)	$7,391	Continue to develop technologies for advanced space platform structures such as spacecraft structural controls for vibration suppression, multi-functional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Develop and complete vibration suppression algorithms. Continue development of multi-functional structures and complete integration techniques. Integrate and ground test component subsystems of deployable large aperture optical arrays to identify performance of deployable optics.
(U)	$2,325	Complete development of 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. Complete MightySat II.1 mission operations and analyze platform and stand-alone experiment operations.
(U)	$12,489	Continue to develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Fabricate components for microsatellite, and complete detailed design of a three-unit flight constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing.
(U)	$1,783	Develop and demonstrate innovative methodology for aluminum aerostructure design. Develop a technical strategy to insert aluminum processing/manufacturing capability into early design and analysis. Identify specific opportunities to employ methodology on Air Force weapon systems. Demonstrate benefits on selected parts/assemblies to minimize cost while maintaining mechanical properties.
(U)	$991	Develop low-cost, lightweight, leak-proof, linerless, non-metallic composite cryogenic tanks for reusable and small expendable launch vehicle applications. Design, fabricate, and test lightweight composite end-bosses and perform studies to address problems with delamination and micro-cracking.
(U)	$3,963	Further develop and evaluate the world's first optically implemented Code Division Multiple Access (CDMA) wide-band network within the

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602601F Space Technology	PROJECT 8809

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

context of the Next Generation Internet. Assess and demonstrate the inherent security capabilities as a means of enhancing information assurance at the transmission level.

(U) $32,501 Total

(U) FY 2002 ($ in Thousands)

(U) $4,396 Develop technologies for advanced space platform subsystems, such as cryocoolers, compact, high-efficiency solar power cells and arrays, and innovative power generation concepts. Continue identification of mechanical mechanisms for assessing cryocooler reliability. Develop improved models for low-temperature cryocooler regenerator performance. Demonstrate a 32 percent efficient solar cell and a ten percent efficient thin-film solar cell.

(U) $8,898 Develop technologies for advanced space platform structures such as structural controls for vibration suppression, multifunctional structures, deployable large aperture optical arrays, and lightweight composite satellite and launch vehicle structures. Ground test payload vibration suppression systems. Fabricate and characterize performance of multi-functional structure designs. Continue integration and ground test of component subsystems of deployable large aperture optical arrays. Start development of multifunctional bus structure for small spacecraft.

(U) $17,628 Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Integrate and test microsatellite engineering model, and begin component fabrication of a three-unit flight constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing.

(U) $30,922 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.
(U) PE 0603311F, Ballistic Missile Technology.
(U) PE 0603401F, Advanced Spacecraft Technology.
(U) PE 0603410F, Space Systems Environmental Interactions.

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

(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-2 Exhibit)

DATE: **June 2001**

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602602F Conventional Munitions

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	36,466	52,734	49,270	49,798	50,900	51,142	52,532	53,964	Continuing	TBD
2068	Advanced Guidance Technology	12,764	0	16,749	17,566	17,778	18,374	18,837	19,526	Continuing	TBD
2502	Ordnance Technology	23,702	52,734	32,521	32,232	33,122	32,768	33,695	34,438	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, Project 2068 was combined with Project 2502. In FY 2002, Project 2068 was separated from Project 2502 for clarity of describing the different technologies. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

The Conventional Munitions program investigates, develops, and establishes the technical feasibility and military utility of advanced guidance and ordnance technologies for conventional air-launched munitions. The program includes two projects: (1) development of advanced guidance technologies including seekers, navigation and control, target detection and identification algorithms, and simulation assessments; and, (2) development of conventional ordnance technologies including warheads, fuzes, explosives, munition integration, and weapon lethality and vulnerability assessments. Note: In FY 2001, Congress added $8.0 million for MicroSat Technology (XSS-10). Program Element 0603401F, Advanced Spacecraft Technology was the more appropriate Program Element for this effort.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	37,892	45,223	45,350	
(U)	Appropriated Value	38,205	53,223		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-61			
	b. Small Business Innovative Research	-901			

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BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602602F Conventional Munitions

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

		FY 2000	FY 2001	FY 2002	Total Cost
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-502			
	e. Rescissions	-275	-489		
(U)	Adjustments to Budget Years Since FY 2001 PBR			3,920	
(U)	Current Budget Submit/FY 2002 PBR	36,466	52,734	49,270	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: June 2001

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602602F Conventional Munitions

PROJECT: 2068

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2068 Advanced Guidance Technology	12,764	0	16,749	17,566	17,778	18,374	18,837	19,526	Continuing	TBD

Note: In FY 2001, Project 2068 was combined with 2502. In FY 2002, Project 2068 was separated from 2502 for clarity of describing the different technologies.

(U) A. Mission Description

The Advanced Guidance Technology 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, signal and processing algorithms, and guidance and control simulations. Project payoffs include: adverse-weather and autonomous precision guidance capability; increased number of kills per sortie; increased aerospace vehicle survivability; improved reliability and affordability; and, improved survivability and effectiveness of conventional weapons.

(U) FY 2000 ($ in Thousands)

(U) $4,067 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) $4,611 Investigated and developed advanced navigation and control technologies for current and future munitions that will decrease pilot workload and increase survivability.

(U) $2,076 Investigated and developed advanced optical and digital processors and advanced target detection, classification, and identification algorithms for autonomous seekers. These seekers will provide the basis for smart autonomous weapons that will decrease pilot workload and increase survivability.

(U) $2,010 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) $12,764 Total

(U) FY 2001 ($ in Thousands)

(U) $0 This work was performed in Project 2502.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT **2068**

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

(U) FY 2002 ($ in Thousands)

(U) $5,733 Investigate and develop advanced guidance component technologies for lower cost, enhanced precision, adverse weather, and autonomous seekers for air-delivered munitions. These technologies will enable the development of next generation seekers that will increase a weapon's kill probability, reduce pilot workload, and enhance sortie effectiveness. Develop software tools for the development of laser radar (LADAR) algorithms and create a database for both measured and synthetic LADAR information. Initiate development and ground test of a scanner-less LADAR system with simultaneous, multi-wavelength capabilities. In conjunction with DARPA, investigate and develop focal plane array architecture capable of flash (one shot) range imaging for application in LADAR seekers.

(U) $4,782 Investigate and develop advanced navigation and control technologies for air-delivered munitions. These technologies will allow a more efficient flight path to the target, increase standoff ranges, and enhance strike aircraft effectiveness and survivability. Design and fabricate a reliable, accurate, miniaturized, and low-cost anti-jam weapon guidance system capable of operating in highly dynamic flight environments in the presence of Global Positioning System (GPS) jamming systems. Complete development of a miniature navigation system, based on micro-electro mechanical system technology, that couples the GPS signal with an inertial navigation system to provide ultra-high GPS jamming resistance and accuracy without the need for an anti-jam antenna.

(U) $3,177 Investigate and develop advanced optical and digital processors and target detection, classification, and identification algorithms for improved seeker performance to allow greater air delivered weapon autonomy. These seekers will deny an enemy the ability to hide or camouflage a target while also decreasing the pilot's workload. Develop an in-house, state-of-the-art signal and imaging processing capability used to assess current and future, single-mode, ultra-spectral, and multi-mode seeker concepts. Investigate and transition biomimetic principles and concepts, including Foveal vision and neuromorphic imaging systems, into advanced seeker components for moving target scenarios. Continue in-house activities including algorithms and simulation development/validation, statistical analysis of fixed/mobile targets/background data, independent evaluation of target classification software, pattern recognition concepts, and seeker processing techniques to support design of autonomous munitions.

(U) $3,057 Investigate and develop detailed six-degree-of-freedom and hardware-in-the-loop simulations and models to analyze guided munitions and their components that will enable requirements studies, design iteration and evaluation, and experiment risk reduction. These simulations will shorten development time, reduce development cost, and provide more effective munitions. Continue analysis efforts and multi-sensor modeling to improve target signature prediction models, expedite development, and reduce the acquisition cycle expense for state-of-the-art seekers. Develop hardware-in-the-loop LADAR scene projector instrumentation. The instrumentation will combine optical signals to produce a complex LADAR return signal capable of providing real-time scene generation capabilities to test seeker components. Develop six-degree-of-freedom simulations to provide detailed performance estimates of guidance related component technology for guided weapon systems. Develop modular system level analysis tools to provide comprehensive comparisons among inventory, planned, and conceptual munitions to identify high payoff technologies and weapon attributes.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT **2068**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued
(U) $16,749 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 **June 2001**

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

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2502	Ordnance Technology	23,702	52,734	32,521	32,232	33,122	32,768	33,695	34,438	Continuing	TBD

Note: In FY 2001, Project 2068 was combined with 2502. In FY 2002, Project 2068 was separated from 2502 for clarity of describing the different technologies.

(U) **A. Mission Description**

The Ordnance Technology project investigates, develops, and evaluates conventional ordnance 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, warheads, and weapon airframe and carriage technology. The project also assesses the lethality and effectiveness of current and planned conventional weapons technology programs and assesses target vulnerability. The payoffs include: improved storage capability and transportation safety of fully assembled weapons; improved warhead and fuze effectiveness; improved submunition dispensing; low-cost airframe/subsystem components and structures; and, reduced aerospace vehicle/weapon's drag. Note: In FY 2001, Congress added $8.0 million for MicroSat Technology (XSS-10). Program Element 0603401F, Advanced Spacecraft Technology was the more appropriate Program Element for this effort.

(U) FY 2000 ($ in Thousands)

(U) $5,625 Investigated and developed high fidelity analytical tools such as computational mechanics models for predicting weapon's 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 Investigated and developed 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 and less expensive explosive fills for inventory and future weapons.

(U) $5,417 Investigated and developed 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 Investigated and developed advanced air-delivered munition control and carriage technologies for ordnance packages in order to enhance weapon lethality. These technologies will contribute to increased weapon load-out on strike aircraft and increased sortie effectiveness.

(U) $5,605 Investigated and developed 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 load-out and sortie effectiveness.

(U) $23,702 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT **2502**

(U) A. Mission Description Continued

(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. These analysis tools 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, involved in predicting penetrator performance against hard targets. Investigate innovative kill mechanisms for defeating weapons of mass destruction. Transition selected high fidelity analytical tools to weapon designers in the 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. The advanced fuze technologies enhance lethality through precise selection of burst-height either at, above, or below the surface to increase weapon safety and tactical performance while simultaneously decreasing procurement costs and system supportability requirements. Investigate micro-electro mechanical system 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 per 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 ordnance packages in order to enhance weapon lethality. These technologies will contribute to increased weapon load-out on strike aircraft and increased sortie effectiveness. Design, fabricate, and test submunitions for survivability during high mach number dispensing. Begin ground testing of technologies that will enable the development of a fast reaction weapon to engage and destroy time-critical targets. Investigate the communication architectures to determine if they can be utilized to improve munitions planning, performance, and deployment.

(U) $7,118 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 load-out and sortie effectiveness. Perform sub-scale and full-scale experiments of several candidate payload technologies to determine their effectiveness to neutralize, deny, or destroy specially formulated chemical and biological targets. Continue testing and characterizing the effectiveness of tantalum warheads against targets that simulate the full spectrum of ground mobile threats. Complete in-house research on the effects of explosives on chemical and 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602602F Conventional Munitions	PROJECT 2502

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U)	$5,020	Investigate and develop advanced component technologies for lower cost, enhanced precision, adverse weather, and autonomous seekers for air-delivered munitions. These technologies will enable the development of next generation seekers that will increase a weapon's kill probability, reduce pilot workload, and enhance sortie effectiveness. Design and fabricate the subsystems for a gimbal-less laser radar sensor with total electronic scanning. Develop and validate advanced algorithms that identify mobile targets using their unique external components, such as guns or antenna.
(U)	$6,331	Investigate and develop advanced navigation and control technologies for air-delivered munitions. These technologies will allow a more efficient flight path to the target and increase standoff ranges, enhancing strike aircraft effectiveness and survivability. Investigate guidance and control technologies that may provide significantly enhanced capability to locate and engage a moving or partially hidden target. Develop a low-cost, multi-sensor navigation device using micro-electro mechanical system 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 for the multi-sensor navigation device. Combine brassboard components of advanced Global Positioning System to begin laboratory bench tests for the multi-sensor navigation device.
(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. The advanced seekers will further deny an enemy's ability to hide or camouflage a target while decreasing the pilot's workload. Complete the phenomenology studies required validating the performance enhancements to be realized with a 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 for the dual-mode seeker.
(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 and evaluation, and experiment risk reduction. These advanced simulations will reduce development cost and time, and provide more effective munitions. Develop tactical scene generation capability to produce re-useable, 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)	$8,000	Develop microsatellite (10-100 kg) technologies, combine sub-system technologies, and launch first microsatellite in the XSS series to evaluate autonomous space operations. (Note: In FY 2001, Congress added $8.0 million for MicroSat Technology (XSS-10). However, this is not the correct Program Element for this effort and current plans are to transfer these funds to PE 0603401F, Advanced Spacecraft Technology, for execution).
(U)	$52,734	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT **2502**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $6,206 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 providing weapons that can generate maximum lethality against a given target class. Develop new hydro-code to improve predictive warhead performance capabilities by adding metal cutting, detonation waves, shear banding, and phase transitions. Develop a high fidelity model that predicts the dispersion of chemical and biological neutralizing agents from warheads. Upgrade and refine basic models describing fragmentation effects against various target facilities, including weapons of mass destruction (WMD). Perform phenomenology tests to provide data for the development of lethality and vulnerability codes for ground-fixed WMD targets.

(U) $3,477 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. Utilize micro-scale and nano-scale fuel and oxidizer particles to create new, intermolecular energetic materials. In collaboration with Department of Energy labs, complete efforts to develop a new class of materials for use in fragments, shaped charges and explosively formed projectiles. Complete development of insensitive explosive formulations for use in penetrator warheads capable of mach four impact velocities. Initiate development of a highly energetic material with twice the power density of conventional explosives, but exhibiting insensitive munition attributes. Evaluate intermolecular energetic material to measure mixing and fabrication techniques, material properties, and performance augmentations for specific applications. Initiate dense reactive metal explosive's research to investigate cost effective methods to improve current explosives.

(U) $6,258 Investigate and develop advanced fuze, including safe and arm, technologies for air-delivered munitions. The advanced fuze techniques will enhance lethality through precise selection of burst-height at, above, or below the surface to increase weapon safety and tactical performance while simultaneously decreasing procurement costs and system supportability requirements. Develop test methodology to analyze hardened-influence-fuze components, and bench-level, field-shock testing of fuze components. Initiate critical component design and brassboard fabrication for the next generation burst-height fuze with discrimination against foliage, rain, chaff, electronic countermeasures, and electromagnetic interference. Investigate technologies with potential for allowing the reporting of battle damage assessment through hardened mediums.

(U) $7,394 Investigate and develop advanced air-delivered munition control and carriage technologies for ordnance packages to enhance weapon lethality. These technologies will increase weapon system effectiveness by contributing to increased weapon load-out on strike aircraft and enhanced sortie effectiveness. Develop advanced munition dispenser electronics and software and investigate reduction of platform integration cost for the advanced carriage technology. Investigate alternate technologies, such as microbots, nano-encapsulation, to disrupt, deny, destroy, or damage facilities involved with chemical and biological weapons. Increase emphasis on defeating hard and deeply buried targets.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602602F Conventional Munitions**	PROJECT **2502**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $9,186 Investigate and develop advanced warhead kill mechanisms to enhance air-delivered munition lethality. This enhanced lethality supports the development of smaller munitions with effectiveness similar to current inventory weapons and with a corresponding increase in strike aircraft load-out and sortie effectiveness. Design, fabricate, and evaluate initiation-based, adaptable, and multi-mode warheads using enhanced lethality materials and miniaturization technologies for the advanced warhead kill mechanism. Fabricate and test a working agent defeat warhead design to determine its ability to deny an adversary access to a facility containing chemical or biological weapons. Analyze improvements to multi-mode warheads using heavy metal liners to enhance lethality. Perform in-house experiments to characterize the interaction of munitions with chemical and biological containers.

(U) $32,521 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
June 2001

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602605F DIRECTED ENERGY TECHNOLOGY

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	0	32,041	36,678	37,827	36,773	37,266	38,186	39,126	Continuing	TBD
4866	Lasers & Imaging Technology	0	15,871	20,118	21,823	21,614	21,610	22,150	22,699	Continuing	TBD
4867	Advanced Weapons & Survivability Technology	0	16,170	16,560	16,004	15,159	15,656	16,036	16,427	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: Starting in FY 2001, the two projects in this PE were moved from PE 0602601F. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

This PE covers research in directed energy technologies, primarily lasers and high power microwaves. In lasers, this includes moderate to high power lasers (solid state and chemical), associated optical components and techniques, and long-range optical imaging concepts. In advanced weapons, this PE examines technologies such as narrow and wideband high power microwave devices and antennas. Both areas also provide vulnerability/lethality assessments of representative systems.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	0	32,337	32,017	
(U)	Appropriated Value	0	32,337		
(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		-296		

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Adjustments to Budget Years Since FY 2001 PBR			4,661	
(U)	Current Budget Submit/FY 2002 PBR	0	32,041	36,678	TBD

(U) Significant Program Changes:

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)										DATE June 2001	
BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY							PROJECT 4866
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4866	Lasers & Imaging Technology	0	15,871	20,118	21,823	21,614	21,610	22,150	22,699	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 applications such as illuminators and imaging sources for target identification and assessment are developed. Laser technologies are studied for their utility in aimpoint selection, target maintenance, and damage assessment.

(U) FY 2000 ($ in Thousands)

(U) $0 This work was performed in PE 0602601F/Project 3326. The funding was $17.279 million.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $2,091 Develop long-range optical technologies for increased resolution, characterization, and data fusion applications. Explore lightweight membrane mirror issues for scaling to very large size (~ 10-meter mirrors). Address issues associated with producing the mirror close to final curvature and demonstrate on 0.5 meter class mirror with holographic correction.

(U) $724 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) $4,855 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) $2,684 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 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT **4866**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

ultra-fast laser source for investigations of novel atmospheric propagation characteristics.

(U) $5,517 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) $15,871 Total

(U) FY 2002 ($ in Thousands)

(U) $2,036 Develop and field test advanced optics technologies to support beam projection and imaging applications associated with large aperture lightweight optics. Develop new integrated component nonlinear optics /liquid crystal devices for faster corrections, increased resolution, and larger apertures. Test and characterize these devices in a laboratory environment. Emphasize extending the wavelength coverage and decreasing number of system components. Decreasing the number of system components and extending the wavelength coverage have major applications to space-based optical systems. Produce one-meter class membrane mirror with near final curvature and demonstrate holographic correction of the mirror surface.

(U) $5,667 Develop high power chemical laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications. Optimize high pressure ejector nozzle performance and iodine atom generation for potential long-range technology insertion into applications such as airborne lasers. Demonstrate a 500-watt microwave-driven supersonic all gas-phase iodine laser. Begin construction of a combustor-driven one kilowatt supersonic all gas-phase iodine laser. Optimize efficiency of the radio frequency-pumped overtone carbon monoxide laser in various spectral bands of interest for infrared countermeasures and remote sensing applications.

(U) $3,811 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. Demonstrate multifunctional laser countermeasure components capable of detecting, tracking, and defeating advanced anti-aircraft missiles. Test a full-up integrated countermeasures concept utilizing static pointer/tracker optics and the new surrogate missile seeker obtained in FY 2001. Demonstrate a pulsed/ultrafast laser source capable of countering focal plane array missile seekers.

(U) $6,090 Develop low-cost, scalable, high power solid state laser architectures 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 35%), compactness (goal greater than one kilowatt per cubic foot), and scalability. Develop integration technologies necessary for combining multiple

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT 4866

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

		fiber laser modules including nonlinear optical phasing technologies.
(U)	$528	Develop advanced laser remote optical sensing technology to support standoff detection requirements for chemical/biological agent aerosols for measurement and signature intelligence, bomb damage assessment, target characterization, and theater intelligence, surveillance, and reconnaissance. Complete Phase II experiments for frequency agile heterodyne receiver development.
(U)	$1,986	Assess the vulnerability of six satellites (U.S., NATO, and foreign) to the effects of directed energy weapons, primarily high energy lasers. Update previously completed assessments on catalogued satellites. Fuse finite state models with other satellite data and observables to produce a more complete space situational awareness posture.
(U)	$20,118	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 June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT 4867

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4867 Advanced Weapons & Survivability Technology	0	16,170	16,560	16,004	15,159	15,656	16,036	16,427	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 aircraft self-protection are developed. This project provides for vulnerability assessments of representative U.S. strategic and tactical systems to HPM weapons, HPM weapon technology assessment for specific Air Force missions, and HPM weapon lethality assessments against foreign targets.

(U) FY 2000 ($ in Thousands)

(U) $0 This work was performed in PE 0602601F/Project 625797. The funding was $18.110 million.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $3,046 Investigate and develop technologies for multi-pulsed narrowband and wideband HPM components to support multiple Air Force applications as recommended by the Phase II Directed Energy Applications in Tactical Airborne Combat (DE ATAC) study. Continue investigation of better source modeling techniques in order to incorporate HPM technologies into warfighting/war gaming activities. Investigate high efficiency repetitively-pulsed HPM source. Develop frequency agile HPM source. Develop compact repetitively operated sources. Start pulsed atmospheric breakdown experiments. Start explosive generator development experiments to support compact single-shot HPM sources.

(U) $1,846 Assess effects/lethality of HPM weapon technologies against representative air and ground military systems. Continue to conduct susceptibility tests of representative command and control warfare targets. Investigate effects on targets of HPM sources pulsed at high repetition rates.

(U) $1,982 Investigate and develop wideband HPM technologies that support command and control warfare and other wideband applications. Research advanced antenna designs driven by mission concepts. Continue applied research to improve wideband HPM sources in order to achieve greater range or smaller packaging. Continue advancement of computer codes' ability to predict the electromagnetic coupling to target equipment and probability of effect inside increasingly complex structures. Expand HPM effects prediction models for implementation into engagement scenario models. Research methods to enhance HPM source technology such as power throughput for solid state switches and high repetition rates for high pressure gas switches.

(U) $2,873 Develop narrowband HPM technologies that support suppression of enemy air defenses through the use of reusable airborne platforms and munitions. Continue to expand range of predictability of HPM narrowband effects models for military electronic targets of interest. Continue validation of predictability of models. Continue investigation of pulsed power and HPM source capability to support an integrated experiment to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602605F DIRECTED ENERGY TECHNOLOGY	PROJECT 4867

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

show proof-of-principle capability for single shot technologies. Complete design of subscale (laboratory) breadboard high power microwave (HPM) system to validate approach and capability for repetitively pulsed technologies for HPM munitions and airborne electronic attack. Continue development of component technologies – pulsed power, sources, and antennas – for repetitively pulsed airborne and munitions systems.

(U) $3,691 Investigate HPM technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible based on increased power available on future aircraft. Design and fabricate optimal sources for the most promising concepts identified by the FY 2000 trade off study. Perform effects experiments upon targets of interest to determine effectual lethality of each concept. Develop HPM aircraft self-protect effects database of commercial-off-the-shelf sources, missile targets, and aircraft platforms.

(U) $1,933 Assess the vulnerability of seven satellites (U.S., NATO, and foreign) to the effects of directed energy weapons, primarily high energy lasers. Update previously completed assessments on catalogued satellites. Support Space Situational Awareness by developing finite state models to predict satellite performance from observed behavior. Compile assessment data and models into easily accessible folders for satellite characterization.

(U) $799 Investigate the best means for active denial technologies to support agile combat support applications. Continue development of millimeter wave sources for active denial technology and conduct experiments including beam transport and power extraction. Investigate HPM source enhancement technologies using computer simulations.

(U) $16,170 Total

(U) FY 2002 ($ in Thousands)

(U) $3,262 Investigate and develop technologies for multi-pulsed narrowband and wideband HPM components to support multiple Air Force applications as recommended by the Phase II Directed Energy Applications in Tactical Airborne Combat (DE ATAC) study. Continue developing better HPM source modeling techniques to incorporate HPM technologies into warfighting/war gaming activities. Design high efficiency repetitively pulsed HPM source. Conduct laboratory test of frequency agile HPM source. Continue development of compact repetitively operated sources. Continue pulsed atmospheric breakdown experiments. Continue explosive generator development experiments to support compact single-shot HPM sources.

(U) $2,560 Assess effects/lethality of HPM weapon technologies against representative air and ground military systems. Continue to conduct susceptibility tests of representative command and control warfare targets. Conduct susceptibility tests of high, repetitively pulsed effects on targets. Implement effects data and results into narrowband and wideband HPM experiments and demonstrations.

(U) $1,029 Investigate and develop wideband HPM core technologies that support wideband applications. Continue to improve the electrical efficiency of

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

high power microwave (HPM) sources in order to achieve greater range, longer lifetime, or smaller packaging. Continue validation of computer codes' ability to predict the wideband electromagnetic coupling to increasingly complex structures.

(U) $3,485 Develop narrowband HPM technologies that support suppression of enemy air defenses through the use of reusable airborne platforms and munitions. Continue to expand range of predictability of HPM narrowband effects models to damage or disrupt military electronic targets of interest. Continue validation of predictability of models. Integrate pulsed power and HPM source to show capability for single shot technologies. Select a repetitively pulsed multi-gigawatt technology for HPM breadboard munitions and airborne electronic attack proof-of-concept. Continue development of component technologies – pulsed power, sources, and antennas – for repetitively pulsed airborne and munitions systems.

(U) $4,417 Investigate HPM technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible based on increased power available on future aircraft. Fabricate and test optimal sources for the most promising concepts identified by the tradeoff study to include an HPM repetitively pulsed source on an unmanned combat air vehicle platform. Continue to perform effects experiments upon targets of interest to determine effectual lethality of each concept. Continue development of HPM aircraft protect effects database and characterize commercial-off-the-shelf sources, missile targets, and aircraft platforms.

(U) $1,807 Investigate the best means for active denial technologies to support agile combat support applications. Continue development of millimeter wave sources for active denial technology, including airborne active denial technologies -- conduct experiments including power combining, depressed collector, and modulation schemes. Begin development of components other than the millimeter wave source such as the prime power, power conditioning, and antenna required to enable a man-portable system. Investigate HPM source enhancement technologies using computer simulations.

(U) $16,560 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602605F DIRECTED ENERGY TECHNOLOGY**	PROJECT **4867**

(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 **June 2001**

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	55,551	86,448	59,672	67,480	67,631	69,753	71,788	73,920	Continuing	TBD
4506	Surveillance Technology	6,421	0	0	0	0	0	0	0	Continuing	TBD
4519	Communications Technology	11,992	22,313	14,368	15,513	14,640	15,975	16,444	16,940	Continuing	TBD
4594	Information Technology	13,861	32,367	22,606	22,998	23,516	23,820	24,530	25,272	Continuing	TBD
4600	Electromagnetic Technology	9,273	10,496	0	0	0	0	0	0	Continuing	TBD
4917	Collaborative Information Tech	0	0	5,200	5,741	5,182	5,321	5,441	5,572	Continuing	TBD
5581	Command and Control (C2) Technology	14,004	21,272	17,498	23,228	24,293	24,637	25,373	26,136	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, the effort performed in Project 4506 moves into Project 4594. In FY 2002, portions of efforts accomplished in Project 4519, Project 4594, and Project 5581 move into Project 4917. In FY 2002, the effort accomplished in Project 4600 moves into PE 0602204F, Project 4916. This realignment aligns projects with the Air Force Research Laboratory organizational structure. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(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. The program has four projects. The Communication Technology project develops assured, secure communications technology. The Information Technology project develops improved and automated capabilities to generate, process, fuse, exploit, interpret, and disseminate timely and accurate information. The Collaborative Information Technology project develops high payoff emerging technologies for the next generation of distributed, collaborative command and control systems. The Command and Control Technology project investigates and develops planning, assessment, and knowledge base technologies to allow the warfighter to plan, assess, execute, monitor, and re-plan on the compressed time scales required for tomorrow's conflicts. Note: In FY 2001, Congress added $8.5 million for simulation-based acquisition.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	52,085	78,749	63,166	
(U)	Appropriated Value	52,148	87,249		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-18			
	b. Small Business Innovative Research	-1,064			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	4,689			
	e. Rescissions	-204	-801		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-3,494	
(U)	Current Budget Submit/FY 2002 PBR	55,551	86,448	59,672	TBD

(U) Significant Program Changes:

In FY 2002, a decrease in this program is due to the realignment of electromagnetic efforts. Electromagnetic efforts move from this PE into PE 0602204F as part of the Air Force's Science and Technology PE realignment.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 4506

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4506 Surveillance Technology	6,421	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, the effort accomplished in Project 4506, moves into Project 4594.

(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: spatial coordinate and time processing techniques; sensor and data fusion; and advanced signal processors.

(U) FY 2000 ($ in Thousands)

(U) $2,024 Demonstrated and assessed 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) $2,016 Developed multisensor fusion algorithms in a fully distributed environment. Completed development and demonstration of fusion quality measures validating enhanced performance.

(U) $2,381 Developed embedded, affordable, scalable, teraflop processing technologies for real-time information fusion and exploitation. Completed design and implementation technologies for fully programmable, scaleable, affordable teraflop processors for real-time fusion and processing.

(U) $6,421 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moves to Project 4594.

(U) $0 Total

(U) FY 2002 ($ 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 June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT **4506**

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

(U) Related Activities:

(U) PE 0603789F, C3I Advanced Development.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE **June 2001**

BUDGET ACTIVITY
02 - Applied Research

PE NUMBER AND TITLE
0602702F Command Control and Communications

PROJECT
4519

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4519 Communications Technology	11,992	22,313	14,368	15,513	14,640	15,975	16,444	16,940	Continuing	TBD

Note: In FY 2002, a portion of the effort accomplished in Project 4519 moves into Project 4917.

(U) A. Mission Description

The Air Force requires technologies that enable assured, worldwide communications for an agile Expeditionary Aerospace Force (EAF). These communication technologies will provide en-route and deployed reachback communications for distributed collaborative command and control (C2). A rapidly deployed EAF requires assured connectivity with reliable, responsive, affordable information exchange via all available communications media. This project provides the technologies for: multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques; lightweight, phased array antennas; and modular, programmable, low-cost radios. It includes technologies for advanced processors and devices, advanced network protocols and services, intelligent communications management and control, advanced communications algorithms, and enabling communication signal processing techniques.

(U) FY 2000 ($ in Thousands)

(U) $4,500 Developed assured and survivable information and networking technologies enabling the capability for worldwide command, control and communication operations for EAF. Developed 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 Developed critical communications and signal processing technologies to provide adaptive, covert, anti-jam, and assured global battlespace connectivity to aerospace forces and greatly reduce equipment footprint. Continued millimeter component development and the Smart Network Radio program.

(U) $2,439 Developed Defensive Information Warfare tools and technologies to ensure information protection and security of sensitive and encrypted Air Force communication and information systems. Developed net visualization tools and attack indicators. Developed automated capability for computer forensics analysis.

(U) $11,992 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 EAF. Develop information systems and networking technologies for globally distributed information systems. Continue to develop technologies to provide managed, seamless global information exchange for the 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 4519

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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. (In FY 2002, a portion of this effort moves into Project 4917.)

(U) $7,429 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) $22,313 Total

(U) FY 2002 ($ in Thousands)

(U) $5,600 Develop assured and survivable information and networking technologies enabling the capability for worldwide command, control and communication operations for Expeditionary Aerospace Forces. Continue to develop technologies to improve quality of service for globally distributed information systems. Continue to develop assured networking and information systems technologies to improve survivability to critical infrastructure attacks. Complete development of technologies for assured wireless networking algorithms.

(U) $3,539 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. Investigate and develop techniques to improve information assurance capabilities for mobile wireless networks to preclude information attacks aimed at denial of service and quality of service degradation. Continue to develop mobile communication technologies for wide-band data and video services to beyond-line-of-sight airborne command and control, and sensor platforms.

(U) $5,229 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 automated capability for damage assessment and recovery of information systems. Develop computer and network forensics tools. Develop data mining tools for coordinated information warfare attack assessment. Investigate techniques to perform analysis on detection and eradication of malicious software.

(U) $14,368 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT **4519**

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

(U) Related Activities:

(U) PE 0603789F, C3I Advanced Development.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 4594

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4594 Information Technology	13,861	32,367	22,606	22,998	23,516	23,820	24,530	25,272	Continuing	TBD

Note: In FY 2002, a portion of the effort accomplished in Project 4594 moves into Project 4917.

(U) A. Mission Description

The Air Force requires technologies that improve and automate their capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information. This project improves global awareness at all levels, enabling warfighters to understand relevant military situations on a consistent basis, with the timeliness and precision needed to accomplish their missions. Global awareness is achieved by exploiting information provided by the Air Force and other government agencies. The information is fused to support the dynamic planning and execution cycle via the global information enterprise. Knowledge, information, and data are 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. Note: In FY 2001, Congress added $8.5 million for simulation-based acquisition.

(U) FY 2000 ($ in Thousands)

(U) $4,235 Developed information exploitation technologies for imagery and electronic signals to increase global awareness. Automated multisensor and multimedia technologies to automatically detect and track targets using radiated signals across the entire spectrum for precision location and identification.

(U) $4,783 Developed and evaluated innovative multisensor collaborative fusion technologies in a fully distributed aerospace environment. Developed 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) $4,843 Developed global information base technologies for global, theater, and local situation awareness providing timely and accurate input to dynamic planning and execution operations. Developed 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.

(U) $13,861 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 4594

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U)	$7,569	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)	$6,083	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. (In FY 2002, this effort moves to Project 4917.)
(U)	$6,160	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)	$32,367	Total

(U) FY 2002 ($ in Thousands)

(U)	$5,900	Develop information exploitation technologies for imagery and electronic signals to increase global awareness. Develop advanced multi-sensor open systems techniques and tools for production of imagery (including hyperspectral), electronic signals, and speech intelligence products to achieve situation awareness. Develop advanced information dissemination techniques for seamless integration into global information databases.
(U)	$6,000	Develop and evaluate innovative multi-sensor collaborative fusion technologies in a fully distributed aerospace environment. Develop techniques to quantitatively evaluate fusion algorithms. Develop and evaluate fusion technologies for multi-platform cross-cueing of sensors for the location and identification of military targets, addressing surface, airborne, and spaceborne systems in a fully distributed environment.

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BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT **4594**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $6,480 Develop global information base technologies to achieve situational awareness at all command levels for the dynamic planning and execution process. Investigate information extraction techniques to automatically populate very large knowledge base systems. Develop approaches for synthesizing a common data representation from multiple sources for improved situational awareness. Investigate methods of content-based retrieval techniques for improved sensor data exploitation and faster data base access.

(U) $2,688 Develop affordable, scalable, teraflop processing technologies for real-time information fusion and exploitation. Develop processor-in-memory, content-addressable architecture for rapid extraction of information from globally distributed knowledge bases. Develop architectures to support real-time requirements for dominant battlespace awareness.

(U) $1,538 Develop modeling and simulation technologies to support next generation planning, execution, and assessment environments. Evaluate, exploit, and develop model abstraction and multi-resolution modeling techniques to reduce the complexity of existing high-resolution models and simulations, and to support the National Air and Space Model and the joint battlespace infosphere.

(U) $22,606 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0603789F, C3I Advanced Development.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602702F Command Control and Communications							PROJECT 4600

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4600 Electromagnetic Technology	9,273	10,496	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2002, the effort accomplished in this project moves into PE 0602204F, Project 4916.

(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 2000 ($ in Thousands)

(U) $2,760 Designed and developed electromagnetic technologies for advanced surveillance and reconnaissance systems applications. Developed and evaluated algorithms for a digital beam-formed multibeam antenna.

(U) $2,760 Designed and developed antenna concepts for aerospace surveillance and reconnaissance applications. Developed and evaluated advanced concepts for large, lightweight arrays. Developed and evaluated a three-dimensional optically excited antenna array.

(U) $3,753 Designed and developed electro-optical technology to enable passive or active targeting of difficult targets. Investigated ways of mitigating atmospheric phenomenology effects on extended range aerospace sensors. Developed turbulence compensation techniques for precision targeting, target signatures, and phenomenology models, and selected multifunction sensor target characteristics. Designed and developed infrared focal plane array technology.

(U) $9,273 Total

(U) FY 2001 ($ in Thousands)

(U) $3,396 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) $3,176 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) $3,924 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

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BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT **4600**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

and develop infrared focal plane array technology.

(U) $10,496 Total

(U) FY 2002 ($ in Thousands)

(U) $0 In FY 2002, the effort moves into PE 0602204F, Project 4916.

(U) $0 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 June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 4917

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4917 Collaborative Information Tech	0	0	5,200	5,741	5,182	5,321	5,441	5,572	Continuing	TBD

Note: Prior to FY 2001, the effort in this project was previously accomplished in PE 0602204F, Projects 6096, 2003, and 7622. In FY 2001, the effort in this project was accomplished in Projects 4519, 4594, and 5581 in this PE.

(U) A. Mission Description

To implement the Expeditionary Aerospace Force concept, the Air Force requires a distributed, collaborative command and control (C2) system, allowing the majority of the C2 center to remain in CONUS, while only a small command element is deployed forward. This project accomplishes the initial exploration of high payoff emerging technologies for the next generation of distributed collaborative C2 systems. This program develops technologies for platform connectivity, collaboration and embedded information systems. Platform connectivity technologies focus on advanced modulation waveforms for bandwidth efficiency, assured aerospace platform connectivity for C2, and conceptual design approaches for seamless integration of aerospace weapon systems into the information grid. Collaboration technologies advance collaboration science, virtual environments, and predictive simulation tools to facilitate the development and fielding of next generation operational collaborative enterprises. Embedded information systems technologies explore high payoff technologies for the next generation of distributed information integration architectures, which will provide cross disciplinary products/capability to a decision maker when, where, and how it is needed. It also provides embedded information system technologies for affordable and adaptable design and development of complex C2 systems, facilitated by an open system architecture approach.

(U) FY 2000 ($ in Thousands)
(U) $0 The effort was accomplished in PE 0602204F, Projects 6096, 2003, and 7622.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 The effort was accomplished in Projects 4519, 4594, and 5581 in this PE.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $1,258 Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems command and control, intelligence, surveillance, and reconnissance data/information. Continue to develop assured, secure communications technology, leveraging the commercial infrastructure, for positive command and control of aerospace assets in civilian airspace. Continue to develop secure, wide-band wireless information transfer technology for assured communications by multiple weapon systems. (Prior to FY 2002, this effort was accomplished in Project 4519.)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 4917

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $2,250 Develop advanced information technologies for collaborative decision support, knowledge management, and rapid adaptation/re-allocation of assets in response to the continuing changing threat environment. Develop technologies to support distributed decision making and collaborative planning for Expeditionary Aerospace Forces in a battlespace information environment. Develop technology to support a sensor-to-shooter scenario stressing the time-critical-target (TCT) requirement, resulting in denying the enemy the sanctuary of time. (Prior to FY 2002, this effort was accomplished in Projects 5581 and 4594.)

(U) $1,692 Develop processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Develop dynamically reconfigurable aerospace systems using adaptive computing techniques. Continue to develop concepts, designs, and models for the next generation command and control global information systems, which will allow affordable design and development of highly complex aerospace systems, and autonomous unmanned airborne/spaceborne platforms for deployment against time-critical targets. (Prior to FY 2002, this effort was accomplished in Project 5881.)

(U) $5,200 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Related Activities:

(U) PE 0603789F, C3I Advanced Development.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602702F Command Control and Communications							PROJECT 5581
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
5581	Command and Control (C2) Technology	14,004	21,272	17,498	23,228	24,293	24,637	25,373	26,136	Continuing	TBD

Note: In FY 2002, a portion of the effort accomplished in Project 5581 moves into Project 4917.

(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, distributed battle management. Technologies being developed in this project will increase capability and quality, while reducing the cost of C2 systems and infrastructure. Technology development in this project focuses on planning and assessing techniques, knowledge bases, and distributed information systems. Advances in planning and assessment technologies will vastly improve the military decision making process within C2 systems. Advances in development of very large comprehensive knowledge bases to rapidly formulate and create new knowledge are needed by the Expeditionary Aerospace Force. Advances in distributed intelligent information systems will allow automatic rapid reconfiguration to varying crisis levels required by the Expeditionary Aerospace Force.

(U) FY 2000 ($ in Thousands)

(U) $6,616 Developed the next generation of planning and assessment technologies and tools enabling aerospace commanders to determine and create the desired operational effects at the right place at the right time. Developed intelligent information technologies including planning technology for coalition C2. Developed high performance knowledge-based technology for coordination and cooperative use of aerospace C2 resources.

(U) $2,078 Investigated and developed technologies for the rapid development and application of next generation knowledge-bases for C2 aerospace systems. Completed development of architecture-centered technology and modeling and analysis of evolvable software for increased capability, quality, and reliability of software-intensive systems. Developed techniques for knowledge-base theory slicing, merging, and conflict resolution.

(U) $5,310 Investigated, analyzed, and developed intelligent information management and user interface systems that tailor visualization strategies, information, access, and assurance mechanisms based on C2 application parameters.

(U) $14,004 Total

(U) FY 2001 ($ in Thousands)

(U) $6,158 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 C2 systems. Develop tools and techniques needed by an Expeditionary Aerospace Force for building very large comprehensive knowledge bases by rapidly

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602702F Command Control and Communications	PROJECT 5581

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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) $6,172 Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by Expeditionary Aerospace Forces. Develop and evaluate advanced display and human-computer interface technologies for current and next generation command and control (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 global C2 information systems which will allow the seamless insertion of highly autonomous unmanned airborne and spaceborne platforms for deployment against time-critical targets. (In FY 2002, this effort moves to Project 4917.)

(U) $5,000 Develop the technologies, tools, and techniques required to ensure protection of critical command, control, and communications (C3) 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) $21,272 Total

(U) FY 2002 ($ in Thousands)

(U) $5,399 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. Continue to 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 tools to visualize the probability of success of qualitatively different courses of action. Continue to develop technologies to provide alternative courses of action and feasibility assessment in uncertain environments. Investigate intelligent agent technologies capable of supporting C2 systems for various missions, from humanitarian relief to major theater warfare. Develop techniques to enable the rapid insertion of new forces and their C2 information management systems into a battlespace infosphere.

(U) $4,500 Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Develop tools that allow users to enter, validate, and manipulate knowledge using natural language, sketching, and templating approaches. Develop knowledge representation techniques to enable the structured common representation (SCR) required for a battlespace infosphere.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602702F Command Control and Communications**	PROJECT **5581**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

Develop capabilities that learn to extract, correlate, and classify link patterns. Investigate enhanced reasoning techniques and algorithms for more complex inferencing and performance.

(U) $7,599 Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by Expeditionary Aerospace Forces. Develop dynamic and adaptable interface technologies that allow commanders to create a mission-tailored view of the configuration and status of the currently executing Air Operations Center (AOC) command and control (C2) process. Develop advanced interactive displays suitable for deployment with C2 applications and command centers. Develop techniques and applications for information visualization for use in conjunction with multiple, heterogeneous data sets. Develop techniques for integrating legacy client-server C2 systems into the next generation of agile, web-enabled information management environments. Investigate approaches to enable C2 systems to smoothly scale to over 1,000 clients exchanging information using a publish-subscribe paradigm as required for a battlespace infosphere.

(U) $17,498 Total

(U) B. Project Change Summary

Not Applicable.

(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 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 **June 2001**

BUDGET ACTIVITY **02 - Applied Research**

PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**

PROJECT **4770**

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4770	Dual Use Science and Technology (S&T)	9,498	10,051	10,417	10,652	10,886	11,126	11,360	11,600	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

The Dual Use Science and Technology program seeks to leverage industry investments in advanced technologies that are mutually advantageous to 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 to provide greater access to commercial technologies, and lead to 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 the FY 1997 Defense Authorization Act Section 804, Other Transactions Authority, as part of the Dual Use Science and Technology program to educate the Air Force Science and Technology (S&T) workforce in non-traditional or commercial contracting practices. Technology areas considered include advanced materials and manufacturing, affordable sensors, advanced propulsion, power and fuel efficiency, information and communications systems, and weapon systems sustainment.

(U) FY 2000 ($ in Thousands)

(U) $3,942 Developed 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 included improving flight control, lightweight structures, common electronics, and vehicle subsystems. Specific projects included 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) $4,114 Developed information and sensor technologies that improve the capability of aerospace command and control, information dominance, and battlefield management, as well as enhance commercial communications and awareness. Technology areas included intelligent information systems, communication systems, information fusion, and collaborative environment development. Specific projects included development of low-cost Continuous Transverse Stub array antennas, and smart imaging sensors for application to military operations and civilian navigation.

(U) $1,442 Developed space technologies that will reduce the cost and improve the capability of both Air Force and commercial space vehicles and launch systems. Technology areas included improved space vehicle survivability, space vehicle control, and space-based sensing. Specific projects included 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602805F Dual Use Science & Technology	PROJECT 4770

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $9,498 Total

(U) FY 2001 ($ in Thousands)

(U) $2,774 Developed 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 included: 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) $2,576 Developed affordable advanced sensors technologies 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 included: 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) $1,727 Developed 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) $1,487 Developed 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 included: automation of logistics and equipment failure reporting; information recovery; intelligent information systems; information fusion; intelligent image correlators; smart data processing; and web-based virtual consortiums for modeling and simulation research/application.

(U) $1,487 Developed 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001	
BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602805F Dual Use Science & Technology	PROJECT 4770

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $10,051 Total

(U) FY 2002 ($ in Thousands)

(U) $2,617 Develop information technologies to ensure the collection, dissemination, security, accuracy, and presentation of information to U.S. military decision-makers and corresponding commercial industry sectors. Technology areas considered include gathering of pertinent information; providing for the fusion, accuracy, security, and transmission of information; and presenting the information in a consistent and easily understood manner to a decision maker.

(U) $2,600 Develop innovative techniques and processes for non-destructive inspection, evaluation, and maintenance of Air Force and commercial aircraft assets. These techniques and processes are relevant to enable critical maintenance and repair decisions by depot and flight line maintenance personnel. The focus is on refinement and optimization of inspection, evaluation, and prediction techniques for maintenance and troubleshooting. Technology areas include inspection, evaluation, and maintenance of avionics, propulsion, structures, flight controls, and expendables such as fuels, lubricants, and hydraulic fluid; application of these new techniques to in-flight monitoring and early warning indicators; and automated and/or autonomous operation of inspection and evaluation techniques.

(U) $2,600 Develop affordable, robust manufacturing processing and fabrication techniques for metals and special materials critical to defense weapon system applications. The technology will also support commercial applications and significantly impact the cost and performance of future aircraft, missiles, space systems, or other defense related applications. Technology areas considered include more efficient and affordable manufacturing processes/components, part count reduction techniques, improved yields, improved process/dimensional control, reduced lead times, improved inspection techniques, and advanced prototyping techniques.

(U) $1,300 Develop and demonstrate advanced power generation, power conditioning, energy conversion, energy storage, thermal management and power distribution component and system technologies for space applications. Military and commercial applications include satellites, energy storage, power distribution and conditioning, and thermal management systems. The focus is on enabling power generation improvements in efficiency, volume, mass, life, and reliability. The goal is to demonstrate significant improvements in size, weight, and reliability over state-of-the-art systems and/or enable new concepts.

(U) $1,300 Develop and demonstrate advanced power generation, power conditioning, energy conversion, energy storage, thermal management, and power distribution technologies for More Electric Aircraft military and civilian use. Applications include commercial aircraft, inhabited and uninhabited aircraft, and airborne directed energy weapons. Technologies of interest include aircraft power components and systems that demonstrate significant improvements in size, weight, and reliability over-state-of-the-art systems and/or enable new concepts. The focus is on improvements in reliability, maintainability, commonality, and supportability. Technology areas considered include concepts to replace

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602805F Dual Use Science & Technology	4770

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

hydraulic, mechanical and pneumatic power subsystems and their costly logistics support; compact high power generation and conditioning; and high rate energy storage.

(U) $10,417 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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	9,879	10,144	10,358	
(U)	Appropriated Value	10,000	10,144		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1			
	b. Small Business Innovative Research	-236			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-160			
	e. Rescissions	-105	-93		
(U)	Adjustments to Budget Years Since FY 2001 PBR			59	
(U)	Current Budget Submit/FY 2002 PBR	9,498	10,051	10,417	TBD

(U) Significant Program Changes:

Not Applicable.

(U) D. Other Program Funding Summary ($ in Thousands)

(U) Related Activities:

(U) PE 0601102F, Defense Research Sciences.

(U) PE 0602102F, Materials.

(U) PE 0602201F, Aerospace Flight Dynamics.

(U) PE 0602202F, Human Effectiveness.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY **02 - Applied Research**	PE NUMBER AND TITLE **0602805F Dual Use Science & Technology**	PROJECT **4770**

(U) D. Other Program Funding Summary ($ in Thousands)
(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) PE 0603112F, Advanced Materials for Weapon Systems.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) PE 0603270F, Electronic Combat Technology.
(U) PE 0603401F, Advanced Spacecraft Technology.
(U) PE 0603601F, Conventional Weapons Technology.
(U) PE 0603605F, Advanced Weapons Technology.
(U) PE 0603789F, C3I Advanced Development.
(U) This program has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) 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: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603106F Logistics Systems Technology

PROJECT: 2745

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2745	Logistics Performance and Support Technology (S&T)	10,896	13,768	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, efforts transfer to PE 0603231F, Crew Systems and Personnel Protection Technology, Project 634923, Logistics Readiness and Sustainment, to align resources with the Air Force Research Laboratory organization. FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.

(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 2000 ($ in Thousands)

(U) $713 Developed and demonstrated 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. Began 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, transitioned technology to support the assessment of battle damaged aircraft.

(U) $3,631 Developed and demonstrated 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. Defined technology requirements for intelligent software agents that automate the setting-up and running of synthetic exercises to reduce the costs of running these simulations. Defined technology requirements for computer agents that improve the human interface effectiveness for airlift command and control systems.

(U) $6,552 Developed and demonstrated 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603106F Logistics Systems Technology	PROJECT 2745

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

initiatives and the emerging Air Expeditionary Force (AEF) concepts. Continued 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. Continued design and development of an integrated, easily deployable, waste management system to process all types of waste materials produced during deployed operations. Demonstrated agile/lean deployment capability, reduced airlift requirements, and reduced on-site footprint using highly reliable, modular, multi-function support equipment for flightline maintenance.

(U) $10,896 Total

(U) FY 2001 ($ in Thousands)

(U) $1,949 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) $4,900 Develop and demonstrate intelligent software agents and realistic human behavior models. Develop 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 the planning and scheduling of airlift missions.

(U) $4,761 Develop and demonstrate logistics technologies for improved deployment operations and improved system supportability. 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) $2,158 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. Complete and transition specifications for the next generation of powered support equipment for more agile/lean flightline maintenance. Complete and transition specifications and technology for next generation ground refueling systems to support Air Force Special Operations Command.

(U) $13,768 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603106F Logistics Systems Technology	PROJECT 2745

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Effort moved to PE 060231F, Project 4923.
(U) $0 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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	10,651	13,895	11,367	TBD
(U)	Appropriated Value	10,786	13,895		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-6			
	b. Small Business Innovative Research	-254			
	c. Omnibus or Other Above Threshold Reprogram	-409			
	d. Below Threshold Reprogram	892			
	e. Rescissions	-113	-127		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-11,367	
(U)	Current Budget Submit/FY 2002 PBR	10,896	13,768	0	TBD

(U) Significant Program Changes:

In FY 2002, efforts transfer to PE 0603231F, Crew Systems and Personnel Protection Technology, Project 634923, Logistics Readiness and Sustainment, to align resources with the Air Force Research Laboratory organization.

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE **June 2001**
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603106F Logistics Systems Technology**	PROJECT **2745**

(U) D. Other Program Funding Summary ($ in Thousands)

(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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603112F Advanced Materials for Weapon Systems

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	33,134	43,575	32,748	25,734	28,695	28,903	25,183	25,716	Continuing	TBD
2100	Laser Hardened Materials	10,797	10,632	23,478	14,940	17,411	16,662	12,686	12,954	Continuing	TBD
3153	Non-Destructive Inspection Development	3,480	10,421	3,657	3,496	3,842	4,189	4,277	4,368	Continuing	TBD
3946	Materials Transition	18,857	22,522	4,199	5,175	5,492	5,616	5,733	5,855	Continuing	TBD
4918	Deployed Air Base Demonstrations	0	0	1,414	2,123	1,950	2,436	2,487	2,539	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, the deployed air base demonstration efforts in PE 0603205F, Flight Vehicle Technology, Project 4398, Air Base Technology, and PE 0603112F, Advanced Materials for Weapon Systems, Project 3946, Materials Transition, are transferred into this PE in Project 4918, Deployed Air Base Demonstrations. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) **A. Mission Description**

The advanced materials for weapon systems program develops and demonstrates materials technology for transition into Air Force systems. The program has four projects: (1) develops laser hardened materials technologies for the broadband laser protection of aircrews and sensors; (2) develops non-destructive inspection and evaluation (NDI/E) technologies; (3) develops transition data on structural and non-structural materials for air and space; and, (4) develops airbase operations technologies including power generators, deployable shelters, and fire fighting capabilities. Note: In FY 2001, Congress added $4.5 million for special aerospace materials and manufacturing processes, $2.0 million for next generation launch vehicle payload fairings and shrouds, $0.8 million for vehicle health monitor, $6.5 million for aging aircraft, $1.8 million for National Composite Programmable Powdered Preform Process for Aerospace (P4I) initiative, $3.9 million for advanced low-observable coatings, $1.8 million for National Center for Industrial Competitiveness, and $1.0 million for handheld holographic radar gun which explains the perceived decrease in FY 2002.

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

DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603112F Advanced Materials for Weapon Systems

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	33,978	21,678	20,778	
(U)	Appropriated Value	34,390	43,978		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1			
	b. Small Business Innovative Research	-810			
	c. Omnibus or Other Above Threshold Reprogram	-996			
	d. Below Threshold Reprogram	909			
	e. Rescissions	-358	-403		
(U)	Adjustments to Budget Years Since FY 2001 PBR			11,970	
(U)	Current Budget Submit/FY 2002 PBR	33,134	43,575	32,748	TBD
	Significant Program Changes:				

(U) Significant Program Changes:

In FY 2002, the increase in this program is due to realignment of efforts to align with Air Force Research Laboratory organizational structure.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development					PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems						PROJECT 2100
	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2100	Laser Hardened Materials	10,797	10,632	23,478	14,940	17,411	16,662	12,686	12,954	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 for transition to Air Force systems. The goal is to ensure mission capability before, during, and after threat exposure. Current protection schemes are activated by intensity or color and are only capable of countering a specific portion of the laser threat. To harden systems against all potential lasers the development of a combination of approaches is required.

(U) FY 2000 ($ in Thousands)

(U) $1,620 Developed and demonstrated advanced materials technologies that enhance laser hardening of Air Force spacecraft sensors to ensure safety, survivability, and operability in a laser threat environment. Evaluated hybrid optical limiters and establish specific performance improvement goals for the protection of staring focal plane array . Optimized rugate fixed-wavelength filters and optical switches for mid-wave infrared space systems. Evaluated hardening solutions for critical space sensor designs and environments.

(U) $5,398 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. Designed and developed fixed filters for panoramic night vision goggles. Fabricated and tested wrap-around tristimulus spectacles (eye-glasses). Designed and developed prescription capable flexible filter for eye protection. Demonstrated prescription-capable, eye-centered rugates on lenses with dyed plastic substrates. Transitioned eye centered rugate spectacles for preliminary human factors study.

(U) $3,779 Developed and demonstrated advanced materials technologies that enhance laser hardening for sensors, avionics, and components to increase survivability and mission effectiveness of air vehicles systems. Integrated laser hardening modules into operational electro-optical systems. Performed flight test demonstrations of hardened sensor for Air Force Special Operational Command. Characterized and transitioned enhanced sensor modules for Air Force targeting systems. Initiated development of hardening architecture for low light level television systems.

(U) $10,797 Total

(U) FY 2001 ($ in Thousands)

(U) $1,598 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 2100

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $5,327 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) $3,707 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 low light level television systems. Initiate development of specific hardening techniques for specific munitions. Develop specific hardening techniques for MWIR and long-wave infrared staring forward looking infrared systems.

(U) $10,632 Total

(U) FY 2002 ($ in Thousands)

(U) $5,663 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. Design and fabricate hybrid optical limiters for the protection of mid-wave infrared staring FPAs. Test and update hardened coating process for rugate fixed-wavelength filters and optical switches for MWIR space systems. Fabricate hardening solutions for critical space sensor designs and environments based on successful approaches employed in tactical sensors.

(U) $9,146 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. Fabricate and validate flexible filter technology (rugate and enhanced thin films) in prescription capable spectacles. Demonstrate first generation tristimulus filter technology (enhanced thin films combined with absorbing dyes) for daytime missions. Complete and transition both flexible filters and tristimulus filters in wraparound spectacles for human factors evaluations. Demonstrate laser protective fixed filters for the PNVG program. Begin development of tunable liquid crystal filter technology for the PNVG program.

(U) $8,669 Develop and demonstrate advanced materials technologies that enhance laser hardening for sensors, avionics and components to increase survivability and mission effectiveness of areospace systems. Develop damage resistant image intensifier tubes. Develop laser damage resistant image intensifiers, charge couple devices, and architectures for fielded television targeting systems. Evaluate laser hardening materials for mid-wave infrared targeting systems and precision-guided munitions.

(U) $23,478 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 2100

(U) <u>B. Project Change Summary</u>
Not Applicable.

(U) <u>C. Other Program Funding Summary ($ in Thousands)</u>
(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
(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) <u>D. Acquisition Strategy</u>
Not Applicable.

(U) <u>E. Schedule Profile</u>
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603112F Advanced Materials for Weapon Systems	3153

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3153 Non-Destructive Inspection Development	3,480	10,421	3,657	3,496	3,842	4,189	4,277	4,368	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 more rapidly than current capability. This project provides technology to satisfy Air Force requirements to extend lifetimes of current systems through increased reliability and cost-effectiveness at field and depot maintenance levels. Equally important is assuring manufacturing quality, integrity, and safety requirements. Note: In FY 2001, Congress added $0.8 million for vehicle health monitor, $6.5 million for aging aircraft, and $1.0 million for handheld holographic radar gun which explains the perceived decrease in FY 2002.

(U) FY 2000 ($ in Thousands)

(U) $1,507 Developed and demonstrated 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. Demonstrated enhanced laser generated ultrasonics 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 sensors for remote access inspection. Demonstrated 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) $1,372 Developed and demonstrated advanced inspection technologies supporting low-observable (LO) and space systems to enhance affordability and ensure full performance and survivability and rapid turnaround of space systems. Validated a signature assessment tool for fighter aircraft and initiated development of an advanced multispectral LO non-destructive evaluation (NDE) tool for assessing radio frequency signature (zone versus whole aircraft) that is real-time, small, lightweight, portable, user friendly, and covers multiple frequency bands. Selected multiple NDE methods to 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) $601 Developed and demonstrated advanced technologies for improved capabilities to assess high cycle fatigue and engine life prediction practices to extend the total 'safe' life of turbine engine disks. Established NDE benchmarks and designed an automated inspection capability to inspect engine rotary components for planned life extension of engine rotors. Established a baseline capability to retain digital NDE records for extended periods and enable enhanced analysis of the aging aircraft fleet.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 3153

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $3,480 Total

(U) FY 2001 ($ in Thousands)

(U) $7,122 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 for corrosion detection that use an alternate source of laser pulses to generate ultrasound and are efficiently transmitted through fiber optics. This enables laser-based ultrasonics 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. This technique eliminates the need for hazardous material usage and enables electronic storage, transmission, and analysis of images.

(U) $1,857 Develop and demonstrate advanced inspection technologies supporting low-observable (LO) systems to enhance affordability and ensure full performance and survivability. Transition a LO material assessment tool for fighter aircraft. Develop an advanced multispectral LO nondestructive evaluation (NDE) tool for assessing radio frequency signature (zone versus whole aircraft) that is real-time, small, lightweight, portable, user friendly, and covers multiple frequency bands. Evaluate an advanced hand-held directional reflectometer for field level infrared signature NDE.

(U) $548 Develop and demonstrate advanced technologies for improved capabilities to assess high cycle fatigue 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) $894 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) $10,421 Total

(U) FY 2002 ($ in Thousands)

(U) $1,200 Develop and demonstrate advanced technologies for improved capabilities in materials corrosion, fatigue monitoring, and testing of aging aircraft to reduce operation and maintenance costs. These technologies will guarantee full operability and safety of the aircraft fleet. Develop and demonstrate advanced technologies for improved capabilities in detection and characterization of corrosion in aging aircraft while emphasing improving the probability of detecting serviceable cracks. Develop advanced methods to detect cracks in multiple layers to meet aging aircraft life extension requirements.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 3153

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $1,454 Develop and demonstrate advanced technologies for improved capabilities to assess high cycle fatigue and engine life prediction practices to extend the total `safe' life of turbine engines. Transition nondestructive evaluation (NDE) benchmarks and continue development of an automated inspection capability to inspect engine rotary components for increased rotor life extension. Investigate candidate NDE techniques to extend the life of fracture-critical gas turbine engine components and develop techniques for subsurface component evaluations. Develop an advanced X-ray robotic brassboard to measure surface residual stress on full-scale turbine engine components.

(U) $1,003 Develop and demonstrate advanced inspection technologies supporting low-observable (LO) systems to enhance affordability and ensure full performance and survivability. Demonstrate an advanced multispectral LO NDE tool for assessing radio frequency signature (zone versus whole aircraft) that is real-time, lightweight and portable, user friendly, and covers multiple frequency bands. Complete and transition to the field an advanced hand-held directional reflectometer for field level infrared signature NDE.

(U) $3,657 Total

(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 June 2001

BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 3946

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3946 Materials Transition	18,857	22,522	4,199	5,175	5,492	5,616	5,733	5,855	Continuing	TBD

Note: In FY 2002, the deployed air base demonstration efforts in PE 0603205F, Flight Vehicle Technology, Project 4398, Air Base Technology, and PE 0603112F, Advanced Materials for Weapon Systems, Project 3946, Materials Transition, are transferred into this PE in Project 4918, Deployed Air Base Demonstrations.

(U) A. Mission Description

Develops and demonstrates advanced material and processing technologies for fielded and planned Air Force weapon, airframe, engine, and space applications. Advanced materials and processes that have matured beyond applied research are characterized, critical data are collected, and critical evaluations in the proposed operating environment are performed. This design and scale-up data enhances overall affordability of promising material and processing technologies, providing needed initial incentive for their industrial development. Note: In FY 2001, Congress added $4.5 million for special aerospace materials and manufacturing processes, $2.0 million for next generation launch vehicle payload fairings and shrouds, $1.8 million for National Composite Programmable Powdered Preform Process for Aerospace (P4I) initiative, $3.9 million for advanced low observable coatings, and $1.8 million for National Center for Industrial Competitiveness which explains the perceived decrease in FY 2002.

(U) FY 2000 ($ in Thousands)

(U) $5,436 Developed and demonstrated advanced materials technologies for air vehicles and subsystems to enhance lift, propulsion, low-observable performance, and affordability of manned and unmanned air vehicles. Developed advanced aircraft brake materials with improved braking capacity, increased life, and better environmental stability. Developed large integrated composite structures for aircraft with reduced part count and assembly costs. Developed advanced non-linear optical materials for aircraft infrared countermeasures against far-infrared laser sources.

(U) $6,990 Developed and demonstrated advanced materials technologies for space vehicles and subsystems to provide enhanced surveillance and sensing capabilities and improved access to space. Initiated development of robust, high performance, and producible infrared focal plane array materials. Developed materials and materials processing technologies to improve spacecraft component designs, performance, and reliability.

(U) $1,004 Developed and demonstrated 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. Developed and verified an accelerated environmental effects test to determine in-service performance degradation of aircraft coating systems and initiated development of large aperture Aluminum Oxynitride window material with high optical quality, durability, and strength. Demonstrated the utilization of residual stress measurements in the fatigue life management of turbine engine disks.

(U) $2,438 Provided 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,

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

including executives, middle managers, and all advanced development program managers. Enhanced Integrated Product and Process Development (IPPD) and cost modeling course material, including web-based methods and tools.

(U) $2,989 Developed technologies (i.e., utilities and shelters) that improve airmobile systems performance and reduce airlift requirements in support of Air Expeditionary Force (AEF) operations. Emphasized two areas of AEF operations: deployed base systems and physical force protection. Demonstrated small air-inflatable shelters that reduce deployment weight by 50% and require 30% less set-up time. Fabricated advanced cycle technologies for mobile heat pumps that reduce weight and volume by 30%. Developed a small-footprint fuel cell reformer capable of converting logistics fuels into hydrogen for fuel cell power generation. Developed structural retrofit and evaluated deployable blast protection reinforcement systems for buildings to reduce blast debris hazards.

(U) $18,857 Total

(U) FY 2001 ($ in Thousands)

(U) $13,318 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 materials for aircraft infrared countermeasures against far-infrared laser sources.

(U) $4,116 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 focal plane array materials. Demonstrate materials and materials processing technologies to improve spacecraft component designs, performance, and reliability. Evaluate effort to develop the key data needed for reduced risk and increased confidence in organic matrix composite materials.

(U) $1,871 Develop and demonstrate advanced materials technologies to enhance the sustainability of Air Force areospace systems by lowering 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 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) $447 Provide affordability education and training through the application of 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

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 3946

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

		Directorate.
(U)	$2,770	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)	$22,522	Total

(U) FY 2002 ($ in Thousands)

(U)	$1,377	Develop and demonstrate advanced materials and processing technologies for air vehicles and subsystems to enhance the lift, propulsion, low-observable performance, and overall affordability of air vehicles. Fabricate and characterize integrated composite structure assemblies for aircraft with reduced part count and assembly costs. Complete demonstration of advanced aircraft brake materials with improved braking capacity, increased life, and better environmental stability. Characterize advanced non-linear optical materials for aircraft infrared countermeasure against far-infrared laser sources.
(U)	$1,557	Develop and demonstrate advanced materials and processing technologies for space vehicles and subsystems to provide enhanced surveillance capabilities, improved access to space, and improve the overall affordability of space vehicles. Characterize improved material processes with increased yields for robust, high performance, and producible infrared detector materials. Continue efforts to validate and demonstrate materials and materials processing technologies to improve performance, reliability, and affordability of spacecraft components and subsystems. Characterize effects of space exposure on advanced material systems.
(U)	$1,265	Develop and demonstrate advanced materials and processing technologies to enhance the sustainability of Air Force air and space systems by lowering operations and maintenance costs while ensuring full operability and safety of systems and personnel. Complete the characterization of a large-aperture Aluminum Oxynitride (ALON) window material with high optical quality, durability, and strength. Evaluate the effectiveness of corrosion abatement treatments and transition the results.
(U)	$4,199	Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 3946

(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.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development					PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems						PROJECT 4918
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4918	Deployed Air Base Demonstrations	0	0	1,414	2,123	1,950	2,436	2,487	2,539	Continuing	TBD

Note: In FY 2002, the deployed air base demonstration efforts in PE 0603205F, Flight Vehicle Technology, Project 4398, Air Base Technology, and PE 0603112F, Advanced Materials for Weapon Systems, Project 3946, Materials Transition, are transferred into this PE in Project 4918, Deployed Air Base Demonstrations.

(U) A. Mission Description

Supports the Air Expeditionary Forces (AEF) through technology development and demonstration of advanced rapid deployment airbase technologies that reduce airlift, setup times, manpower requirements, and sustainment costs. Develops and demonstrates efficient and cost-effective technologies to provide physical protection technologies including fire fighting, to AEF deployed warfighters and infrastructure. Develops and demonstrates affordable, rapid deployment technologies that ensure military readiness, support advanced weapon systems, and enable enhanced peacetime training operations.

(U) FY 2000 ($ in Thousands)

(U) $0 This effort was performed in PE 0603205F, Flight Vehicle Technology, Project 4398, Air Base Technology, ($1.363 million) and PE 0603112F, Advanced Materials for Weapon Systems, Project 3946, Materials Transition, ($2.989 million).

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 This effort was performed in PE 0603205F, Flight Vehicle Technology, Project 4398, Air Base Technology, ($7.794 million) and PE 0603112F, Advanced Materials for Weapon Systems, Project 3946, Materials Transition, ($2.770 million).

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $556 Demonstrate and transition advanced rapid deployment airbase technologies that reduce airlift, setup times, manpower requirements, and sustainment costs in support of Air Expeditionary Forces (AEF) technologies. Develop deployable shelters/heat pump, power, and rapid airfield assessment technologies that improve air mobile systems performance and reduce airlift requirements in support of AEF. Develop advanced aircraft fire fighting agents and equipment. Demonstrate highly effective, deployable crash/rescue technologies based on three-dimensional foam technology to support AEF operations.

(U) $108 Demonstrate and transition affordable, rapid deployment technologies that ensure military readiness, maintain aerospace missions, support advanced weapon systems, and enable peacetime training operations. Develop advanced waste reactor technologies to support deployed waste management systems. Develop full-scale design and fabricate rapidly deployable mixed-base hydrogen peroxide production plant for airborne

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603112F Advanced Materials for Weapon Systems	PROJECT 4918

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

laser operations.

(U) $750 Demonstrate and transition efficient and cost-effective technologies to provide physical protection technologies to Air Expeditionary Forces (AEF) deployed warfighters and infraststructure. Develop deployable protective and reactive blast suppression technologies to protect deployed warfighters. Develop autonomous ground vehicles to support Air Force operational requirements for unexploded ordnance clearance and active range operations.

(U) $1,414 Total

(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 harmionize 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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603202F Aerospace Propulsion Subsystems Integration	668A

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
668A	Aircraft Propulsion Subsystem Integration	18,912	34,619	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, the efforts performed under this program will be shifted to PE 0603216F, Aerospace Propulsion and Power Technology, Project 4921, in order to align projects with the Air Force Research Laboratory organization.

(U) A. Mission Description

This project develops and demonstrates gas turbine propulsion technologies applicable to a broad range of aircraft. The Aircraft Propulsion Subsystem Integration (APSI) project includes demonstrator engines such as the Joint Technology Demonstrator Engine for manned systems and the Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. The APSI demonstrator engines integrate the core (high-pressure spool) technology developed under the Advanced Turbine Engine Gas Generator with the engine (low-pressure spool) technology such as fans, turbines, engine controls, and exhaust nozzles. This project also focuses on integration aspects of inlets, nozzles, engine/airframe compatibility, and low-observable technologies. APSI will provide enabling technology for increasing aircraft range and 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 project supports the goals of the Integrated High Performance Turbine Engine Technology (IHPTET) program, which is focused on doubling 1987 turbine engine propulsion capabilities by 2005 while reducing cost of ownership. The IHPTET program provides continuous technology transition for military turbine engine upgrades and derivatives, and has the added dual-use benefit of enhancing the United States turbine engine industry's international competitiveness. Technology innovations developed in this project are applicable to current and future Air Force turbine engines. Note: In FY 2001, Congress added $0.5 million for IHPTET.

(U) FY 2000 ($ in Thousands)

(U) $4,200 Designed, fabricated, and demonstrated durability and integration technologies for turbofan/turbojet engines for improved supportability and affordability of current and future Air Force aircraft. Initiated engine testing in support of the national High Cycle Fatigue (HCF) program including fan blade damage tolerance, frangible bearings, prognostics and health management, and turbine engine explosive blade out concept demonstration.

(U) $11,225 Designed, fabricated, and tested advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Completed advanced engine designs for fixed inlet guide vanes and Moderate Aspect Ratio (MAR) rotor, Integrally Bladed Rotor (IBR) repair, fan rim damper, high cycle fatigue (HCF) mistuning technologies, vaneless counterrotating high/low

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603202F Aerospace Propulsion Subsystems Integration	PROJECT 668A

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

pressure turbine (LPT), probabilistic rotor system design, gamma titanium aluminide LPT coverplate, sprayform cast hardware, and Ceramic Matrix Composite (CMC) technologies. Initiated advanced engine designs for High Cycle Fatigue (HCF) robust front frame, two-stage forward swept fan, tiled low pressure turbine (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 current Air Force inventory as well as future turbine engines.

(U) $3,487 Designed, fabricated, and tested advanced component technologies for improved performance, durability, and affordability of engines for missile and uninhabited air vehicle applications. Completed 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. Initiated design of Organic Matrix Composite (OMC) fan, high stage loading splittered fan, uncooled ceramic high/low pressure turbine, and slinger combustor.

(U) $18,912 Total

(U) FY 2001 ($ in Thousands)

(U) $5,310 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 testing in support of the national HCF program, including fan blade damage tolerance, frangible bearings, prognostics and health management, and turbine engine explosive blade out concept demonstration.

(U) $22,109 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-demonstrator engine test fixed inlet guide vanes and moderate aspect ratio rotor, Integrally Bladed 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 swept fan, tiled LPT blade, uncooled CMC LPT blade, and model-based control with diagnostics. All of these technologies are applicable to a significant part of the current Air Force inventory as well as future turbine engines.

(U) $4,695 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) $2,005 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) $500 Design a low volume, high temperature and pressure combustor. Evaluate performance in cruise missile or uninhabited air vehicle applications.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603202F Aerospace Propulsion Subsystems Integration	PROJECT 668A

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued
(U) $34,619 Total

(U) FY 2002 ($ in Thousands)
(U) $0 Efforts moved to PE 0603216F, Project 4921.
(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.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	19,586	34,440	32,161	
(U)	Appropriated Value	19,825	34,940		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2			
	b. Small Business Innovative Research	-467			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-237			
	e. Rescissions	-207	-321		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-32,161	
(U)	Current Budget Submit/FY 2002 PBR	18,912	34,619	0	TBD

(U) Significant Program Changes:

Note: In FY 2002, the efforts performed under this program will be shifted to PE 0603216F, Aerospace Propulsion and Power Technology, Project 4921.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603202F Aerospace Propulsion Subsystems Integration**	PROJECT **668A**

(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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603203F Advanced Aerospace Sensors

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	36,360	46,381	55,809	43,098	36,774	34,262	34,756	35,471	Continuing	TBD
665A	Advanced Aerospace Sensors Technology	12,176	18,925	19,203	17,234	17,683	19,128	19,304	19,692	Continuing	TBD
69CK	Advanced Electronics	759	0	0	0	0	0	0	0	Continuing	TBD
69DF	Target Attack and Recognition Technology	23,425	27,456	36,606	25,864	19,091	15,134	15,452	15,779	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, work performed in this PE, Project 69CK, and in PE 0603726F, Project 2863, moves to this PE, Project 665A. In FY 2002, work performed under PE 0603253F, Projects 2735 and 666A, moves to this PE, Project 665A. Apparent project ramp in Project 665A due only to realignment of the projects. FY 2003 - FY 2007 budget numbers do not reflect the DOD Strategy Review results.

(U) **A. Mission Description**

Divided into two broad project areas, this program develops technologies to enable the continued superiority of sensors from space and aerial platforms. The first project develops and demonstrates advanced technologies for electro-optical (EO) sensors, radar sensors and electronic counter-countermeasures (ECCM), and components and algorithms. The second project develops and demonstrates radio frequency (RF) and EO sensors for detecting, locating, and targeting airborne, fixed, and time-critical mobile ground targets obscured by natural or man-made means. Together, the projects in this program develop the means to find, fix, target, track, and engage air and ground targets anytime, anywhere, and in any weather. Note: In FY 2001, Congress added $4.5 million for Hyperspectral System Development (High Altitude), $3.5 million for the Integrated Demonstrations and Applications Laboratory (IDAL) Infrared (IR) Simulator and Radio Frequency (RF) and IR Integration, and $10.5 million for the National Radar Signature Production and Research Capability.

(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.

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DATE
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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603203F Advanced Aerospace Sensors

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	37,948	28,311	29,714	
(U)	Appropriated Value	38,405	46,811		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2			
	b. Small Business Innovative Research	-905			
	c. Omnibus or Other Above Threshold Reprogram	-785			
	d. Below Threshold Reprogram	44			
	e. Rescissions	-397	-430		
(U)	Adjustments to Budget Years Since FY 2001 PBR			26,095	
(U)	Current Budget Submit/FY 2002 PBR	36,360	46,381	55,809	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: June 2001

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

PROJECT: 665A

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
665A Advanced Aerospace Sensors Technology	12,176	18,925	19,203	17,234	17,683	19,128	19,304	19,692	Continuing	TBD

Note: In FY 2002, work performed under PE 0603253F, Projects 2735 and 666A, transfers to this project.

(U) A. Mission Description

This project 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. It provides 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. Project activities include developing both complete sensor capabilities as well as advanced component technologies. Desired warfighting capabilities include the ability to detect concealed targets in difficult background conditions, especially the ability to counter improvements in camouflage, concealment, and deception techniques.

(U) FY 2000 ($ in Thousands)

(U) $1,618 Developed integrated 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. Completed fabrication and initiated flight test of an EO sensor that operates in day or night across multiple bands.

(U) $2,175 Developed EO sensor technologies to detect and locate deep hide targets from high altitudes. Collected infrared sensor model validation data. Created hyperspectral imaging/fusion algorithms.

(U) $2,122 Developed radar signal processing techniques to mitigate clutter and interference and improve detection and tracking of difficult targets. Developed adaptive processing for fighter detection of low-observable targets, demonstrating improved radar performance via enhanced antenna implementation. Developed integrated processing methods for improved ground target detection and tracking.

(U) $3,264 Developed 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 tested image formation processing and automatic target detection.

(U) $1,494 Developed technology to lower life cycle costs of radar systems. Laboratory tested low-cost digital receivers and sensor components. Evaluated space-based apertures using micro-electro-mechanical phase shifters. Demonstrated a millimeter wave array for high-altitude unmanned aerial vehicles.

(U) $1,503 Developed technology for non-cooperative target identification. Built high resolution algorithms. Validated models. Flight tested sensor hardware. Evaluated laser vibration as a solution to target identification.

(U) $12,176 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT **665A**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$1,894	Develop integrated electro-optical (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)	$7,665	Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace intelligence, surveillance, and reconnaissance (ISR) 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 (RF) 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 RF sensor and real-time image formation algorithms.
(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 EO 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 this PE, Project 69CK.)
(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 ISR applications. (In FY 2000, this effort was conducted under PE 0603726F, Project 2863.)
(U)	$18,925	Total

(U) FY 2002 ($ in Thousands)

(U)	$3,452	Develop integrated electro-optical (EO) sensor technology to search, detect, locate, and identify air and ground targets at ranges significantly longer than currently achievable, including targets that are camouflaged, low-observable, or employ other means of deception. Design and begin demonstrating active and passive sensor components of an affordable, integrated targeting capability.
(U)	$3,720	Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace intelligence, surveillance, and

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT 665A

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

		reconnaissance (ISR) applications. Continue fabrication of a demonstration sensor for high altitude reconnaissance aircraft, perform initial system utility demonstrations, and develop signature-based data processing techniques.
(U)	$1,068	Develop advanced radar signal processing techniques to mitigate clutter and jamming interference and improve detection and tracking of difficult targets. Design processing architecture for evaluation of multi-dimensional adaptive processing techniques. Demonstrate these techniques for multi-mission aerospace radar applications.
(U)	$3,453	Develop and demonstrate the radio frequency (RF) sensor techniques required to detect, track, and target high-value, time-critical targets that are obscured by foliage or concealed through deceptive techniques. Demonstrate concealed target detection through analysis of flight test data. Demonstrate detection range improvements for low-observable targets.
(U)	$941	Develop advanced EO sensor technology for non-cooperative target identification. Complete design and begin development of multi-function laser for air and ground target identification.
(U)	$714	Develop advanced multi-function sensor component technologies for radar, electronic warfare, navigation, and communications applications. Initiate evaluation of very high density two-dimensional and three-dimensional interconnects for phased array transmit/receive modules on manned and unmanned platforms. Finalize testing of a multi-chip module implementation of the monobit receiver for electronic warfare applications. Develop advanced RF photonic signal control and distribution technologies for phased array apertures.
(U)	$2,308	Develop and demonstrate advanced modular, sharable digital RF sensor technologies for aerospace sensor suites performing ISR applications. Demonstrate a multi-channel radar digital receiver with channel match greater than 60dB and jammer cancellation. (In FY 2001, this work was performed in PE 0603253F, Project 2735.)
(U)	$3,547	Develop technologies to maximize Global Positioning System (GPS) jam resistance, positional accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Design advanced GPS M-Code technology. Develop geo-registration and precise target location technology supporting multi-sensor and distributed sensor integration. (In FY 2001, this work was performed in PE 0603253F, Project 666A.)
(U)	$19,203	Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT 665A

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

(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0603205F, Flight Vehicle Technology.
(U) PE 0603707F, Weather Systems Advanced Development.
(U) PE 0602111N, Weapons Technology.
(U) PE 0602232N, Space and Electronic Warfare (SEW) Technology.
(U) PE 0604249F, LANTIRN Night Precision Attack.
(U) PE 0603270F, Electronic Combat Technology.
(U) An MOA has been established between AFRL and 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.
(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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT 69CK

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
69CK Advanced Electronics	759	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, this effort transferred to this PE, Project 665A.

(U) A. Mission Description

This project 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 2000 ($ in Thousands)

(U) $429 Developed advanced multi-function sensor electronics. Developed affordable, high performance RF circuits and packaging technologies for use in phased array transmit/receive modules on manned and unmanned platforms.

(U) $330 Performed application trade studies for space-based photonics RF signal distribution, including photonic beamforming for Global Positioning System (GPS) applications.

(U) $759 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort transferred to this PE, Project 665A.

(U) $0 Total

(U) FY 2002 ($ 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 June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT **69CK**

(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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603203F Advanced Aerospace Sensors	69DF

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
69DF Target Attack and Recognition Technology	23,425	27,456	36,606	25,864	19,091	15,134	15,452	15,779	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates advanced technologies for attack management, fire control, and target identification and recognition. This includes developing and demonstrating integrated and cooperative fire control techniques to provide for adverse-weather precision air strikes against multiple targets per pass and at maximum weapon launch ranges. Specific fire control technologies under development include attack management, sensor fusion, automated decision aids, advanced tracking for low radar cross section threats, and targeting using both on-board and off-board sensor information. This project also evaluates targeting techniques to support theater missile defense efforts in surveillance and attack. These fire control technologies will provide force multiplication and reduce warfighter exposure to hostile fire. This project also develops and demonstrates target identification and recognition technologies for positive, high confidence cueing, recognition, and identification of airborne and ground-based, high-value, time-critical targets at longer ranges than are currently possible. The goal is to apply these technologies to tactical air-to-air and air-to-surface weapon systems so they are able to operate in all weather conditions, during day or night, and in high-threat, multiple target environments. Model-based vision algorithms and target signature development techniques are the key to target identification and recognition. This project is maturing these technologies in partnership with the Defense Advanced Research Projects Agency (DARPA) 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 2000 ($ in Thousands)

(U) $2,470 Developed advanced situational awareness technologies for rapid detection, location, and prosecution of time-critical targets. Demonstrated ground station fusion of synthetic aperture radar and signals intelligence. Developed on-board/off-board data and image fusion algorithms.

(U) $2,719 Developed and demonstrated real-time information-in-the-cockpit technologies. Flight demonstrated and simulated real-time route replanning and retargeting for stealth strike platforms. Developed real-time retargeting algorithms for special operation forces.

(U) $1,490 Developed and evaluated radar automatic target recognition (ATR) algorithms for tracking moving ground targets. Evaluated radar algorithms for tracking moving ground target. Reduced transition risk by planning affordable upgrades to strike and reconnaissance platforms.

(U) $1,127 Developed target recognition concepts using hyperspectral imaging and other candidate sensor inputs to determine requirements for ATR and target/background phenomenology efforts. Built algorithms using hyperspectral imaging data.

(U) $2,777 Tested and integrated DARPA multi-sensor ATR fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, and reconnaissance functions.

(U) $1,852 Developed advanced tactical targeting technology in conjunction with DARPA for suppression of enemy air defenses. Conducted

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT **69DF**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

		hardware-in-the-loop testing against threat radio frequency (RF) signals.
(U)	$2,073	Developed air-to-ground radar imaging technology for all-weather detection and identification of ground targets.
(U)	$8,917	Developed Integrated Demonstrations and Applications Laboratory (IDAL) testbed for maturing aerospace sensor technologies through hardware-in-the-loop simulation. Created 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)	$23,425	Total

(U) FY 2001 ($ in Thousands)

(U)	$2,054	Develop advanced situational 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)	$2,798	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)	$1,810	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.
(U)	$1,136	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)	$2,542	Continue testing and integrating Defense Advanced Research Projects Agency (DARPA) multi-sensor ATR fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, and reconnaissance missions.
(U)	$3,116	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. (In FY 2002, this effort transfers to PE 0603270F, Project 2432.)
(U)	$3,500	Develop IDAL technology. Perform integration of infrared (IR) and RF sensors to simulate battlefield-condition sensor operation at dramatically reduced cost.
(U)	$10,500	Develop a National Radar Signature Production and Research Capability (RCAS). Develop computer modeling and simulation of aircraft radar signature libraries necessary to discriminate friend, foe, and neutral targets.
(U)	$27,456	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603203F Advanced Aerospace Sensors**	PROJECT **69DF**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$2,843	Develop advanced global awareness and precision engagement automated targeting technologies for rapid detection, location, and prosecution of time-critical targets. Integrate modeling, simulation, and analysis testbed to demonstrate automatic target recognition (ATR) and information fusion algorithms for time-critical targeting, emphasizing the difficult targeting missions where weather, terrain, foliage, camoflauge, or deception techniques obscure or conceal the targets of interest.
(U)	$3,730	Develop common, open system technologies for integrating real-time information in- and out-of-the-cockpit (RTIC/RTOC) to improve aircrew situational awareness, target nomination, and target engagement capabilities. Demonstrate a capability to fuse all-source threat, target, and survivor location data for use on special operations forces aircraft.
(U)	$2,309	Develop and evaluate radar ATR algorithms for tracking and identifying moving and stationary ground targets. Continue demonstration of affordable risk reduction for transition via planned sensor upgrades to strike and reconnaissance platforms.
(U)	$1,421	Develop ATR solutions using hyperspectral imaging data and other candidate sensor inputs. Develop target and background phenomenology technology to recognize and identify targets using hyperspectral imaging data.
(U)	$3,553	Continue testing and integrating Defense Advanced Research Projects Agency multi-sensor ATR fusion algorithms into the Air Force ATR evaluation test facility for application to intelligence, surveillance, and reconnaissance missions. Test and assess these automated decision aids for cost versus capability against specific air and surface targeting mission requirements.
(U)	$22,750	Develop technology to detect and identify targets under trees. Design and fabricate a very-high frequency (VHF) foliage penetration radar. Develop and implement VHF radar change detection algorithms for robust target detection with a low false alarm rate. Perform VHF radar data collections for algorithm development and foliage penetration characterization. Develop imagery exploitation algorithms for target identification sensor fusing techniques. Perform high fidelity modeling of the VHF radar, change detection capability, data fusion process, and weapon effectiveness. Develop integration plans for a warfighter-selected operational platform.
(U)	$36,606	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.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603203F Advanced Aerospace Sensors	PROJECT 69DF

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

(U) PE 0603270F, Electronic Combat Technology

(U) Theater Missile Defense System Program Office.

(U) Low Altitude Night Targeting and Infrared Navigation (LANTIRN) System Program Office.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603205F Flight Vehicle Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	5,554	10,944	0	0	0	0	0	0	Continuing	TBD
2978	Flight Vehicle Technologies	4,279	3,167	0	0	0	0	0	0	Continuing	TBD
4398	Air Base Technology	1,275	7,777	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: Beginning in FY 2002, this program element (PE) has been eliminated. The ongoing technical efforts from Project 2978 have been transferred to PE 0603211F, Aerospace Structures, Project 4920, Flight Vehicle Technology Integration. The ongoing efforts from Project 4398 have been transferred into PE 0603112F, Advanced Materials for Weapon Systems, Project 4918, Deployed Air Base Demonstrations.

(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. Note: In FY 2001, Congress added $1.4 million for fiber optics control technologies, $4.2 million for weapon systems logistics, deployed base systems technology, and force protection, and $3.0 million for E-SMART Warning and Response System (Congress funded this effort in PE 0603723F in FY 2000).

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	5,960	2,445	500	
(U)	Appropriated Value	5,992	11,045		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				

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

DATE
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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603205F Flight Vehicle Technology

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

		FY 2000	FY 2001	FY 2002	Total Cost
	b. Small Business Innovative Research				
	c. Omnibus or Other Above Threshold Reprogram	-386			
	d. Below Threshold Reprogram	-29			
	e. Rescissions	-23	-101		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-500	
(U)	Current Budget Submit/FY 2002 PBR	5,554	10,944	0	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to program element realignment within the Science and Technology Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603205F Flight Vehicle Technology	2978

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2978 Flight Vehicle Technologies	4,279	3,167	0	0	0	0	0	0	Continuing	TBD

Note: Beginning in FY 2002, the ongoing technical efforts from Project 2978 have been transferred to PE 0603211F, Aerospace Structures, Project 4920, Flight Vehicle Technology Integration.

(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. Note: In FY 2001, Congress added $1.4 million for fiber optics control technologies.

(U) FY 2000 ($ in Thousands)

(U) $1,864 Developed technologies for automatic in-flight replanning for the cockpit to reduce pilot workload. Began testing autonomous unmanned combat air vehicles systems for automatic in-flight replanning.

(U) $854 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. Began integrated control system testing of advanced flight control algorithms.

(U) $1,561 Developed advanced integrated aerospace vehicle subsystems to provide increased performance and decreased vulnerability while decreasing both cost and logistic supportability requirements. Started ground demonstration of a nacelle ballistic fire suppression concept. Continued flight critical stabilator actuator test to demonstrate operational military and utility.

(U) $4,279 Total

(U) FY 2001 ($ in Thousands)

(U) $201 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.

(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) $1,033 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) $1,400 Initiate Congressionally directed efforts to address development issues associated with fiber optics control technologies.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603205F Flight Vehicle Technology	PROJECT 2978

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued
(U) $3,167 Total

(U) FY 2002 ($ in Thousands)
(U) $0 Efforts transferred to PE 0603211F, Project 4920.
(U) $0 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) 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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development					PE NUMBER AND TITLE 0603205F Flight Vehicle Technology						PROJECT 4398
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4398	Air Base Technology	1,275	7,777	0	0	0	0	0	0	Continuing	TBD

Note: Beginning in FY 2002, the ongoing technical efforts from Project 4398 have been transferred into PE 0603112F, Advanced Materials for Weapon Systems, Project 4918, Deployed Air Base Demonstrations.

(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. Note: In FY 2001, Congress added $4.2 million for weapon systems logistics, deployed base systems technology, and force protection, and $3.0 million for E-SMART Warning and Response System (Congress funded this effort in PE 0603723F in FY 2000).

(U) FY 2000 ($ in Thousands)

(U) $533 Developed aircraft and air base fire fighting and power generation technologies to improve fire fighting rescue. Tested fire fighting agents and equipment. Developed protective clothing, fire risk assessment technologies, and fire fighting training systems.

(U) $362 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 Aerospace Expeditionary Force (AEF) operations rapid deployment.

(U) $380 Constructed an air transportable shelter advanced development model for field testing to support AEF operations. Began laboratory testing of advanced lightweight shelter components.

(U) $1,275 Total

(U) FY 2001 ($ in Thousands)

(U) $206 Develop aircraft and air base fire fighting and power generation technologies to improve fire fighting rescue. Test safe fire fighting agents. Continue 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) $3,000 Continue directed E-SMART Warning and Response System effort that develops and integrates chemical and biological sensor and monitoring technologies into the E-SMART.

(U) $4,200 Initiate Congressional directed effort to expand efforts related to providing increased explosion mitigation, increased ability to conduct rapid airfield assessment, improved lightweight airfield matting, and more efficient deployable utility systems.

(U) $7,777 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603205F Flight Vehicle Technology	PROJECT 4398

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Efforts transferred to PE 0603112F, Project 4918.
(U) $0 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 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603211F Aerospace Structures

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	16,576	18,291	26,269	22,469	25,684	28,767	29,371	29,993	Continuing	TBD
486U	Advanced Aerospace Structures	16,576	18,291	5,602	4,949	5,511	6,055	6,096	6,234	Continuing	TBD
4920	Flight Vehicle Tech Integration	0	0	20,667	17,520	20,173	22,712	23,275	23,759	0	0
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	Continuing	TBD

Note: Beginning in FY 2002, this Program Element (PE) in Project 4920 contains the ongoing technical efforts from PE 0603205F, Project 2978, and PE 0603245F, Project 2568, in order to align projects with the Air Force Research Laboratory organization. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

The demonstration and transition of advanced aerospace vehicle technologies are accomplished in this program. The two project areas are advanced aerospace structures and flight vehicle technology integration. Advanced aerospace structures are demonstrated to sustain and enhance the capability of current and future aerospace vehicles. Flight vehicle technology integration is accomplished through system level integration of various technologies to include avionics, propulsion, and weapon systems for demonstration in near-realistic operational environments. Note: In FY 2001, Congress added $4.0 million for polymeric foam core technology and $1.5 million for three-dimensional woven preform composites.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	16,638	12,961	11,918	
(U)	Appropriated Value	16,749	18,461		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research				

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603211F Aerospace Structures**

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

		FY 2000	FY 2001	FY 2002	Total Cost
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-88			
	e. Rescissions	-85	-170		
(U)	Adjustments to Budget Years Since FY 2001 PBR			14,351	
(U)	Current Budget Submit/FY 2002 PBR	16,576	18,291	26,269	TBD

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to program element realignment within the Science and Technology Program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)										DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development					PE NUMBER AND TITLE 0603211F Aerospace Structures					PROJECT 486U
COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
486U Advanced Aerospace Structures	16,576	18,291	5,602	4,949	5,511	6,055	6,096	6,234	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates affordable aerospace vehicle technologies to sustain the existing fleet, reduce the cost of aircraft ownership, and enhance the capability of current and future aerospace vehicles. Sustainment of the existing fleet through their extended operational service life with innovative technology application will lead to reduced operations and support costs and increased operational readiness. Analytical certification will reduce the cost associated with component replacement by allowing and certifying new designs under reduced test requirements. Development of capability enhancing technologies will expand the operational envelope and increase survivability in high threat environments. Demonstration of these technologies will restore structural integrity, extend structural life, enhance the capability, and reduce the life cycle costs of fielded aircraft. Note: In FY 2001, Congress added $4.0 million for polymeric foam core technology and $1.5 million for three-dimensional woven preform composites.

(U) FY 2000 ($ in Thousands)

(U) $7,420 Improved durability and performance, affordability, and longevity of existing aging aircraft and future aerospace vehicle structures operating in extreme thermal and acoustic environments. Continued to fabricate an integrated aft fuselage and nozzle section.

(U) $8,671 Developed 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. Designed a full-scale structural component for demonstration of a flexible wing that twists to control flight. Evaluated polymeric foam technology for a wide variety of secondary structures (i.e., leading and trailing edges, flaps, doors, spoiler, etc.).

(U) $485 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) $16,576 Total

(U) FY 2001 ($ in Thousands)

(U) $4,998 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 or

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603211F Aerospace Structures**	PROJECT **486U**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

		eliminating fatigue in weapons bay areas. 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)	$4,000	Continue developing the processing and domestic production capability of constituent material for high strength polymeric foam for aerospace vehicles.
(U)	$1,500	Initiate Congressionally directed efforts to accelerate development of three-dimensional woven preform composite technology to produce low weight, non-corroding structural components.
(U)	$18,291	Total

(U) FY 2002 ($ in Thousands)

(U)	$2,360	Complete the development of analysis methods to accurately predict the impact of corrosion on the onset of cracking, crack progression, and structural failure. Improve the ability to predict the effect of corrosion and corrosion treatments on structural integrity to greatly reduce instances and levels of repair/replacement.
(U)	$2,197	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. Continue the development of technology required for full implementation of bonded repair technology. While bonded repair is being applied more frequently, several technical challenges must be met so that this technology can be fully implemented on a larger class of problems. Bonded repair can be used to reduce the frequency of crack nucleation and also used to slow or stop crack growth allowing for a decrease in the frequency and magnitude for repair or replacement.
(U)	$1,045	Develop technologies that will extend aircraft life, increase aircraft availability, and reduce operations and support costs. Concepts and methods

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603211F Aerospace Structures**	PROJECT **486U**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

will be developed to reduce dynamic loads. This will result in the capability to cost-effectively and safely utilize aircraft longer than originally intended. It will also result in decreased maintenance actions due to damage in dynamically loaded structure.

(U) $5,602 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) 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603211F Aerospace Structures

PROJECT
4920

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4920 Flight Vehicle Tech Integration	0	0	20,667	17,520	20,173	22,712	23,275	23,759	Continuing	TBD

Note: Beginning in FY2002, this project contains the ongoing technical efforts from PE 0603205F, Project 2978, and PE 0603245F, Project 2568, in order to align projects with the Air Force Research Laboratory organization.

(U) A. Mission Description

This project integrates and demonstrates advanced flight vehicle technologies that will improve the performance and supportability of existing and future manned and unmanned aerospace vehicles. System level integration brings together the aerospace vehicle technologies along with avionics, propulsion, and weapon systems for demonstration in a near-realistic operational environment. Integration and technology demonstrations reduce the risk and time required to transition technologies into operational aircraft. This program provides proven aerospace vehicle technologies for all-weather, day/night operations with significantly improved performance and affordability.

(U) FY 2000 ($ in Thousands)
(U) $0 Efforts were performed in PE 0603205F, Project 2978, and PE 0603245F, Project 2568.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 Efforts were performed in PE 0603205F, Project 2978, and PE 0603245F, Project 2568.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $13,975 Develop and demonstrate technologies to support the joint Air Force/Defense Advanced Research Projects Agency unmanned combat air vehicle goals. Flight test unmanned combat air vehicle to demonstrate integration of critical technologies, autonomous ground operations, inter-vehicle communication, and multi-vehicle flight operations to complete an end-to-end technology demonstration of mission utility.
(U) $2,120 Develop and validate novel control automation techniques and algorithms to enable the safe and interoperable application of unmanned vehicle systems while providing mission responsiveness and adaptability for improved operational effectiveness of manned and unmanned systems. Complete the simulation assessment of intelligent-agent-based algorithms and modular software system architecture for cooperative control of unmanned vehicles. Integrate unmanned vehicle software with photonic vehicle management system hardware.
(U) $848 Demonstrate and validate advanced control mechanization technologies to provide highly reliable operation for manned and unmanned systems at significantly reduced size, weight, and cost. Complete advanced development and demonstration of direct optical control and interfacing of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603211F Aerospace Structures	PROJECT 4920

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

		vehicle management and more-electric subsystems. Transfer technology to unmanned air vehicle control integration efforts. Assess benefits of applying photonic technologies to vehicle and health management for military space access systems.
(U)	$1,515	Develop multifunctional integrated structures to reduce acquisition and support costs weight and volume. Develop concepts for embedding high frequency multi-element antenna arrays in loadbearing structure for antenna performance improvement. Mature concepts with advanced aerodynamic technologies that enable structurally integrated highly survivable and maintainable inlet and exhaust systems.
(U)	$1,768	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. Develop design concepts and methods to allow more widespread use of low-cost bonded structure with particular attention to verification of analyses methods through test articles.
(U)	$441	Develop advanced structural concepts and design methods for future aerospace vehicles for enhanced affordability and higher performance. Complete flight test demonstration of the increased control authority of an active aeroelastic wing, and transition technology to reduce airframe cost and weight for future air vehicles.
(U)	$20,667	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) 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 **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603216F Aerospace Propulsion and Power Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	35,345	43,413	114,335	96,161	88,044	83,114	84,861	86,654	Continuing	TBD
2480	Aerospace Fuels and Atmospheric Propulsion	2,134	3,542	12,501	3,185	3,253	3,321	3,391	3,462	Continuing	TBD
3035	Aerospace Power Technology	1,370	2,401	4,647	4,252	4,341	4,431	4,525	4,621	Continuing	TBD
4921	Aircraft Propulsion Subsystems Int	0	0	35,845	32,569	27,287	23,626	24,122	24,632	Continuing	TBD
4922	Space & Missile Rocket Propulsion	0	0	26,506	21,469	22,944	24,644	25,162	25,693	Continuing	TBD
681B	Advanced Turbine Engine Gas Generator	31,841	37,470	34,836	34,686	30,219	27,092	27,661	28,246	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.
In FY 2002, all turbine engine technology efforts performed in PE 0603202F, Aircraft Propulsion Subsystem Integration, Project 668A, are transferred to PE 0603216F, Project 4921. Also in FY 2002, all rocket propulsion technology efforts performed in PE 0603302F, Space and Missile Rocket Propulsion, Projects 4373 and 6340, are transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory organization.

(U) A. Mission Description

The Aerospace Propulsion and Power Technology program develops and demonstrates technologies to achieve enabling and revolutionary advances in turbine and rocket propulsion, power generation and storage, and fuels. The program has five projects, each focusing on technologies with high potential to enhance performance of existing and future Air Force weapons systems. 1) The Advanced Turbine Engine Gas Generator project develops and demonstrates core turbine engine technologies for current and future aircraft propulsion systems. 2) The Aerospace Propulsion Subsystem Integration project integrates the engine cores demonstrated in the Turbine Gas Generator project with low-pressure components into demonstrator engines. 3) The Aerospace Power Technologies project develops and demonstrates power technologies for weapons and aircraft. 4) The Space and Missile Rocket Technology project develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques. 5) The Aerospace Fuels and Atmospheric Propulsion project develops and demonstrates improved hydrocarbon fuels and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**

(U) A. Mission Description Continued

advanced propulsion systems for hypersonic flight. Turbine engine propulsion projects are part of the Integrated High Performance Turbine Engine Technology (IHPTET) program. Rocket propulsion projects within this program are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program. Note: In FY 2001, Congress added $1.5 million for Next Generation Aerospace Research Initiative and $0.350 million for Vectored Thrust Ducted Propeller Compound Helicopter Demonstration for Combat Rescue.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	38,723	41,964	40,254	
(U)	Appropriated Value	39,178	43,814		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2			
	b. Small Business Innovative Research	-923			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-2,514			
	e. Rescissions	-394	-401		
(U)	Adjustments to Budget Years Since FY 2001 PBR			74,081	
(U)	Current Budget Submit/FY 2002 PBR	35,345	43,413	114,335	TBD

(U) Significant Program Changes:

Changes to this PE since the previous Presidents Budget are due to PE realignments in order to align projects with the Air Force Research Laboratory organization. Fiscal Year 2002 increases are also due to the recent DoD strategy review which increased funding for technologies in space lift propulsion and next generation aerospace vehicles for long range strike.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603216F Aerospace Propulsion and Power Technology	2480

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2480	Aerospace Fuels and Atmospheric Propulsion	2,134	3,542	12,501	3,185	3,253	3,321	3,391	3,462	Continuing	TBD

Note: In FY 2001, Congress added $1.5 million for Next Generation Aerospace Research Initiative.

(U) A. Mission Description

The Aerospace Fuels and Atmospheric Propulsion project develops and demonstrates improved hydrocarbon fuels and advanced, novel aerospace propulsion systems, including systems for hypersonic flight and access to space. Emphasis is on developing and demonstrating new thermally stable, high heat sink, and controlled chemically reacting fuels. The project also develops and demonstrates fuel system components that minimize cost, reduce maintenance, and improve performance of future aerospace systems.

(U) FY 2000 ($ in Thousands)

(U) $868 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. Determined the effects/benefits of thermally stable JP-8+100 and JP-8+225 fuel for several current and advanced fighter configurations.

(U) $702 Demonstrated effectiveness of thermally stable JP-8+100 for reduced maintenance in a variety of aircraft. Fabricated a sub-scale 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) $396 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. Designed and fabricated heat exchanger for indirect cooling concept for advanced, high temperature engine designs.

(U) $168 Demonstrated a direct fuel/air heat exchanger to provide cooled cooling air for hear exchanger systems. Compared performance and benefits of the direct fuel/air heat exchanger to the indirect system.

(U) $2,134 Total

(U) FY 2001 ($ in Thousands)

(U) $842 Continue demonstrating 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 sub-scale 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.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **2480**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $797 Demonstrate effectiveness of thermally stable JP-8+100 for reduced maintenance in a variety of aircraft. Fabricate a sub-scale integrated fuel/air heat exchanger-combustor in a cooled cooling air heat exchanger configuration, using fuel/air heat exchanger technology designed and fabricated in FY 2000.

(U) $403 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) $1,500 Investigate a broad range of technologies to support propulsion capabilities, improve the nation's aerospace research, development, and manufacturing base, and address the growing shortfall within the aerospace specialized technological workforce. The focus is on propulsion concepts and technologies for next generation military aerospace vehicles. These propulsion concepts will enable practical sustained hypersonic flight and affordable, routine military access to space.

(U) $3,542 Total

(U) FY 2002 ($ in Thousands)

(U) $4,000 Develop techniques for merging the scramjet with other engine cycles such as rockets and gas turbine engines to enable responsive, reliable, operable, and affordable access to space. Evaluate options to enable variable geometry scramjet technology. Initiate development of variable geometry scramjet flow path. Develop inlet system for air-breathing space access vehicles requiring multiple scramjet engine modules to enable fuller dominance of space. Design, fabricate, and initiate wind tunnel testing of a sub-scale multiple scramjet engine inlet system. Quantify scramjet inlet mass capture and boundary layer characteristics of each module resulting from multi-engine interactions.

(U) $3,500 Develop high fidelity analytical tools to evaluate combined cycle engine options (e.g., gas turbine and ramjet/scramjet combinations) for next generation aerospace vehicles and their weapons for long range strike. Identify key combined/combination cycle engine technologies to maximize the use of vehicle speed in force miniaturization and platform survivability for a capability beyond low observables. Conduct analyses to identify optimum transition Mach number between gas turbine engine and ramjet/scramjet engine cycles and the maximum cruise speed of the ramjet/scramjet engine. Conduct pre-design study to evaluate force-multiplier and bomber survivability as a function of maximum sustainable flight Mach number achievable with select gas turbine based combined/combination cycle engine options.

(U) $1,000 Develop enhanced high heat sink endothermic fuel system cooling technology to enable responsive, reliable, operable, and affordable access to space. Determine optimum operating conditions to ensure low catalyst coking and high efficiency cooling. Begin evaluation of advanced fuel/additive combinations to improve ignition and aerospace vehicle operational characteristics. Design and fabricate subscale hardware to assess component operability and durability in small scale simulators.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **2480**

(U) A. Mission Description Continued

(U)	FY 2002 ($ in Thousands) Continued	
(U)	$1,000	Evaluate advanced high heat sink fuels and advanced fuel cooling technology for next generation aerospace vehicles for long range strike. Determine requirements for fuel/fuel additive combinations to improve component life and durability, improve fuel efficiency, reduce weight, and enable operation of advanced propulsion cycles. Develop comprehensive test and qualification strategy for advanced high heat sink fuels. Initiate design and fabrication of reduced scale fuel system simulation components unique to next generation bombers.
(U)	$251	Demonstrate thermally stable fuels to enhance cooling capacity (performance) and reduce fuel system maintenance. Demonstrate advanced high heat sink fuels to increase fuel delivery system durability at high temperatures and reduce maintenance due to fuel degradation in a sub-scale integrated fuel/air heat exchanger.
(U)	$402	Determine fuel cooling requirements for advanced aircraft sensors and directed energy weapons to meet the needs of evolving manned and unmanned aerospace systems. Determine properties for low temperature additives to prevent fuel from freezing and allow advanced unmanned and manned systems to sustain high altitude loiter for extended periods.
(U)	$805	Develop low-cost fuel additives for Air Force applications. Evaluate and demonstrate optimum low-cost fuel additive to reduce particulate emissions from gas turbine engines by 50 percent. Evaluate and demonstrate low-cost fuel additives to improve ignition characteristics and combustion in current and advanced and combined cycle engines.
(U)	$805	Develop fuel system technology. Design and develop fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles. The focus will be on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling. Identify fuel concepts to maximize performance of advanced and combined cycle engines and minimize logistics costs.
(U)	$738	Identify and develop low-cost approaches to reducing the fuel logistics footprint for the Expeditionary Air Force. Determine benefits of advanced additive packages to improve any commercially available jet fuel to meet military standards. Develop novel methods to inject additives to improve fuels and advanced field diagnostic techniques such as smart nozzles to assess fuel quality, additive injection requirements, and aid in mission planning by monitoring mission limiting fuel properties.
(U)	$12,501	Total

(U) B. Project Change Summary

Not Applicable.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT 2480

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602102F, Materials.

(U) PE 0602204F, Aerospace Sensors.

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

(U) PE 0603253, Advanced Sensor 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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	**0603216F Aerospace Propulsion and Power Technology**	**3035**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3035 Aerospace Power Technology	1,370	2,401	4,647	4,252	4,341	4,431	4,525	4,621	Continuing	TBD

(U) A. Mission Description

The Aerospace Power Technology project develops and demonstrates aircraft and ground power technology for engine starters, auxiliary power units, and electrical power generation and distribution systems. This technology enhances reliability and survivability; it reduces vulnerability, weight, and life cycle costs for (manned and unmanned) aircraft and spacecraft. The electric power system components developed are projected to provide a two to five times improvement in aircraft reliability and maintainability, and a 20 percent reduction in power system weight. This project also develops and demonstrates high power generation and storage technologies to enable high power density sources for directed energy weapons.

(U) FY 2000 ($ in Thousands)

(U) $635 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. Integrated a switched reluctance starter generator with magnetic bearings and the turbomachine to demonstrate IPU feasibility, weight savings, and reliability improvements over conventional Auxiliary Power Unit/Emergency Power Unit (APU/EPU) approaches.

(U) $88 Performed IPU aircraft integration analysis to determine mission available power for Directed Energy Weapon (DEW) applications.

(U) $647 Developed power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. Developed IPU prognostics health management and power electronics for increased reliability, decreased maintenance, and two times increase in power density which is enabling for advanced fighter aircraft and Uninhabited Combat Aerial Vehicles (UCAV).

(U) $1,370 Total

(U) FY 2001 ($ in Thousands)

(U) $573 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 IPU. The demonstrator will integrate the switched reluctance starter generator with magnetic bearings and the turbomachine to demonstrate IPU feasibility, weight savings, and reliability improvements over conventional APU/EPU approaches.

(U) $99 Design, fabricate, and test for emergency power capabilities of an IPU. Applications include rapid rotor spin-up and light-off, and continuous power generation using stored oxidizer.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **3035**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U) $1,729 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 two times increase in power density, which is enabling for advanced fighter aircraft and Uninhabited Combat Aerial Vehicles (UCAV).

(U) $2,401 Total

(U) FY 2002 ($ in Thousands)

(U) $2,000 Develop high-density secondary power system and advanced weapons power technology for a next generation aerospace vehicle for long range strike. Initiate trade studies, detailed design, and critical technology development to optimize secondary power system size, weight, and efficiency. Evaluate electric power technology options for advanced weapon systems.

(U) $251 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 to operate directed energy weapons. Fabricate lengths of Yttrium Barium Copper Oxide (YBCO) sufficient to fabricate coated conductors for cryogenic generators.

(U) $792 Develop power generation, conditioning, and distribution; energy storage; and thermal management component and subsystem technologies for manned and unmanned aircraft systems. Demonstrate technologies for an integrated power unit for advanced fighter aircraft and unmanned vehicles.

(U) $1,604 Define requirements for high power generation systems for directed energy weapons. Evaluate trade offs and define approaches for superconducting and conventional generators for weapons power systems.

(U) $4,647 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) PE 0602605F, Directed Energy Technology.

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

(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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT 4921

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4921 Aircraft Propulsion Subsystems Int	0	0	35,845	32,569	27,287	23,626	24,122	24,632	0	0

Note: In FY 2002, all turbine engine technology efforts performed in PE 0603202F, Aircraft Propulsion Subsystem Integration, Project 668A, are transferred to Project 4921.

(U) A. Mission Description

The Aerospace Propulsion Subsystems Integration (APSI) project develops and demonstrates gas turbine propulsion system technologies applicable to aircraft. The APSI project includes demonstrator engines such as the Joint Technology Demonstrator Engine for manned systems, and the Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. The demonstrator engines integrate the core (high-pressure spool) technology developed under the Advanced Turbine Engine Gas Generator project with the engine (low-pressure spool) technology such as fans, turbines, engine controls, and exhaust nozzles. This project also focuses on system integration aspects of inlets, nozzles, engine/airframe compatibility, and low-observable technologies. APSI provides 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 project supports the goals of the national Integrated High Performance Turbine Engine Technology (IHPTET) program, which is focused on doubling turbine engine propulsion capabilities while reducing cost of ownership. Anticipated technology advances include turbine engine improvements providing a ~30 percent reduction in tactical fighter aircraft takeoff gross weight and 100 percent increase in aircraft range/loiter. The IHPTET program provides continuous technology transition for military turbine engine upgrades and derivatives, and has the added dual-use benefit of enhancing the United States turbine engine industry's international competitiveness.

(U) FY 2000 ($ in Thousands)
(U) $0 Previously accomplished in PE 0603202F, Project 668A.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 Previously accomplished in PE 0603202F, Project 668A.
(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **4921**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $5,778 Design, fabricate, and demonstrate durability and integration technologies for turbofan/turbojet engines. These technologies will improve durability, supportability, and affordability of current and future Air Force aircraft. Complete engine testing in support of the national High Cycle Fatigue (HCF) program including forward swept fan blade damage tolerance, advanced instrumentation, model validation, and improved test protocol.

(U) $20,357 Design, fabricate, and demonstrate advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Complete demonstrator engine test of fixed inlet guide vanes and Moderate Aspect Ratio (MAR) rotor, Integrally Bladed Rotor (IBR) repair, fan rim damper, High Cycle Fatigue (HCF) mistuning technologies, vaneless counterrotating high/low pressure turbine, probabilistic rotor system design, gamma titanium aluminide Low Pressure Turbine (LPT) coverplate, sprayform cast hardware, and Ceramic Matrix Composite (CMC) technologies. Continue 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.

(U) $6,210 Design, fabricate, and demonstrate advanced component technologies for limited life engines. These technologies improve performance, durability, and affordability of engines for missile and unmanned air vehicle applications. Complete design and fabricate Organic Matrix Composite (OMC) fan, high stage loading splittered fan, uncooled ceramic high/low pressure turbine, slinger and low volume combustors. Complete engine testing the high stage loading splittered fan and uncooled ceramic low pressure turbine in a demonstrator engine.

(U) $3,500 Develop high speed turbine engine technology for next generation aerospace vehicles for long range strike. Initiate study to evaluate gas turbine technologies for long range strike vehicles (e.g., gas turbine and ramjet/scramjet combined/combination cycle engines). Initiate integrated design of turbine engine controls, exhaust nozzles, high temperature material components, and mechanical systems for capability beyond low observables.

(U) $35,845 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 0602122N, Aircraft Technology.

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

(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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	**0603216F Aerospace Propulsion and Power Technology**	**4922**

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4922	Space & Missile Rocket Propulsion	0	0	26,506	21,469	22,944	24,644	25,162	25,693	0	0

Note: In FY 2002, all rocket propulsion technology efforts performed in PE 0603302F, Space and Missile Rocket Propulsion, Projects 4373 and 6340, are transferred to Project 4922, in order to align projects with the Air Force Research Laboratory organization.

(U) **A. Mission Description**

The Space and Missile Rocket Propulsion project develops advanced and innovative low-cost rocket turbomachinery and components, low-cost space and missile launch propulsion system technologies, and demonstrates advanced propellants for launch and orbit transfer propulsion. Characteristics such as environmental acceptability, affordability, reliability, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. This project also develops chemical, electrical, and solar rocket propulsion system technologies for station keeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program will improve the performance of expendable systems' payload capabilities by ~20 percent and reduce the launch and operations and support (O&S) costs by ~30 percent. Technology advances will also lead to seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload. The projects in this program are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, a joint Department of Defense, National Aeronautics and Space Administration (NASA), and industry effort to focus rocket propulsion technology on national needs.

(U) FY 2000 ($ in Thousands)
(U) $0 Previously accomplished in PE 0603202F, Projects 4373 and 6340.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 Previously accomplished in PE 0603202F, Projects 4373 and 6340.
(U) $0 Total

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DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603216F Aerospace Propulsion and Power Technology

PROJECT
4922

(U) A. Mission Description Continued

(U)	FY 2002 ($ in Thousands)	
(U)	$10,814	Develop propulsion technology for current and future space launch vehicles. Continue to develop turbomachinery components for integration into advanced liquid test bed demonstrator. Complete fabrication and assembly of combustion chamber and injector for liquid engine booster. Continue fabrication of oxygen turbopump for integration into an advanced liquid booster engine. Complete testing of oxygen and hydrogen preburner components for integration into an advanced liquid booster engine. Complete the design of advanced hydrocarbon test bed engine and begin fabrication of hardware.
(U)	$5,000	Conduct detailed design of hydrocarbon rocket engine test bed to enable responsive, reliable, operable, and affordable access to space. Conduct analyses to determine optimum operating conditions and cooling requirements for hydrocarbon rocket engine. Develop rocket engine test bed component design to include turbopumps, boost pumps, and thrust chambers. Demonstrate use of hydrocarbon fuels and additives to cool engine without causing coking or stability problems.
(U)	$3,818	Develop propulsion technologies for current and future upper stage and orbit transfer vehicles. Continue to demonstrate solar thermal propulsion technologies, such as strut development, pointing, and tracking, for orbit transfer and maneuvering propulsion. Continue program to develop electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of low-earth orbit-geosynchronous earth orbit (LEO-GEO) transfer.
(U)	$4,024	Develop technologies for the sustainment of strategic systems. Continue the Post Boost Control System program to demonstrate component technologies with readily available materials to reduce hardware costs, achieve a 90 percent reduction in hydrazine leakage, and five times increase in service life for ballistic missiles. Begin evaluating the Strategic Sustainment Demonstration program hardware that integrates advanced propellant, case, and nozzle technologies.
(U)	$2,850	Develop electric propulsion technologies for satellite formation flying, station keeping, and repositioning. Continue development of mathematical models to address different propulsion technologies that could be used for small satellite formation flying. Continue brass board level testing of a pulsed plasma thruster. Continue development of propulsion systems for Air Force small satellites (<100 kg) required for key Air Force Space Command concepts. Complete design of flight hardware and begin technology transition of selected propulsion concepts. Complete the fabrication of engine hardware for the TechSat 21 spacecraft.
(U)	$26,506	Total

(U) B. Project Change Summary

Not Applicable.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **4922**

(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.

(U) PE 0603114N, Power Projection Advanced Technology.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603216F Aerospace Propulsion and Power Technology	681B

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
681B Advanced Turbine Engine Gas Generator	31,841	37,470	34,836	34,686	30,219	27,092	27,661	28,246	Continuing	TBD

Note: In FY 2001, Congress added $0.350 million for Vectored Thrust Ducted Propeller Compound Helicopter Demonstration for Combat Rescue.

(U) A. Mission Description

The Advanced Turbine Engine Gas Generator project develops turbine engine gas generator technology for current and future aircraft propulsion systems. The objective is to provide the continued evolution of technologies into an advanced gas generator in which the performance, cost, durability, reparability, and maintainability 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. Component technologies are demonstrated in a core (sub-engine) test. Performance is subsequently proven in demonstrator engines under realistic conditions (Project 4921). Efforts are part of the Integrated High Performance Turbine Engine Technology (IHPTET) program.

(U) FY 2000 ($ in Thousands)

(U) $25,990 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. Initiated 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. Designed 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 materials. All of these technology innovations are applicable to a significant part of the Air Force engine inventory along with future engines.

(U) $1,935 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. Fabricated 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) $3,916 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. Conducted core engine testing of splittered compressor rotor, rich quench lean combustor, counter rotating turbines, ceramic turbine vanes, and hybrid ceramic bearings. Designed hardware for core engine testing of forward swept splittered compressor rotor, high temperature

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **681B**

(U) <u>A. Mission Description Continued</u>

(U) <u>FY 2000 ($ in Thousands) Continued</u>

rise combustor, counter rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings.

(U) $31,841 Total

(U) <u>FY 2001 ($ in Thousands)</u>

(U) $28,442 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 technologies to mitigate High Cycle Fatigue. 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 technologies are applicable to a significant part of the Air Force engine inventory along with future engines.

(U) $2,054 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.

(U) $4,399 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) $2,225 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) $350 Evaluate novel vectored thrust propellers for turboprop/turboshaft engine concepts for application to helicopters for combat rescue.

(U) $37,470 Total

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $29,414 Design, fabricate, and test performance of technology demonstrator core engines to provide improved performance and fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports. Complete design and continue fabrication of 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. Design advanced hardware for core engine testing of a high pressure ratio four stage compressor with stability enhancing control, integrated lightweight combustor with ceramic matrix composite panels, a microplasma ignitor, revolutionary turbine blade material, and an endothermic fuel/air heat exchanger.

(U) $2,273 Design, fabricate, and test durability of technology demonstration core engines to provide increased life and affordability for turbofan/turbojet engines for fighters, attack aircraft, bombers, and large transports. Design turbine engine advanced hardware for core engine evaluation in the national durability program.

(U) $3,149 Design, fabricate, and evaluate technology demonstration core engines to provide improved performance and fuel consumption for turboshaft/ turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, theater transports, and large unmanned air vehicles. Continue evaluation of core engine forward swept splittered compressor rotor, high temperature rise combustor, counter rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings.

(U) $34,836 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 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.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT **681B**

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE
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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603227F Personnel Training and Simulation Technology

PROJECT
2743

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2743 Advanced Training/Force Management	5,878	6,432	0	0	0	0	0	0	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, efforts transfer to PE 0603231F, Crew Systems and Personnel Protection Technology, Project 634924, Distributed Mission Training Technology, to align resources with the Air Force Research Laboratory (AFRL) organization. FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.

(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.

(U) FY 2000 ($ in Thousands)

(U) $2,747 Developed, demonstrated, and evaluated technologies to create 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. Developed real-time intelligence fusion into the DMT battlespace environment to simulate real-time intelligence updates and developed technologies to include weapons controller interfaces and wing command and control systems to incorporate live ground segments. Began 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) $901 Demonstrated advances in simulator visual system technologies through the development of high fidelity image generation, display, and database

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603227F Personnel Training and Simulation Technology	PROJECT 2743

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

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. Began development of a PC-based high resolution real-time image generator. Continued development of an ultra-high resolution laser projector for Distributed Mission Training (DMT) simulators.

(U) $836 Developed DMT guidelines and technologies for combat support teams. Technologies will enhance readiness of support forces and increase survivability of warfighters. Developed specifications for training development and performance assessment focused on combat support, night vision ground operations, and force protection situational awareness. Conducted technology needs assessment for force protection DMT in Military Operations Other than War (MOOTW).

(U) $1,394 Developed and demonstrated 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. Developed perceptual training guidelines for distance estimation, scanning techniques, task management techniques, and maintenance of situational awareness and spatial orientation when wearing NVGs. Designed interim NVG compatible cockpit lighting systems for selected fighter and bomber aircraft.

(U) $5,878 Total

(U) FY 2001 ($ in Thousands)

(U) $743 Develop and demonstrate integrated techniques for 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) $1,349 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

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603227F Personnel Training and Simulation Technology**	PROJECT **2743**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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) $1,835 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 Distributed Mission Training (DMT) simulators. Continue development and integration of a less expensive, optical infinity display material for the simulator.

(U) $1,040 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. Develop physics-based radar threat, and other sensor models and their interaction with the environment. Develop an HLA compliant simulation architecture optimized for real-time, distributed, scalable training activities. Develop and test imagery manipulation tools for automatic database generation including automatic materials encoding of source imagery versus current hand coding.

(U) $1,465 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 NVG training techniques to include distance estimation for aircraft, formation and aerial refueling, and combat maneuvering.

(U) $6,432 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort moved to PE 0603231F, Project 4924.

(U) $0 Total

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DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603227F Personnel Training and Simulation Technology

PROJECT
2743

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	6,250	6,491	7,633	TBD
(U)	Appropriated Value	6,327	6,491		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-2			
	b. Small Business Innovative Research	-149			
	c. Omnibus or Other Above Threshold Reprogram	-175			
	d. Below Threshold Reprogram	-57			
	e. Rescissions	-66	-59		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-7,633	
(U)	Current Budget Submit/FY 2002 PBR	5,878	6,432	0	TBD

(U) Significant Program Changes:

In FY 2002, efforts transfer to PE 0603231F, Crew Systems and Personnel Protection Technology, Project 634924, Distributed Mission Training Technology, to align resources with the Air Force Research Laboratory (AFRL) organization.

(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.

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

DATE
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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603231F Crew Systems and Personnel Protection Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	31,474	17,319	32,356	34,775	35,625	34,995	34,082	34,803	Continuing	TBD
2830	Crewstations, Life Support, and Escape	20,670	5,787	6,508	7,519	8,057	8,746	8,929	9,118	Continuing	TBD
3257	Helmet-Mounted Sensory Technologies	10,804	11,532	8,627	8,907	9,848	10,489	9,061	9,254	Continuing	TBD
4923	Logistics Readiness and Sustainment	0	0	10,425	10,799	11,903	9,823	10,030	10,241	Continuing	TBD
4924	Distributed Mission Training Technology	0	0	6,796	7,550	5,817	5,937	6,062	6,190	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, all activity previously reported in PE 0603106F will be reported in Project 4923 and all activity previously reported in PE 0603227F will be reported in Project 4924. FY 2003-FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

This program develops and demonstrates technologies to enhance human performance and effectiveness and enable the aerospace force. State-of-the-art advances are made to train personnel, protect and sustain warfighters, and improve human interfaces with weapon systems. The Crewstations, Life Support, and Escape project develops and demonstrates aircrew and information operations technologies that will protect and sustain the force in operational environments. The Helmet-Mounted Sensory Technologies project develops and demonstrates advanced operator interface technologies for multi-functional helmet-mounted displays, night vision devices, and laser eye protection. The Logistics Readiness and Sustainment project develops and demonstrates technologies that will protect the force, enhance logistics, and improve the design, deployability, performance, and support of current and future weapon systems. The Distributed Mission Training Technology project develops and demonstrates advanced training, simulation, and mission rehearsal technologies. In FY 2001, Congress added $5.0 million for Helmet-Mounted Display Technology.

(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.

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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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	30,953	12,479	13,157	TBD
(U)	Appropriated Value	31,341	17,479		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-11			
	b. Small Business Innovative Research	-739			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	1,213			
	e. Rescissions	-330	-160		
(U)	Adjustments to Budget Years Since FY 2001 PBR			19,199	
(U)	Current Budget Submit/FY 2002 PBR	31,474	17,319	32,356	TBD

(U) Significant Program Changes:

The large increase in FY 2002 is because all activities previously reported in PE 0603106F will be reported in Project 4923 and all activity previously reported in PE 0603227F will be reported in Project 4924.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **2830**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2830 Crewstations, Life Support, and Escape	20,670	5,787	6,508	7,519	8,057	8,746	8,929	9,118	Continuing	TBD

(U) A. Mission Description

This project provides technology to improve human combat performance and aviation safety through effective crewstation integration, improved life support and protection, increased safety during emergency escape, and better information delivery and presentation. Crewstations represent the fundamental interface between the warfighter and equipment across the gamut of aerospace operations. To cope with the recognized data overload in command centers, as well as individual weapon platforms, this project develops technologies for quantifying human-system requirements, designing effective information interfaces, and evaluating crew performance in selected operational environments. This project develops bioaccoustic technologies for the protection of human hearing and enhanced force security. Escape system technologies improve the crewmembers' physical safety during the emergency escape and recovery from high performance aircraft.

(U) FY 2000 ($ in Thousands)

(U) $1,818 Developed and demonstrated 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. Began to integrate simulation software combining a human operator model with a representative weapon system simulation. Demonstrated 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) $1,131 Developed and demonstrated subsystems to protect the aircrew member during emergency ejection in current and future high performance fighter aircraft. Initiated effort to improve head and neck protection by demonstrating a modification to the current inventory HGU-55/P helmet and/or visor to be safely retained up to 600 knots equivalent airspeed (KEAS) and demonstrate the effectiveness of the design in ejection seat tests.

(U) $5,620 Developed and demonstrated 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. Completed redesign of energetics and electronics using U.S. sources. Initiated Phase II fighter aircraft integration risk reduction study.

(U) $11,617 Developed a set of common ejection seat characteristics and qualification criteria consistent with joint Air Force/Navy requirements. Initiated 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) $484 Developed and demonstrated 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. Performed task analysis of

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **2830**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

information operations center and developed measures of performance and effectiveness. Began to develop visualizations promoting battlespace situational awareness.

(U) $20,670 Total

(U) FY 2001 ($ in Thousands)

(U) $1,940 Develop and demonstrate human modeling technologies and simulation tools to verify 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) $3,104 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 600 Knots Equivalent Air Speed threshold.

(U) $743 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) $5,787 Total

(U) FY 2002 ($ in Thousands)

(U) $259 Develop and demonstrate human modeling technologies and simulation tools to verify 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 feasibility demonstration for integrating human modeling technology in a simulation-based testbed to establish performance-based crew system requirements. Develop plan to extend human modeling and simulation technologies to make effective trade-off assessments of crew system concepts to quantify impact on performance, mission effectiveness, and affordability.

(U) $3,500 Develop and demonstrate aircrew escape subsystems to protect the aircrew member during emergency ejection in current and future high-performance fighter aircraft. Develop head/neck protection systems that will provide a decrease in head and neck injuries for crewmembers

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **2830**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

wearing Helmet-Mounted Devices during high-speed emergency ejections. Conduct windblast testing to verify head, neck, and eye protection are provided to 600 Knots Equivalent Air Speed.

(U) $1,000 Develop and demonstrate 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. Develop and demonstrate tools to improve information operations planning, execution, and combat assessment within the information warfare flights of the numbered air forces. Perform cross-cultural analysis as a first step in developing a tool to support adversarial decision-making. Demonstrate the effectiveness of combat assessment tools in joint or Air Force specific exercises.

(U) $749 Develop high performance bioacoustic hearing protection technologies to achieve 40-45 dB noise attenuation for personnel working in and around aircraft. Demonstrate improved noise attenuation performance metrics in laboratory and field environments. Integrate deep insert earplug technology to achieve 35-40 dB field attenuation.

(U) $1,000 Develop and demonstrate technologies to enhance security force situational awareness and threat response time using acoustic sensors. Demonstrate that using an eight microphone array can increase signal to noise ratio for a given look angle, provide three-dimensional (3-D) sound localization, and provide a limited remote detection capability for security forces. Develop and evaluate acoustic algorithms for locating, tracking, and detecting threats. Begin to develop an information management concept for deployed security forces to improve situational awareness by using intelligent algorithms, 3-D audio, and audio symbology to code the detected threats and assist in threat intervention.

(U) $6,508 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 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.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **2830**

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	**0603231F Crew Systems and Personnel Protection Technology**	**3257**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3257 Helmet-Mounted Sensory Technologies	10,804	11,532	8,627	8,907	9,848	10,489	9,061	9,254	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates advanced technologies for multi-functional helmet-mounted displays (HMD), night vision devices, and laser eye protection (LEP). Helmet-mounted tracker and display (HMT/D) technologies development will enable pilots to detect, identify, target, and launch weapons faster and more accurately. Development of improved aircrew night vision goggles (NVG) technologies will enhance aerial combat capabilities at night. This project will also develop operator interface technologies to provide protection against laser threats and hazards, and will improve pilot situational awareness and mission effectiveness.

(U) FY 2000 ($ in Thousands)

(U) $5,667 Developed and demonstrated 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. Continued to develop and demonstrate Fighter Data Link symbology on HMT/D, and pre-planned product improvement technologies for Joint Helmet Mounted Cueing System. Continued 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) $3,880 Developed and demonstrated 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. Continued 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. Continued to evaluate the operational utility of panoramic night vision goggles (PNVGs) with symbology overlay. Demonstrated insertion of imagery into the PNVG in the laboratory.

(U) $1,257 Developed and demonstrated technologies that counter the laser threat, and permit the deployment and use of high-energy laser weapons. Evaluated the biological effects of laser weapons and high-energy laser systems. Completed human factors evaluation of dielectric stack and dye/dielectric stack technologies for laser eye protection against infrared and selected visible laser wavelengths. Continued developing automated laser eye protection device evaluation system for economically validating reproducibility of manufacturing processes. Initiated development of Laser Range Safety Tool for missile Test Range to support flight test of Airborne Laser and other high-energy laser systems.

(U) $10,804 Total

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **3257**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $8,055 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. 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 a HMT/D into the air-to-ground strike mission. Continue to develop and demonstrate a high-luminance, high-resolution, low-voltage Active Matrix Organic Light Emitting Diode image source and an inertial head-mounted tracker.

(U) $2,163 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 panoramic night vision goggles (PNVG). Integrate imagery insertion on PNVG for flight test.

(U) $1,314 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 aircrew evaluation of dye and dielectric stack technologies for infrared and visible laser eye protection. Conduct optical and performance evaluations, and begin aircrew evaluations of airborne laser, and vision corrective laser eye protection (LEP) spectacles. Deliver Laser Range Safety Tool to missile test ranges to support flight testing of Airborne Laser and other high-energy laser systems.

(U) $11,532 Total

(U) FY 2002 ($ in Thousands)

(U) $3,630 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. Demonstrate advanced symbology and video insertion on HMT/D for air-to-ground strike missions. Demonstrate inertial head tracker on HMT/D for air-to-ground strike missions.

(U) $2,125 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. Demonstrate 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 effects. Demonstrate Integrated Panoramic Night Vision Goggles (IPNVG) technologies integrated with laser eye protection technologies. Continue flight evaluation of IPNVG and demonstrate imagery insertion in flight.

(U) $2,872 Develop and demonstrate technologies that counter the multiple wavelength and agile laser threat and permit safe testing, deployment, and use of high-energy laser weapons. Continue evaluation of the biological effects of non-lethal laser weapons and high-energy laser systems. Finish

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT 3257

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

aircrew evaluation of dye/dielectric stack combination laser eye protection (LEP). Complete performance evaluation of vision-corrective prescription capability and airborne laser eye protection of dielectric stack-based LEP, and begin aircrew evaluations of these devices. Demonstrate next generation rugate technology for visible wavelength protection. Continue assessment of laser glare effects on visual performance of human subjects wearing reflective LEP compared to combined dye/dielectric stack technologies.

(U) $8,627 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 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-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	**0603231F Crew Systems and Personnel Protection Technology**	**4923**

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4923	Logistics Readiness and Sustainment	0	0	10,425	10,799	11,903	9,823	10,030	10,241	Continuing	TBD

Note: Prior to FY 2002, efforts in this project were previously accomplished in PE 0603106F, Project 2745.

(U) A. Mission Description

This project develops and demonstrates technologies that will enhance logistics, and improve the design, deployability, performance, and support of current and future weapon systems. This includes technology development to model and simulate intelligent behavior; improve the accuracy of logistics process modeling; create intelligent software agents to perfect human and logistics representation in large-scale military simulations; and create more effective logistics information systems. This project also develops and demonstrates technologies to incorporate human operator, maintenance, and support considerations into the weapon systems design process, and to make related data electronically available throughout weapon system life cycles. The resulting efforts will reduce deployment airlift and footprint requirements, improve the logistics information system, and improve the command, control, and decision making in world wide logistics management.

(U) FY 2000 ($ in Thousands)

(U) $0 FY 2000 activity reported in PE 0603106F, Project 2745.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $0 FY 2001 activity reported in PE 0603106F, Project 2745.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $1,838 Develop and demonstrate technologies that will enhance and streamline aircraft maintenance processes to improve the Air Force's ability to meet Air Expeditionary Force requirements by providing faster and more accurate methods of diagnosing and predicting component failures. 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. Begin development of a prognostics capability to accurately predict when a component will fail so that parts can be replaced before failure.

(U) $4,340 Develop and demonstrate intelligent software agents and realistic human behavior models. These software 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 intelligent agents that extend the role players' ability to monitor events and execute missions, and better represent logistics functions in synthetic

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **4923**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

exercises. Develop software agents that anticipate problems and offer decision options to command center personnel during mobility operations.

(U) $4,247 Develop and demonstrate logistics technologies for improved deployment operations, supportability, and planning. These technologies will enhance deployments and mobility operations. Continue to develop technology to provide wing commanders and senior logisticians with advanced logistics information and management capabilities, including rapid access to real-time resources status information, proactive problem identification, decision support aids, and process tracking. Focus will be on the information feeds required to support the wing commander and senior logisticians in effectively assessing the wing logistics support status.

(U) $10,425 Total

(U) B. Project Change Summary

Not Applicable.

(U) C. 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) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603231F Crew Systems and Personnel Protection Technology	PROJECT 4924

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4924 Distributed Mission Training Technology	0	0	6,796	7,550	5,817	5,937	6,062	6,190	Continuing	TBD

Note: Prior to FY 2002, efforts in this project were previously accomplished in PE 0603227F, Project 2743.

(U) A. Mission Description

This project develops and demonstrates advanced training, simulation , and mission rehearsal technologies that will improve warfighter capabilities and mission readiness by enhancing operator and team performance skills. This effort includes the development of technologies that enable integration of computer models, live weapon systems, and weapon system simulators to portray the global battlespace, including all-weather, day/night flight operations, command and control, force protection, and space operations. This project develops and demonstrates advanced training and simulation technologies that will improve warfighter readiness by enhancing mission training and mission rehearsal capabilities Development and effective use of this global battlespace requires advances in training systems, interconnection, information, visual, and representation technologies. The resulting mission training and rehearsal capabilities will enhance the mission essential competencies of the combat and combat support individuals and teams that comprise the aerospace force.

(U) FY 2000 ($ in Thousands)
(U) $0 FY 2000 activity reported in PE 0603227F, Project 2743.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 FY 2001 activity reported in PE 0603227F, Project 2743.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $1,829 Advance warfighter training capabilities by developing and demonstrating representational technologies and training techniques for integrated aerospace operations training which includes training for aerospace, command and control force protection warfighters. Techniques will increase fidelity of mission training and rehearsal systems, reduce the learning time for new operators, sustain critical mission competencies, and ensure that deployed personnel have the knowledge and skills to accomplish their mission. Demonstrate training benefits of distributed mission training technology for fighter aircraft individual flying skills, fighter weapons school, and aircrew training program. Complete development of a tactical decision trainer for force protectors. Begin development of data capturing tools for crew and team performance assessment in both simulator and field environments. Design and develop technologies for realistic databases and electronic combat simulators.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **4924**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

(U) $2,002 Develop and demonstrate the application of information and communications technologies for realistic mission training and mission rehearsal in a distributed simulation environment. These technologies will increase readiness training by enabling more realistic employment of weapon systems within a horizontally and vertically integrated system of sensors, command and control, and weapons platforms. Design a communication bridge to enable virtual simulators, operating at different security levels, to interact with one another in a real-time simulation environment. Develop and demonstrate enhancements to the High-Level Architecture that will enable more rapid development of simulator federations and enhanced simulator performance. Develop a testbed for command and control training research with links to existing command and control centers. Evaluate techniques for integrating operational command and control systems into the distributed mission training environment.

(U) $1,600 Demonstrate advances in simulator visual system technologies through the development of high fidelity image generation, display, and databases. 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 a PC-based high resolution real-time image generator. Continue development of an ultra-high resolution laser projector for distributed mission training simulators.

(U) $1,365 Develop and demonstrate technologies for high fidelity Night Vision Goggle (NVG) simulation to support and increase mission training, preview, and rehearsal capabilities. This development will reduce the cost of initial NVG qualification, allow for effective advanced night operation mission pretraining prior to in-aircraft training, and increase combat training realism by adding simulated weather, seasonal, and environmental changes. Test the use of an automated material classification toolset for rapid build of multi-spectral databases. This toolset may increase the capability to rapidly respond to world changes with realistic visualization of the new or changing operating areas. Evaluate effectiveness of on-line NVG and laser courseware, and assess impact of these technologies on mission effectiveness and risk management.

(U) $6,796 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603231F Crew Systems and Personnel Protection Technology**	PROJECT **4924**

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

(U) Related Activities:

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

(U) PE 0604227F, Distributed Mission Training.

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

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

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

DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603245F Flight Vehicle Technology Integration

PROJECT
2568

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2568	Flight Vehicle Technology Integration	7,710	17,960	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: Beginning in FY 2002, this program element (PE) has been eliminated. The ongoing technical efforts from Project 2568 have been transferred to PE 0603211F, Aerospace Structures, Project 4920, Flight Vehicle Tech Integration.

(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. Note: In FY 2001, Congress added $2.0 million for explosion resistant fuel tank lining materials and $4.0 million for the conduct of a Trans-Atmospheric Aerospace Plane (TAAP) study.

(U) FY 2000 ($ in Thousands)

(U) $2,180 Developed and integrated advanced aeromechanics, propulsion, and flight control technologies that will increase combat effectiveness for Air Force aircraft systems. Completed fabrication of next generation exhaust nozzle and airframe structural critical components.

(U) $1,882 Developed and flight-tested control strategies to extend range, ensure safe operation, and allow precision close operations of mixed manned and unmanned aerospace vehicles. Continued development and flight-test control strategies to extend range, ensure safe operation, and allow precision close operations of mixed manned and unmanned aerospace vehicles. Continued unmanned aerospace vehicle technology development.

(U) $3,648 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 electric actuator technologies to demonstrate air-to-air combat effectiveness for aerospace vehicles.

(U) $7,710 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603245F Flight Vehicle Technology Integration	PROJECT 2568

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$10,845	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-observable 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)	$1,115	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)	$2,000	Initiate Congressionally directed effort to address advanced technology development of explosionissues associated with integration of explosion resistant fuel tank lining materials.
(U)	$4,000	Initiate Congressionally directed efforts to conduct a Trans-Atmospheric Aerospace Plane (TAAP) study, to provide a comprehensive evaluation of future strike military utility in order to identify technologies that must be pursued by the Air Force.
(U)	$17,960	Total

(U) FY 2002 ($ in Thousands)

(U)	$0	Efforts transferred to PE 0603211F, Aerospace Structures, Project 4920, Flight Vehicle Tech Integration.
(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.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	8,289	13,184	13,937	
(U)	Appropriated Value	8,335	18,126		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1			
	b. Small Business Innovative Research				
	c. Omnibus or Other Above Threshold Reprogram	-537			

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603245F Flight Vehicle Technology Integration	PROJECT 2568

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

		FY 2000	FY 2001	FY 2002	Total Cost
	d. Below Threshold Reprogram	-54			
	e. Rescissions	-33	-166		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-13,937	
(U)	Current Budget Submit/FY 2002 PBR	7,710	17,960	0	TBD

(U) Significant Program Changes:
Changes to this program since the previous President's Budget are due to Program Element realignment in the Science and Technology Program.

(U) D. Other Program Funding Summary ($ in Thousands)
(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics
(U) PE 0603106F, Logistics Systems 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603253F Advanced Sensor Integration

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	10,069	5,301	0	0	0	0	0	0	Continuing	TBD
2735	Avionics Integration Technology	6,840	1,974	0	0	0	0	0	0	Continuing	TBD
666A	Sensor Fusion & Integration Tech	3,229	3,327	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, most of the work performed in this PE, Project 2735, was moved into PE 0603726F, Project 4850. In FY 2002, the remainder of the work in this PE, Project 2735, transfers to PE 0603203F, Project 665A. In FY 2001, some work in this PE, Project 666A, transferred to PE 0603726F, Project 4850. In FY 2002, the remainder of the work in this PE, Projects 2735 and 666A, transfers to PE 0603203F, Project 665A. FY 2003 - FY 2007 budget numbers do not reflect the DOD Strategy Review results.

(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 situational 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.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	9,327	5,350	5,084	
(U)	Appropriated Value	9,443	5,350		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-3			

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603253F Advanced Sensor Integration**

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

		FY 2000	FY 2001	FY 2002	Total Cost
	b. Small Business Innovative Research	-223			
	c. Omnibus or Other Above Threshold Reprogram	-711			
	d. Below Threshold Reprogram	1,662			
	e. Rescissions	-99	-49		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-5,084	
(U)	Current Budget Submit/FY 2002 PBR	10,069	5,301	0	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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603253F Advanced Sensor Integration	2735

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2735 Avionics Integration Technology	6,840	1,974	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, most of the work performed in this project moved to PE 0603726F, Project 4850. In FY 2002, the remainder of this effort transfers to PE 0603203F, Project 665A.

(U) A. Mission Description

This project develops and demonstrates advanced radio frequency (RF) sensors for integrated intelligence, surveillance, and reconnaissance (ISR) 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 2000 ($ in Thousands)

(U) $2,036 Developed and demonstrated advanced modular, sharable RF sensor technologies for aerospace sensor suites performing ISR applications. Designed a dual-use modular, digital RF receiver. Conducted trade studies for air moving target indication.

(U) $2,600 Developed 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. Evaluated on-board and off-board sensors and multiple platforms in a collaborative engineering environment. (In FY 2001, this work transferred to PE 0603726F, Project 4850.)

(U) $804 Developed and demonstrated technologies to support maximum use of existing avionics software together with new software in real-time environments. Transitioned these technologies to fighter and transport aircraft. (In FY 2001, this work transferred to PE 0603726F, Project 4850.)

(U) $1,400 Developed and demonstrated advanced architecture concepts to support seamless information flow and fusion for application in space and unmanned aerial vehicles (UAVs). Developed UAV architecture concepts applicable to multiple UAV applications. Developed 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 transferred to PE 0603726F, Project 4850.)

(U) $6,840 Total

(U) FY 2001 ($ in Thousands)

(U) $1,974 Develop and demonstrate advanced modular, sharable digital RF sensor technologies for aerospace sensor suites performing ISR applications. Fabricate and test dual-use, modular, digital RF receiver components for multimode radar operation. (In FY 2002, this work transfers to PE 0603203F, Project 665A.)

(U) $1,974 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603253F Advanced Sensor Integration	PROJECT 2735

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Effort transfers to PE 0603203F, Project 665A.
(U) $0 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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development					PE NUMBER AND TITLE 0603253F Advanced Sensor Integration						PROJECT 666A
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
666A	Sensor Fusion & Integration Tech	3,229	3,327	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, some work in this project transferred to PE 0603726F, Project 4850. In FY 2002, the remainder of this effort transfers to PE 0603203F, Project 665A.

(U) A. Mission Description

This project 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 project 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 situational awareness, reduce electromagnetic signatures of navigation and communication systems, and increase aircraft survivability. The focus is on transitioning transceivers, inertial components, and 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 2000 ($ in Thousands)

(U) $2,429 Developed reference and receiver technologies to maximize GPS jam resistance, positional accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Developed integration methods, receiver processor technology, and direct acquisition techniques. Evaluated GPS modernization candidate military signals for exploitable vulnerabilities.

(U) $800 Developed and evaluated 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. Fabricated a space-based air traffic communications and positioning brassboard. (In FY 2001, this work transferred to PE 0603726F, Project 4850.)

(U) $3,229 Total

(U) FY 2001 ($ in Thousands)

(U) $3,327 Develop technologies to maximize 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. (In FY 2002, this effort transfers to PE 0603203F, Project 665A.)

(U) $3,327 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603253F Advanced Sensor Integration	PROJECT 666A

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Effort transfers to PE 0603203F, Project 665A.
(U) $0 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603270F Electronic Combat Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	34,163	26,636	28,221	29,559	30,794	31,130	30,528	31,153	Continuing	TBD
2432	Defensive System Fusion Technology	10,664	8,181	7,388	8,130	8,301	8,474	8,652	8,834	Continuing	TBD
431G	RF Warning & Countermeasures Tech	9,296	8,208	8,484	8,756	8,939	9,124	9,316	9,513	Continuing	TBD
691X	EO/IR Warning & Countermeasures Tech	14,203	10,247	12,349	12,673	13,554	13,532	12,560	12,806	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: FY 2003 - FY 2007 budget numbers do not reflect the DOD Strategy Review results.

(U) A. Mission Description

This program develops and demonstrates technologies to support Air Force electronic combat (EC) requirements. The program focuses on developing components, subsystems, and technologies with potential aerospace combat, special operations, and airlift EC applications in three project areas. The first project develops and demonstrates techniques and technologies for integrating EC sensors and systems into a fused and seamless whole. The second project develops and demonstrates advanced technologies for radio frequency EC suites. The third project develops and demonstrates advanced warning and countermeasure technologies to defeat electro-optical (EO), infrared (IR), and laser threats to aerospace platforms. Note: In FY 2001, Congress added $1.0 million for the Integrated Demonstrations and Applications Laboratory (IDAL) Coherent Command, Control, Communications, Navigation, and Identification (C3NI) Signal Simulations.

(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 EC system developments that have military utility and address warfighter needs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	31,947	25,882	26,161	
(U)	Appropriated Value	32,334	26,882		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-762			
	c. Omnibus or Other Above Threshold Reprogram	-789			
	d. Below Threshold Reprogram	3,718			
	e. Rescissions	-338	-246		
(U)	Adjustments to Budget Years Since FY 2001 PBR			2,060	
(U)	Current Budget Submit/FY 2002 PBR	34,163	26,636	28,221	TBD

(U) Significant Program Changes:
Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 2432

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2432 Defensive System Fusion Technology	10,664	8,181	7,388	8,130	8,301	8,474	8,652	8,834	Continuing	TBD

(U) **A. Mission Description**

This project develops and demonstrates technologies for integrating electronic combat (EC) sensors and EC system fusion. It develops advanced algorithms and assessment techniques needed to evaluate and enable combat aircraft operations in multi-spectral threat and countermeasure environments. It also matures technologies required for command and control (C2) warfare, standoff jamming, and support countermeasures for denial, disruption, and suppression of adversary air defense operations. Technologies included are: 1) advanced components and techniques needed to jam enemy radars; 2) advanced standoff jammer technologies; and 3) electronic collection methods to inform field commanders of changes in the electronic environment. In FY 2001, Congress added $1.0 million to integrate Navy and Air Force Integrated Demonstrations and Applications Laboratory (IDAL) Coherent Command, Control, Communications, Navigation, and Identification (C3NI) signal simulation for joint survivability demonstrations.

(U) FY 2000 ($ in Thousands)

(U) $1,819 Developed low-cost technologies to demonstrate data fusion (e.g., threat, targeting, C2, etc.) from off-board and on-board sensors to enhance situational awareness in both new and existing aerospace platforms. Ground demonstrated optimized sensor fusion algorithms in a coalition environment.

(U) $1,425 Developed, as part of an international cooperative effort, the combat information management technologies necessary to provide real-time situational awareness in a joint or coalition theater environment.

(U) $3,142 Developed and investigated C2 warfare electronic attack (EA) techniques to suppress and counter adversary C2 networks. Completed a brassboard demonstration model. Conducted laboratory testing against modern digital C2 network links. Conducted EA laboratory testing and threat exploitation.

(U) $1,353 Conducted evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness. Conducted technology survivability trade studies for advanced fighter applications.

(U) $2,925 Developed man- and hardware-in-the-loop multispectral synthetic battlespace evaluation technology. Developed effective high fidelity capability for warfighter to assess new combat platform sensor technology, threat systems, and countermeasures in a virtual battlespace.

(U) $10,664 Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 2432

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $1,914 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-in-the-Cockpit (RTIC) effort, perform design of optimized sensor fusion algorithms and processor hardware for joint coalition platforms.

(U) $3,365 Develop and investigate offensive counter information warfare technologies to disrupt and/or deny adversarial command and control (C2) nodes and networks. Continue threat exploitation. Conduct ground/field testing of brassboard against modern digital C2 network links. Design experimental hardware and software to counter adversarial communication and navigation systems.

(U) $2,427 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. Integrate Navy and Air Force Integrated Demonstrations and Applications Laboratory (IDAL) Coherent Command, Control, Communications, Navigation, and Identification (C3NI) signal simulation for joint survivability demonstrations.

(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) $8,181 Total

(U) FY 2002 ($ in Thousands)

(U) $1,350 Develop low-cost technologies to demonstrate data fusion (e.g., threat, targeting, command and control, etc.) from off-board and on-board sensors to enhance situational awareness in both new and existing aerospace platforms. Continue bilateral development and lab integration of tactical processors and optimized sensor fusion algorithms as part of an international cooperative experiment.

(U) $3,217 Develop and investigate offensive counter information warfare technologies to disrupt and/or deny adversarial C2 nodes and networks. Complete laboratory tests and subsequently demonstrate the advanced electronic attack (EA) techniques to counter modern digital C2 network links. Analyze and evaluate technical data to determine technique effectiveness. Integrate hardware/software and conduct laboratory tests to evaluate EA techniques to counter adversarial communication and navigation systems. Continue the detailed planning process for ground and flight tests. Develop offensive countermeasures against high-speed, wideband data links for use by multiple ground-based and airborne platforms.

(U) $297 Conduct evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness. Conduct laboratory risk reduction evaluations/demonstrations which evolve/optimize sensor fusion algorithms for utilization on U.S./coalition tactical platforms that provide real-time threat situational awareness.

(U) $2,524 Develop Advanced Tactical Targeting Technology in conjunction with the Defense Advanced Research Projects Agency (DARPA) for

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

Suppression of Enemy Air Defenses. Integrate and flight test brassboard units that triangulate threat emitter positions and provide targeting for precision guided munitions. (In FY 2001, this effort was performed in PE 0603203F, Project 69DF.)

(U) $7,388 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 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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 431G

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
431G	RF Warning & Countermeasures Tech	9,296	8,208	8,484	8,756	8,939	9,124	9,316	9,513	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates advanced technologies for radio frequency (RF) electronic combat (EC) suites to enhance the survivability of aerospace vehicles and to provide crew situational awareness. One major area addressed covers technologies for missile/threat warning, RF receivers, EC preprocessors, advanced sorting/preprocessing algorithms, and expert software for applications on existing and future EC systems. Another major technology area focuses on the development and demonstration of subsystems and components for generating on-board/off-board RF countermeasure techniques. This includes the development of electronic countermeasures (ECM) techniques as well as advanced ECM technologies such as antennas, power amplifiers, preamplifiers, etc.

(U) FY 2000 ($ in Thousands)

(U) $1,799 Developed low-cost advanced radar and RF emitter warning concepts and techniques. Fabricated a wideband digital receiver for affordable electronic support measures and radar warning receiver suites.

(U) $4,148 Developed wideband, multimode, multifunction apertures for electronic warfare applications. Fabricated an advanced antenna that improves gain by a factor of ten at half the cost of current designs.

(U) $3,349 Developed aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems. Developed EC techniques to increase space system survivability. Laboratory tested a steerable high-power array. Demonstrated advanced monopulse angle jamming techniques.

(U) $9,296 Total

(U) FY 2001 ($ in Thousands)

(U) $1,499 Develop affordable radar and RF emitter warning concepts and techniques. Evaluate a wideband digital receiver for affordable electronic support measures and radar warning receiver suites.

(U) $3,543 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 EC 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 431G

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

(U)	$8,208	Total

(U) FY 2002 ($ in Thousands)

(U)	$2,545	Develop affordable radar and radio frequency (RF) emitter warning concepts and techniques. Develop affordable threat alert and jamming techniques for combat aircraft to increase survivability against advanced, integrated RF, electro-optical, and infrared air defense systems, including trade study analyses for techniques to defeat future radar-guided missile systems. Complete requirements study and transition analysis, begin hardware and software development, and hold preliminary design review for an advanced digital threat warning and response capability.
(U)	$1,952	Develop wideband, multimode, multifunction apertures for electronic warfare applications (i.e., threat detection, threat avoidance, suppression of enemy air defenses, surveillance, and reconnaissance). Fabricate and test in the laboratory low-cost adaptive wideband conformal aperture sub-arrays consisting of structurally integrated, multiple polarization elements.
(U)	$3,987	Develop aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future aerospace weapon systems. Conduct laboratory evaluation of advanced monopulse electronic countermeasure (ECM) brassboard system. Develop and test ECM techniques for aircraft against future RF threat systems. Optimize, laboratory test, and field test electronic protection breadboard that will shield advanced radar systems against electronic attacks.
(U)	$8,484	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 June 2001

BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 691X

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
691X	EO/IR Warning & Countermeasures Tech	14,203	10,247	12,349	12,673	13,554	13,532	12,560	12,806	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.

(U) FY 2000 ($ in Thousands)

(U) $8,102 Developed on-board, closed-loop, laser infrared countermeasures (IRCM) for large aircraft to defeat current and future IR missiles in multiple scenarios. Conducted live fire aerial cable car testing at White Sands Missile Range.

(U) $2,188 Conducted in-house analyses of current and future IR threat missiles. Refined digital threat models. Developed countermeasure techniques for imaging IR missiles. Integrated a target simulator for imaging IR seekers.

(U) $1,405 Developed aerospace laser warning sensor technologies for timely alert and response to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser-guided ordnance) signals. Developed low-cost warning technologies for special operations, combat, and mobility aircrew protection.

(U) $2,508 Developed IR missile warning technologies to detect advanced, low signature threat missiles. Evaluated distributed aperture algorithms. Collected signature data on advanced IR threat missiles. Demonstrated real-time missile warning algorithms for low-cost, uncooled sensors.

(U) $14,203 Total

(U) FY 2001 ($ in Thousands)

(U) $4,224 Develop on-board, closed-loop, laser IRCM for large aircraft to defeat current and future IR missiles in multiple scenarios. Fabricate a flight-worthy closed-loop IRCM suite for demonstration on large aircraft.

(U) $1,298 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 691X

(U) A. Mission Description Continued

(U)	FY 2001 ($ in Thousands) Continued	
(U)	$2,093	Develop electro-optical (EO) and infrared (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)	$10,247	Total
(U)	FY 2002 ($ in Thousands)	
(U)	$6,175	Develop on-board, closed-loop, laser infrared countermeasures (IRCM) for large aircraft to defeat current and future IR-guided missiles in multiple scenarios. Integrate and flight test closed-loop IRCM technology on large aircraft.
(U)	$1,235	Conduct in-house analyses of current and future IR guided threat missiles. Complete evaluation of novel expendable countermeasure design concepts and dispense patterns to defeat conventional IR-guided and imaging antiaircraft IR missiles. Initiate development of expendable decoy technology suitable for peacekeeping operations which can be safely deployed at low altitudes over urban areas.
(U)	$2,593	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. Continue development of laser warning sensor technology for space situational awareness. Test and evaluate laser warning sensor components for aircrew protection. Design laser warning sensor to provide cueing for eye/sensor protection on airborne platforms.
(U)	$864	Develop EO/IR missile warning technologies to alert aircrews and aircraft self-protection systems to the approach of advanced, low-signature threats. Initiate development of multi-color warning technologies that improve threat detection and reduce declaration times in heavy clutter environments.
(U)	$1,482	Develop countermeasure technology to defeat passive EO/IR aircraft tracking sensors and ordnance guidance. Continue evaluation of detection techniques for locating, identifying, and countering conventional and advanced EO/IR tracking sensors. Field test the most promising techniques on a 2km range.
(U)	$12,349	Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603270F Electronic Combat Technology	PROJECT 691X

(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.
(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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603302F Space and Missile Rocket Propulsion

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	16,097	27,776	0	0	0	0	0	0	Continuing	TBD
4373	Launch and Orbit Transfer Propulsion Technology	14,391	22,924	0	0	0	0	0	0	Continuing	TBD
6339	Tactical Propulsion Technology	278	0	0	0	0	0	0	0	Continuing	TBD
6340	Satellite Control and Maneuvering Propulsion Technology	1,428	4,852	0	0	0	0	0	0	0	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2000, strategic sustainment efforts have been consolidated in Project 4373; this involved moving the Post-Boost Control and Non-Destructive Evaluation efforts and associated funding from Project 6340 to Project 4373. In FY 2000, the electric propulsion efforts, originally in Project 4373, have been moved to Project 6340. Efforts in Project 6339 will be terminated at the end of FY 2000. In FY 2000, solar thermal efforts have been moved from Project 6340 to Project 4373. Finally, in FY 2002, Projects 4373 and 6340 will transfer to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory organization.

(U) **<u>A. Mission Description</u>**

The Space and Missile Roket Propulsion program develops and demonstrates advanced rocket propulsion and space launch technologies. It 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) program, 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 percent and reduce the launch and operations and support (O&S) costs by 28 percent. In a reusable launch system, the anticipated improvements are an increase in payload capability of 170 percent and a reduction in launch and O&S costs of 79 percent. The advances in propulsion in this program result from the achievement of the 2010 goals of the IHPRPT program. 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 from this program to enhance the country's industrial competitiveness. Note: In FY 2001, Congress added $3.75 million for Pulse Detonation

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion

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

Engine.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	16,526	24,283	21,382	
(U)	Appropriated Value	16,731	28,033		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-6			
	b. Small Business Innovative Research	-394			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	-61			
	e. Rescissions	-173	-257		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-21,382	
(U)	Current Budget Submit/FY 2002 PBR	16,097	27,776	0	TBD

(U) Significant Program Changes:

In FY 2002, remaining efforts in this PE will transfer to PE 0603216F, Project 634922.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603302F Space and Missile Rocket Propulsion**	PROJECT **4373**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4373 Launch and Orbit Transfer Propulsion Technology	14,391	22,924	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2002, all rocket propulsion technology efforts performed in Project 4373 are transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory organization.

(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 (IHPRPT) program.

(U) FY 2000 ($ in Thousands)

(U) $1,816 Developed propulsion technologies for existing and future launch vehicles. Continued to develop turbomachinery components for integration into advanced liquid test bed demonstrator. Initiated fabrication and assembly of combustion chamber and injector. Continued fabrication of oxygen turbopump for integration into an advanced liquid booster engine. Initiated 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) $3,611 Developed propulsion technologies for existing and future upper stage and orbit transfer vehicles. Continued integration of turbopump and chamber into high-pressure cryogenic upper stage test bed engine. Demonstrated these components in engine level tests. Demonstrated the Phase I goals of increased thrust to weight of 30 percent, decreased hardware/support costs by 15 percent, and increased reliability by 25 percent for the 50k lbs. thrust expander cycle upper stage cryogenic engine. Advanced upper stage engine technology will create significant payload increases for future launch vehicles. Demonstrated solar thermal propulsion technologies on ground tests for orbit transfer and maneuvering propulsion technology.

(U) $1,656 Developed technologies for the sustainment of strategic systems. Continued 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 percent, and maintains current performance levels. Initiated the Strategic Sustainment Demonstration program which integrates advanced propellant, case, and nozzle technologies and demonstrates all cost and performance goals. Continued developing non-destructive evaluation (NDE) technology for large solid rocket motors (SRMs).

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion	PROJECT 4373

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $1,949 Developed propulsion technologies for future orbit transfer vehicles (OTVs). Completed high performance Hall thruster propulsion technologies for orbit transfer and maneuvering propulsion technology. Completed component tests, integration of components, and scheduled ground demonstration of flight qualified high performance Hall thruster system. Analyzed flight data and correlated with ground test data to complete final report on the 30kW ammonia arcjet thruster.

(U) $5,359 Continued developing propulsion technologies to support the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program. Completed the fabrication of the oxygen turbopump for integration into an advance liquid booster engine. Completed the Phase 1 Solid Boost Demo program which develops propulsion technologies for the next generation of space boosters.

(U) $14,391 Total

(U) FY 2001 ($ in Thousands)

(U) $6,477 Develop propulsion technology for existing and future launch vehicles. Continue to develop turbomachinery components for integration into 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. Install oxygen turbopump assembly into test facility and prepare for hot fire testing of pump assembly. Complete fabrication of oxygen and hydrogen preburner components for integration into an advanced liquid booster engine. Begin the design of advanced hydrocarbon test bed engine.

(U) $8,746 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 program to develop electric propulsion systems for orbit transfer by developing high-power Hall thrusters capable of low earth orbit-geosynchronous orbit transfer. Initiate the design of the advanced smallsat propulsion demonstration to develop microsat formation flying for Air Force imaging missions.

(U) $3,967 Develop technologies for the sustainment of strategic systems. Initiate the post boost control system (PBCS) program to demonstrate component technologies with readily available materials to reduce hardware costs, a 90 percent reduction in hydrazine leakage, and a five times 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) $3,734 Develop technologies for Pulse Detonation Engines (PDE) to enable next generation propulsion options for affordable access to space and unmanned missions. Define PDE performance requirements. Design PDE engine and key subsystems including inlet, intake valve, fuel

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion	PROJECT 4373

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

injection, initiation, control, and thrust tube. Fabricate components and evaluate fuel injection, initiation, and cooling systems.

(U) $22,924 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort moved to PE 0603216F, Project 4922.

(U) $0 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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603302F Space and Missile Rocket Propulsion	6339

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
6339 Tactical Propulsion Technology	278	0	0	0	0	0	0	0	0	TBD

Note: Efforts in Project 6339 will be terminated at the end of FY 2000.

(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 (IHPRPT) program, include a 49 percent range increase, 50 percent size reduction, 100 percent payload increase, and 21 percent reduction in time-to-target.

(U) FY 2000 ($ in Thousands)

(U) $278 Developed tactical missile technologies. Integrated component technologies and advanced tactical missile propellants that improve missile thrust and reduce plume exhaust signatures. Manufactured European test motors and selected propellant samples incorporating an advanced high performance, acceptable hazards, low environmental impact, and reduced signature propellant. Shipped these rocket test motors to our European partners (France, Germany, and the United Kingdom) and participated in their evaluations of performance, signature, hazards, mechanical, and aging properties.

(U) $278 Total

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ 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 June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603302F Space and Missile Rocket Propulsion**	PROJECT **6339**

(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: **June 2001**

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	**0603302F Space and Missile Rocket Propulsion**	**6340**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
6340 Satellite Control and Maneuvering Propulsion Technology	1,428	4,852	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2002, all rocket propulsion technology efforts performed in Project 6340 are transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory organization.

(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 (IHPRPT) program include a seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload.

(U) FY 2000 ($ in Thousands)

(U) $262 Developed propulsion systems for satellite formation flying. Completed design of pulsed plasma thruster (PPT) for use in satellite formation flying. Completed data analysis of the Electric Space Experiment (ESEX) space flight.

(U) $194 Developed propulsion for satellite stationkeeping and repositioning. Initiated fabrication of brass board test hardware of the pulsed plasma thruster. Completed fabrication of power conditioning systems for ground testing of complete PPT system.

(U) $972 Continued to test propulsion systems for use in satellite propulsion. Began integration of flight hardware onto the TechSat 21 satellite.

(U) $1,428 Total

(U) FY 2001 ($ in Thousands)

(U) $530 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 small satellites.

(U) $410 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) $3,912 Develop propulsion systems for use in satellite propulsion. Initiate development of propulsion system for fleet of Air Force small satellites (<100 kg) required for key Air Force Space Command concepts. Initiate design of flight hardware and begin technology transition of selected propulsion concepts from the laboratory to the commercial sector. Initiate the fabrication of flight hardware for TechSat 21 spacecraft.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603302F Space and Missile Rocket Propulsion	PROJECT 6340

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued
(U) $4,852 Total

(U) FY 2002 ($ in Thousands)
(U) $0 Effort moved to PE 0603216F, Project 4922.
(U) $0 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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603311F Ballistic Missile Technology	PROJECT 4091

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4091	Missile Electronics	22,218	22,789	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

(U) A. Mission Description

This program develops, integrates, and demonstrates advanced guidance, navigation, and control technologies for ballistic missiles, including upgrades of instrumentation for range safety. 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 FYs 2000 and 2001.

(U) FY 2000 ($ in Thousands)

(U) $3,671 Demonstrated technologies for integration of advanced Global Positioning System - Inertial Navigation System (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. Conducted range instrumentation flight safety approval and certification efforts on qualified technologies.

(U) $4,830 Developed and demonstrated 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. Conducted reentry plasma physics characterization studies, extended existing plasma modeling and simulation tools, and enhanced GPS anti-jamming receiver, antenna architectures, and window material technologies.

(U) $1,063 Validated and demonstrated technologies for evaluating the service life, aging properties, and provided for the subsequent recycling of ballistic missile components and materials while minimizing environmental impacts and costs. Conducted demonstrations and validated advanced technologies for evaluating the aging properties of polymeric materials.

(U) $12,654 Developed and demonstrated advanced common ballistic missile technologies necessary for Air Force and Navy replacement and life extension programs. Advanced common technologies provide the required performance at greatly reduced costs to the government. Conducted preliminary designs to modernize missile flight hardware used in Air Force and Navy flight test programs for vehicle range safety and instrumentation. Conducted concept designs for advanced vehicle technologies to support current, life-extended, and replacement missile system testing requirements.

(U) $22,218 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603311F Ballistic Missile Technology**	PROJECT **4091**

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

(U) FY 2001 ($ in Thousands)

(U)	$16,075	Develop technologies for the integration of advanced Global Positioning System-Inertial Navigation System (GPS-INS) technologies into space and missile range instrumentation and missile guidance systems to meet more stringent range safety requirements. Flight test a site-mobile GPS-INS range safety system to demonstrate greatly improved integrity of missile-tracking data in all phases of flight at greatly reduced operational costs while providing greater range flexibility and supporting launch on demand. Initiate certification of the GPS-INS range safety system at missile launch sites.
(U)	$1,301	Develop and demonstrate GPS-INS technologies to improve performance during all phases of flight to include ballistic reentry plasma blackout and jamming environments. These technologies will mitigate detrimental effects of reentry plasma and jamming on GPS-INS navigation performance. Transition current advanced GPS anti-jamming receiver, enhanced antenna architecture, and novel window material technologies to concept exploration. Design and demonstrate critical components/technologies essential to new reentry architectures.
(U)	$5,413	Develop and demonstrate advanced common ballistic missile technologies necessary for the Air Force and Navy replacement and life extension programs. Advanced concept exploration of common ballistic missile technologies will support an analysis of alternatives for concept exploration. Select affordable, existing advanced-technologies directly tied to user requirements. Conduct concept/technology demonstrations that focus on evolutionary vehicle designs using advanced common guidance and flight control technologies/components and sustainable less costly heat shield materials. Demonstrate revolutionary materials testing, service life prediction/component age out, and recovery techniques.
(U)	$22,789	Total

(U) FY 2002 ($ 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 June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603311F Ballistic Missile Technology**	PROJECT **4091**

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	22,725	0	0	
(U)	Appropriated Value	23,000	23,000		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-542			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram				
	e. Rescissions	-240	-211		
(U)	Adjustments to Budget Years Since FY 2001 PBR			0	
(U)	Current Budget Submit/FY 2002 PBR	22,218	22,789	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 **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603401F Advanced Spacecraft Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	102,511	63,019	54,528	50,373	54,115	55,254	63,021	64,352	Continuing	TBD
1026	Space Structures and Controls Technology	6,226	0	0	0	0	0	0	0	Continuing	TBD
2181	Spacecraft Payloads	18,376	16,889	17,228	15,295	15,537	16,718	17,070	17,431	Continuing	TBD
3784	Space Sensors Technology	4,302	0	0	0	0	0	0	0	Continuing	TBD
3834	Integrated Space Technology Demonstrations	52,692	31,990	17,505	18,294	21,161	19,223	26,232	26,787	Continuing	TBD
4400	Space Systems Protection	4,516	5,560	6,109	7,156	7,525	8,590	8,770	8,954	Continuing	TBD
4844	Discoverer II	12,803	0	0	0	0	0	0	0	Continuing	TBD
4938	Space Developmental Planning	0	0	5,029	0	0	0	0	0	Continuing	TBD
682J	Spacecraft Vehicles	3,596	8,580	8,657	9,628	9,892	10,723	10,949	11,180	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2000, the spectral sensing work in PE 0603605F, Project 3150, moved into this PE, Project 3784. Also in FY 2000, PE 0603302F, Project 0003, Launch Vehicle Technology, was combined with Project 1026 in this PE. In FY 2001, the Discoverer II program was terminated by Congress. In FY 2001, several of the projects in this PE were merged; Project 1026 work was moved to Project 682J, and Project 3784 work was moved to Project 2181. In FY 2002, in order to align projects within the Air Force Research Laboratory organization, all efforts in Program Element 0603410F were transferred into this PE, Project 4400. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

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

DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603401F Advanced Spacecraft Technology

(U) A. Mission Description

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, space systems protection, and spacecraft and launch vehicles. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: Congress added $25.1 million in FY 2001 ($6.5 million for Scorpius Low-Cost Launcher, $5.0 million for Upper Stage Flight Experiment, $6.5 million for Space Maneuver Vehicle, $2.6 million for Solar Orbit Transfer Vehicle, $1.5 million for Miniature Satellite Threat Reporting System, and $3.0 million for Satellite Survivability).

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	102,277	97,327	95,490	
(U)	Appropriated Value	103,529	63,602		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-17			
	b. Small Business Innovative Research	-2,420			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram	2,498			
	e. Rescissions	-1,079	-583		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-40,962	
(U)	Current Budget Submit/FY 2002 PBR	102,511	63,019	54,528	TBD

(U) Significant Program Changes:

In FY 2001, the Discoverer II program was terminated by Congress.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development				PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology						PROJECT 1026	

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
1026	Space Structures and Controls Technology	6,226	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, efforts in this Project moved to Project 682J.

(U) A. Mission Description

This project develops and demonstrates advanced composite structures and structural control technologies for future Air Force space and launch systems. The goal is to significantly improve the payload mass fraction and reduce the overall time and cost of spacecraft fabrication. This project also funds 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 and improve the focusing/imaging ability of space-based optical components such as focal plane arrays.

(U) FY 2000 ($ in Thousands)

(U) $1,342 Developed composites for launch vehicle and spacecraft structures for applications such as the lightweight space antenna. Developed spacecraft to demonstrate multi-functional structures technologies. The composite and multi-functional structures will be lighter and more affordable, with improved functionality, reducing fabrication and launch costs and enabling applications such as large aperture sensing systems. Developed spacecraft that demonstrate inflatable and multi-functional structures technologies and fabricate inflatable and multi-functional structures for launch. Developed sub-scale secondary payload adapter structure.

(U) $335 Developed and demonstrated 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. Designed miniature vibration suppression systems. Launched complex sensor isolation platform for demonstration of vibration isolation and pointing. Launched second sensor isolation platform, which was simpler and more user friendly. Continued development of passive and active acoustic attenuation technologies.

(U) $977 Developed 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. Demonstrated low shock separation systems on the ground and in flight. Flight demonstrated first three-axis small launch vehicle isolation system.

(U) $663 Developed advanced composite launch vehicle structures such as grid stiffened shrouds for launch vehicles and lightweight thermal protection structures for reusable launch vehicles. Defined technological needs for future 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. Developed operational grid-stiffened structures.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT **1026**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

(U) $2,909 Developed 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. Designed and fabricated high-stiffness composite constellation payload dispenser.

(U) $6,226 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Efforts transferred to Project 682J.

(U) $0 Total

(U) FY 2002 ($ 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 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.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 2181

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2181 Spacecraft Payloads	18,376	16,889	17,228	15,295	15,537	16,718	17,070	17,431	Continuing	TBD

Note: In FY 2001, efforts in Project 3784 moved into this Project.

(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 will be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., radiation-hardening) commercial data and signal processor technologies for use in Air Force space systems. For mid-term applications, the Improved Space Computer Program (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. In the long-term, this project area focuses on developing low-cost, easily modifiable software and hardware architectures for fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) FY 2000 ($ in Thousands)

(U) $9,982 Developed 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. Improved radiation-hardened fabrication technologies for component manufacturability. Performed functional proof of design of radiation-hardened Power PC processor. Redesigned commercial next generation space processor, accounting for single event upsets, ten times reduction in the amount of power required per instruction at a central processing unit level, and radiation-hardened fabrication. Provided software and hardware-in-the-loop simulators for advanced, user definable space processor architecture.

(U) $1,243 Developed space-qualifiable, high-density advanced packaging technology for digital, analog, and mixed-signal electronic devices and micro-electro-mechanical systems (MEMS) components and applications, including switches and optical components that exploit MEMS technologies. These technologies decrease size, weight, and power required for space electronic devices while also improving their performance, reliability, and affordability. Designed two-dimensional and three-dimensional space-qualified packaging technologies and reconfigurable electronics and plug-and-play system approaches for space. Developed technologies to enhance/enable optical cross-links such as light-emitting diodes, laser diodes, and MEMS optics which allow 400 Megabit per second data transfer.

(U) $1,529 Developed intelligent satellite system technologies for satellite control, precision spacecraft navigation, and formation flying. Developed cluster management technologies for spacecraft constellations. These intelligent satellite systems provide improved capabilities to monitor satellites in real-time, reduce the time required for data collection, processing, and dissemination, and decrease anomaly resolution time and ground operation

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 2181

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

		requirements. Designed satellite cluster command and control, cluster formation flying, and executive cluster control software. Continued design of ground simulation testbed. Continued to build agent-based software architecture to increase satellite autonomy and simplify the development of complex systems. Demonstrated initial formation flying and orbit determination and satellite control ground station software.
(U)	$773	Developed modeling, simulation, and analysis (MS&A) tools for space-based surveillance systems and distributed satellite architecture payloads. The MS&A tools provide data and validate research and development systems engineering level technology trade off decisions for space-based surveillance missions/campaign level assessments and for intelligent satellite systems testbeds. Delivered first version of the Next Generation Space Telescope simulation. Delivered existing space surveillance simulations to support New World Vista's Global Awareness Virtual Testbed. Delivered enhanced satellite toolkit which encompasses satellite constellation-level, distributed architecture modeling.
(U)	$4,849	Developed 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 a reasonable cost. Improved fabrication process for, and performance of, radiation-hardened Application Specific Integrated Circuits. Fabricated and validated evaluation chips. Fabricated high performance, strategic hardened microprocessors (Power PC 603e equivalent) for space using hardened design techniques and transfer to hardened manufacturing fabrication line. Designed and fabricated a 16 Megabit radiation-hardened memory - a four-fold improvement over current technologies - using innovative techniques and new material application.
(U)	$18,376	Total

(U) FY 2001 ($ in Thousands)

(U)	$9,021	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 the development of packaging and MEMS technologies that enhance/enable optical cross-links and demonstrate the 400 Megabit per second data transfer. Develop reconfigurable electronics and initial plug-and-play system approaches for space.
(U)	$1,569	Continue to develop intelligent satellite system technologies for satellite control, precision spacecraft navigation, formation flying, and cluster

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT **2181**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

management technologies for spacecraft constellations. Demonstrate intelligent satellite software in the distributed-cluster ground testbed for satellite cluster command and control, cluster formation flying, and executive cluster management. Complete and demonstrate enhanced executive cluster controller and begin developing formation flying and orbit determination flight test software and satellite control ground station software.

(U) $1,435 Continue to develop modeling, simulation, and analysis (MS&A) tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. 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) $2,206 Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as 'cold body' targets such as decoys, satellites, and midcourse warheads. Design low temperature, multi-color, and low background detectors and focal plane arrays and higher temperature focal plane arrays with higher levels of radiation-hardness. 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 space backgrounds.

(U) $2,658 Develop satellite antenna technologies that maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to 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) $16,889 Total

(U) FY 2002 ($ in Thousands)

(U) $10,511 Develop spacecraft microelectronic devices which will include radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications. Design advanced general purpose embedded processors capable of performing at 500 million instructions per second. Design digital signal processors capable of performing at 1 billion operations per second. Perform full-scale integration of chalcogenide programmable

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 2181

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

		memory elements into high density, low power chips. Investigate integration of chalcogenide into other component applications. Extend fabrication capability for application specific integrated circuit technology for upwards to eight million gate devices. Develop and demonstrate a MEMS switch box that will use discrete components with non-radiation-hardened control circuitry. Investigate the miniaturization of optical cross-links for advanced packaging applications.
(U)	$1,755	Continue to develop intelligent satellite system technologies for satellite control, precision navigation, formation flying, and cluster management technologies for spacecraft constellations. Develop flight-ready microsatellite cluster management software. Complete and demonstrate flight-ready microsatellite flying algorithms and initiate development of command and control and navigational capability to perform high-fidelity spacecraft proximity operations. Develop a virtual cluster control ground station capable of commanding and controlling multiple satellite clusters. Initiate development of automated planning and scheduling software and integration of distributed payload processing algorithms with the flight software. Develop a spacecraft and simulation data archiving and storage system.
(U)	$866	Continue to develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. Build models for sparse, distributed aperture radio frequency (RF) system simulation to support technology trades, systems engineering, and design reviews for near-term flight test experiments. Build models of sparse aperture RF distributed signal processing to be validated against flight experiment and for systems analysis.
(U)	$2,552	Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well 'cold body' targets such as decoys, satellites, and midcourse warheads. Fabricate and deliver low temperature multi-color and low background detectors and focal plane arrays, and higher temperature arrays with improved radiation-hardness. Continue iterative development of longer wavelength mercury cadmium telluride focal plane arrays, higher operating temperature mid-wavelength infrared focal plane arrays, and focal plane arrays with optimal background-limited performance for stressing space backgrounds.
(U)	$1,544	Develop satellite antenna technologies that maximize the use of high density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to create large, light space antennas. Satellite antenna technologies will be used to improve the affordability and capability of antenna modules for space-based payload subsystems for surveillance and navigation efforts. Fabricate selected embedded-structural transmit-receive electronics antenna modules. Design antenna modules that address requirements for minimizing mass and power by embedding lightweight electronics in the structure. Complete fabrication of modular phased-array antenna tiles. Integrate tiles into modules for performance characterization.
(U)	$17,228	Total

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT **2181**

(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
(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	**0603401F Advanced Spacecraft Technology**	**3784**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3784 Space Sensors Technology	4,302	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, effort transferred to Project 2181.

(U) A. Mission Description

This project funds the development of military space-based ground surveillance technologies. The project 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 meeting spaceborne sensor needs for national missile defense and intelligence, surveillance, and reconnaissance missions.

(U) FY 2000 ($ in Thousands)

(U) $2,220 Developed advanced space infrared sensors and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as 'cold body' targets such as decoys, satellites, and midcourse warheads. Continued development of radiation-hardened mercury cadmium telluride 128 x 128 focal plane array. Developed 1024 x 1024 wavelength mercury cadmium telluride focal plane array. Demonstrated feasibility of a polarization autocue for focal plane arrays. Characterized performance of higher-temperature multispectral infrared focal plane arrays.

(U) $1,199 Developed satellite antenna technologies that maximize the use of high-density interconnects, embed the electronics directly onto the antenna itself, and use antenna modules to create large, light space antennas. Satellite antenna technologies will be used to improve the affordability and capability of antenna modules for space-based payload subsystems for Air Force surveillance and navigation efforts. Designed selected embedded-structural transmit-receive electronics antenna modules. Addressed requirement for minimizing mass and power by embedding lightweight electronics in the antenna structure. Fabricated a modular phased-array antenna tile. Completed fabrication and launch receive-only sub-antenna array and began data analysis.

(U) $883 Developed 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. Launched the FTHSI payload on-board the MightySat II.1 satellite. Initiated analysis of the hyperspectral imaging data received from the FTHSI payload. Began assembly of data images for target identification and image evaluation for commercial and military purposes.

(U) $4,302 Total

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT **3784**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)
(U) $0 Efforts transferred to Project 2181.
(U) $0 Total

(U) FY 2002 ($ 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 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.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 3834

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3834 Integrated Space Technology Demonstrations	52,692	31,990	17,505	18,294	21,161	19,223	26,232	26,787	Continuing	TBD

(U) A. Mission Description

The Integrated Space Technology Demonstration (ISTD) program is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an operational environment. Note: In FY 2001, Congress added $20.6 million ($6.5 million for Scorpius Low-Cost Launcher, $5.0 million for Upper Stage Flight Experiment, $6.5 million for Space Maneuver Vehicle, and $2.6 million for Solar Orbit Transfer Vehicle).

(U) FY 2000 ($ in Thousands)

(U) $9,130 Developed 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 a user in a tactical environment. Hyperspectral imaging sensors provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Developed the Warfighter-1 hyperspectral sensor, mission data center, and mobile ground station. Performed sensor characterization and integration and test on the payload, spacecraft, and space vehicle. Prepared for FY 2001 launch.

(U) $505 Developed and demonstrated precision ballistic missile navigation technologies that 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. Conducted reentry plasma physics characterization studies and started development of miniaturized jam-resistant GPS receivers.

(U) $775 Developed hyperspectral imaging technologies for space-borne assets to provide improved capabilities for the warfighter in target detection, terrain classification, and related surveillance applications. Completed development of the Warfighter-1 hyperspectral imaging sensor payload on-board processing capability.

(U) $5,049 Developed 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. Delivered first microsatellite in the XSS microsatellite series and began system integration in preparation for testing autonomous microsatellite operations, including satellite inspection.

(U) $2,909 Developed scalable booster technologies for low-cost launch vehicles. These technologies will reduce launch vehicle life cycle cost by five to ten times. Initiated development of the Sprite orbital vehicle for launching small payloads at significantly reduced cost. Developed and tested

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

20,000-lb. thrust hardware chamber for the Sprite booster engine. Completed initial demonstration of the hydroxyl ammonium nitrate/triethanol amine nitrate (HAN/TEAN) mixing gas generator tank pressurization technology.

(U) $19,775 Developed and demonstrated 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 method for demonstrating critical Air Force technologies and concept of operations. Developed technologies for a second tail number, leveraging the technology investment in the NASA X-37, and addressed specific Air Force requirements including space operations and operability technologies.

(U) $14,549 Developed and demonstrated a low-cost, liquid propellant rocket engine for an 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. Built a fuel enrichment system that produces the highly concentrated hydrogen peroxide required for optimal engine performance. Built a sub-scale upper stage common bulkhead composite tank and flight structure to reduce risk in fabrication process; refined process and fabricated the full-scale components. Designed, fabricated, and tested a full-scale integrated upper stage ground test article.

(U) $52,692 Total

(U) FY 2001 ($ in Thousands)

(U) $6,423 Continue to develop Warfighter-1, the first in the series of Integrated Space Technology Demonstration systems. Launch 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) $0 Develop and demonstrate precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments. Conduct reentry plasma physics characterization and demonstration planning, and continue development and demonstration of miniaturized jam-resistant Global Positioning System receivers.

(U) $2,951 Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Begin design of second satellite in the XSS microsatellite series. Study bus requirements and potential designs. Develop guidance and navigation and maneuvering software and hardware technologies and proximity operations sensor package.

(U) $2,206 Develop technologies for the Communications/Navigation Outage Forecasting System (C/NOFS) demonstration. C/NOFS will demonstrate the capability for forecasting outages to Global Positioning System (GPS) navigation and satellite communications links, providing the warfighter with information on communications and navigation outages. This allows the preemptive use of backup systems and alternate links, which aids anomaly resolution, and facilitates mission/operations planning. Develop data processing unit. Verify payload interface and support spacecraft

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 3834

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

development and pre-planning of sensor suite integration and testing.

(U) $6,440 Develop scalable booster technologies for low-cost launch vehicles. Continue development of the Sprite orbital demonstration vehicle for launching small payloads at significantly reduced cost. Develop and test 20,000-lb. thrust flight-weight ablative Sprite booster engine. Develop and test all composite liquid oxygen propellant tank for the Sprite vehicle. Begin systems analysis for a Sprite 2,000-lb. thrust upper stage engine. Continue development and demonstration of hydroxyl ammonium nitrate/triethanol amine nitrate (HAN/TEAN) mixing gas generator tank pressurization technology.

(U) $4,954 Develop and demonstrate a low-cost, liquid propellant, expendable upper stage in a cooperative effort with NASA. Design, fabricate, and test a flight ready integrated expendable upper stage.

(U) $6,440 Develop and demonstrate technologies for a military-unique, reusable, satellite bus and upper stage for the Military Spaceplane system. Develop advanced reusable rocket engine technologies for the Space Maneuver Vehicle (SMV) X-40 second tail number flight test article. Continue to develop technologies for the SMV, such as retractable solar arrays for longer on-orbit duration and fine attitude control system to enable proximity operations and precision sensor pointing, and apply the technologies to the X-37 demonstrator to improve military utility and leverage the NASA investment.

(U) $2,576 Develop and demonstrate propulsion and power technologies for solar thermal orbit transfer vehicle (SOTV). These technologies will enable an affordable orbit transfer vehicle for inspection, reposition, and servicing of space assets above low earth orbit. Develop and build modular heat exchanger to enable scaling to operational size. Develop and build flight experiment scale test article of the inflatable concentrator and feedback control sensor and actuators. Develop control system algorithms and simulations and ground test algorithms with feedback control sensor.

(U) $31,990 Total

(U) FY 2002 ($ in Thousands)

(U) $3,619 Continue to develop Warfighter-1, the first in the series of Integrated Space Technology Demonstrations. Continue 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. Complete final report detailing the evaluation and lessons learned from the technology demonstration and commercial leveraging.

(U) $2,400 Develop autonomous micro-satellite (10-100kg) technologies for an integrated, robust, flexible, modular micro-satellite technology concept. Develop micro-satellite technologies for non-cooperative/uncooperative, autonomous operational concept and mission planning tools.

(U) $10,486 Design, develop, integrate and test an autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative/uncooperative, resident space object. Perform design reviews and begin component/hardware fabrication for an autonomous

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 3834

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

		operations micro-satellite.
(U)	$1,000	Develop micro-satellite system test scenarios and design micro-satellite hardware-in-the-loop, software simulations, and mission planning/training tools.
(U)	$17,505	Total

(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 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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603401F Advanced Spacecraft Technology	4400

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4400 Space Systems Protection	4,516	5,560	6,109	7,156	7,525	8,590	8,770	8,954	Continuing	TBD

Note: In FY 2002, all efforts in Program Element 0603410F were transferred into this Project.

(U) **A. Mission Description**

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in both natural and potentially hostile warfighting environments. The project performs assessments of critical components, subsystems, and evaluates susceptibility and vulnerability to radio frequency and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment. Note: In FY 2001, Congress added $4.5 million ($1.5 million for Miniature Satellite Threat Reporting System and $3.0 million for Satellite Survivability).

(U) FY 2000 ($ in Thousands)

(U) $50 Prepared and used multi-threat assessment tool to evaluate 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. Identified passive satellite countermeasures and developed appropriate mitigation techniques.

(U) $352 Developed satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize the receipt of intentional and unintentional ground-based radio frequency (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. Fabricated and tested space-qualified RF hardware and developed proof of concept laser sensor design and laboratory brassboard.

(U) $234 Coordinated integration and testing of Miniature Satellite Threat Reporting System (MSTRS) on host experiment platform for Space Shuttle risk reduction flight scheduled for FY 2001. The flight test will provide performance analysis of key MSTRS hardware components in a space environment and provide users early insight into MSTRS operational performance characteristics.

(U) $3,880 Continued evolution of MSTRS that warns against ground-based, broad-band 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. Developed receiver system miniaturization technologies for power and weight savings.

(U) $4,516 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 4400

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$50	Use multi-threat assessment tool to evaluate space-based electro-optical sensor responses to various candidate laser countermeasures. Begin development of passive satellite countermeasures and appropriate mitigation techniques.
(U)	$659	Continue to develop on-board satellite warning technologies and tools to detect, geolocate, and characterize the receipt of intentional and unintentional ground-based radio frequency (RF) signals. Begin design of integrated RF receiver/laser sensor hardware with weight and power savings compared to individual sensor packages.
(U)	$392	Develop RF threat warning receiver for a one-year space flight. Complete 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)	$1,486	Develop and demonstrate technologies for the Miniature Satellite Threat Reporting System (MSTRS). MSTRS technologies enable detection of ground-based RF threats to satellites from a variety of space platforms. Demonstrate threat reporting package on shuttle flight STS-107. Design, fabricate, and demonstrate miniaturized instantaneous frequency measurement unit, power divider circuits, and high frequency circuit interconnects.
(U)	$2,973	Develop spacecraft protection technologies applicable to commercial and military space satellites to assure operation of space assets. Develop the capability to assess hardware/software threat susceptibility and vulnerability and develop technologies to mitigate identified vulnerabilities. Develop and exercise modeling and simulation tools to extend the current understanding of susceptibility of different commercial satellite subsystems to multi-threat environments. Develop RF and laser threat and effects models to evaluate case studies of existing and developing space systems.
(U)	$5,560	Total

(U) FY 2002 ($ in Thousands)

(U)	$50	Use multi-threat assessment tool to evaluate space-based electro-optical responses to various candidate RF and laser countermeasures. Add interface for analyzing RF and laser interaction effects on satellites. Add response models for satellite subsystems, such as communications, power, and inertial measurement units.
(U)	$2,293	Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Conduct plasma shield experiments to determine effectiveness of filtering the radio frequencies to allow only selected frequencies to reach the satellite communications antennas. Initiate evaluations and ground-based demonstrations of visible and near infra-red laser protection techniques in preparation for space demonstrations.
(U)	$1,455	Develop sensors to specify and forecast conditions in the space environment that degrade the operation of space-based systems. Support

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT **4400**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

integration, launch, and on-orbit operations of instrumentation to improve space radiation hazard specification and forecasting. Specifying and forecasting hazardous space conditions will improve space system designs and lifetime, and enhance operational capabilities for the warfighter. Initiate integration of plasma sensor for the Communications/Navigation Outage Forecasting System onto payload. Launch all-sky camera to detect solar disturbances one to three days prior to Earth impact and complete initial on-orbit validation. Complete integration of relativistic detector for mission to map the dynamic radiation belts and quantify hazards to space systems.

(U) $1,006 Conduct collaborative experiments and develop tools to improve the survivability of advanced spacecraft power, communications, and surveillance systems. Develop preliminary design of second-generation miniaturized charge control system to autonomously protect satellites from harsh charging environments. Initiate conceptual design of an experiment to quantify the effects of space plasma on tethered power generation systems. Develop interface between dynamic space plasma and meteor specification and forecast models and web-based spacecraft charging design tool.

(U) $1,305 Develop technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards and to mitigate the effect of the space environment on DoD space systems. Space environment hazard warnings minimize loss of space assets due to component and system level failures and, when widely deployed, provide global situational awareness of hazards. Control of spacecraft charging levels and high-energy radiation effects will significantly improve space system reliability and availability and reduce operational costs. Complete validation of compact environment anomaly sensor for geosynchronous and highly elliptic orbits and transition to operational use. Develop detailed design for miniaturized space environment distributed anomaly resolution sensor for on-orbit detection of space particle, chemical, and impact hazards. Complete ground tests of particle enhancement and depletion technologies and begin conceptual design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.

(U) $6,109 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.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT **4400**

(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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603401F Advanced Spacecraft Technology

PROJECT
4844

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4844 Discoverer II	12,803	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, the Discoverer II program was terminated by Congress.

(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).

(U) FY 2000 ($ in Thousands)

(U) $8,144 Supported 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. Conducted risk mitigation and demonstration test planning.

(U) $4,659 Supported 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. Conducted mission utility analysis and concept of operations studies.

(U) $12,803 Total

(U) FY 2001 ($ in Thousands)

(U) $0 The D-II program was terminated by Congress.

(U) $0 Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 4844

(U) A. Mission Description Continued

(U) FY 2002 ($ 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 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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development					PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology					PROJECT 4938
COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4938 Space Developmental Planning	0	0	5,029	0	0	0	0	0	Continuing	TBD

(U) A. Mission Description

This project funds the developmental planning for military space technologies. The project focuses on the Pre-Milestone I systems engineering and integration, studies and analysis, concept development, and architecture efforts needed to transition technology into promising space concepts, capabilities, and systems. Of particular importance is the analysis work performed to link military technologies to mission needs through the strategy-to-task methodology of the Air Force modernization process (AFPD 10-14). Another key aspect of this project is the defining, refining, and demonstrating of select space concepts offering significant future military utility to the warfighter, especially those that integrate existing or planned capabilities from across the entire national space community. A key component of this program is the demonstration of future space capabilities for wargames, exercises, experiments, and demonstrations. This project also funds Modeling and Simulation tools and related infrastructure development that are necessary to conduct studies and provide analysis on future space concepts and capabilities.

(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) FY 2002 ($ in Thousands)
(U) $1,064 Conduct concept development on promising space concepts. Products include comprehensive, high-level, integrated and scientifically sound design solutions across the myriad of space disciplines. Functions include space concept design, cost engineering, and measure of performance/ effectiveness inputs to Air Force Space Command's Optimizer of Utility Toolkit model.
(U) $1,186 Conduct in-depth studies and analysis to assess and quantify the military worth of select space concepts. Provides decision-aiding analysis on space capabilities 15 to 25 years into the future.
(U) $1,027 Conduct continuing system-of-systems engineering and integration for promising space concepts. Defines and refines concepts offering significant military utility to the warfighter, focusing on the integration of air and space capabilities. Supports systems security protection measures for current and planned capabilities across the national space community.
(U) $963 Develop capability to demonstrate relationship, impacts, and effects of space assets on the military campaign in Air Force campaign and theater

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 4938

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

simulation models/tools to include processing and presentation hardware and software, model database upgrades, and networking and leased communications lines to support virtual and distributed simulation capability.

(U) $512 Develop and integrate architectural concepts addressing technology transition opportunities against space mission deficiencies and needs.

(U) $277 Decrease the time to transition innovative space technology to the warfighter by demonstrating promising future space capabilities in exercises, wargames, experiments, and demonstrations.

(U) $5,029 Total

(U) B. Project Change Summary

Not Applicable.

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

(U) Not Applicable.

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603401F Advanced Spacecraft Technology	682J

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
682J Spacecraft Vehicles	3,596	8,580	8,657	9,628	9,892	10,723	10,949	11,180	Continuing	TBD

(U) A. Mission Description

This project develops and demonstrates compact, low-cost, spacecraft and launch vehicle power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation activities focus on lightweight, low-cost, low-volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen and sodium sulfur spacecraft batteries and flywheel energy storage systems for extended (five to ten year) satellite missions. The project's power distribution efforts focus on producing lightweight, high-efficiency, standardized power busses for use on future Air Force space programs.

(U) FY 2000 ($ in Thousands)

(U) $1,455 Developed and evaluated 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. Began development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Continued development and evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.

(U) $1,186 Developed innovative 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. Began flywheel ground demonstration. Began development of technologies to increase flywheel safety.

(U) $955 Developed 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. Completed a five-year life cycle test of a 60K cryocooler. Integrated the Reverse Brayton cryocooler into the Hubble telescope. Continued development of 10K model cryocooler.

(U) $3,596 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 682J

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

(U) FY 2001 ($ in Thousands)

(U)	$2,081	Develop and evaluate the 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. Continue development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Continue evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.
(U)	$904	Develop innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system which employs non-electrochemical energy storage. Continue flywheel ground demonstration and development of flywheel safety technologies. Begin microflywheel development.
(U)	$1,178	Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications at temperatures ranging from 10K to 150K. Complete 10K model cryocooler.
(U)	$2,040	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 demonstrate multifunctional structures technologies. Composite and multi-functional structures will be lighter and more affordable, with improved functionality, reducing fabrication and launch costs and enabling applications such as large aperture sensing systems. Ground test and characterize operational grid stiffened structure. Continue development of inflatable structures. Begin ground test of multi-functional structures. Develop full-scale secondary payload adapter structure for an expendable launch vehicle.
(U)	$2,377	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 smart passive payload isolation systems. Ground demonstrate active acoustic attenuation system. Flight demonstrate simplified low shock separation device.
(U)	$8,580	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 682J

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $2,010 Develop and evaluate performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules. Ground demonstrate deployment and operation of large, free-flying, lightweight, flexible, radiation resistant, array of thin film solar cells. Integrate 35% efficient multi-junction solar cells and 12% efficient thin film solar cells into large modules. Begin integration into full arrays.

(U) $830 Develop space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. Ground demonstrate integrated attitude control and energy storage system. Evaluate feasibility of microflywheel technology based on conceptual design; fabricate and test microflywheel components.

(U) $1,369 Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications. Characterize performance of 10K model cryocooler. Develop and deliver high efficiency multi-stage cryocooler with radiation-hardened control electronics. Begin development of high capacity multi-stage 10K cryocooler system for advanced space surveillance and tracking sensor.

(U) $2,053 Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas. Develop spacecraft to demonstrate multi-functional structures technologies. Flight demonstrate grid stiffened shrouds and thermal protection structures. Complete development of inflatable support structures. Continue ground test of multi-functional structures. Initiate integration of power and thermal technologies into multi-functional structures. Ground test full-scale secondary payload adapter structure for an expendable launch vehicle.

(U) $2,395 Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems. Develop launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Ground demonstrate smart passive payload isolation systems. Design operational active acoustic attenuation system. Develop and ground demonstrate passive acoustic attenuation system. Integrate low shock separation devices and whole spacecraft vibration isolation systems. Develop autonomous satellite docking and deployment mechanisms. Develop modular vibration-isolating spacecraft transport container.

(U) $8,657 Total

(U) B. Project Change Summary

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT 682J

(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.

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

DATE
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603410F Space Systems Environmental Interactions Technology

PROJECT
2822

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2822	Space Environmmental Impact Tests	3,312	3,381	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2002, in order to align projects within the Air Force Research Laboratory organization, all efforts in this Program Element were transferred to PE 0603401F, Project 4400.

(U) A. Mission Description

This program develops and demonstrates technologies to improve the survivability and reliability of current and future DoD space systems. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.

(U) FY 2000 ($ in Thousands)

(U) $1,001 Developed 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. Conducted space flight test to demonstrate capability of advanced space plasma sensor to detect environment irregularities that impact Command, Control, Communications, and Intelligence (C3I). Completed fabrication of space-based, all-sky camera for detecting solar disturbances; began integration for space flight test. Completed fabrication of relativistic electron and proton detector with capabilities to determine spectral resolution of the most damaging high-energy particle populations.

(U) $1,105 Supported 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. Completed dynamic Air Force geosynchronous space codes for space environment specification and effects determination. Completed spacecraft charging analysis tool for geosynchronous environments affecting many DoD communications and surveillance spacecraft. Developed web-based spacecraft charging design tool.

(U) $818 Developed technology to warn of spacecraft charging and other deleterious conditions for DoD and commercial spacecraft and investigated technologies for alteration of space particle environment. The ability to specify and warn of spacecraft charging and related hazards, which can

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603410F Space Systems Environmental Interactions Technology	2822

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

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. Demonstrated capability of compact environment anomaly sensors to specify hazardous conditions local to the spacecraft on a low Earth orbit space test flight and validated performance against existing radiation belt methods.

(U) $388 Developed miniaturized chemical contamination and kinetic impact sensors for DoD operational spacecraft. Developed 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. Developed space environment specification and analysis tools that are user-friendly, low-cost, and run on commonly available operational platforms. Designed space environment distributed anomaly sensor for space particle, chemical contamination, and kinetic impact hazards. Transitioned the leading Air Force space environment specification and analysis software to common Air Force operating system.

(U) $3,312 Total

(U) FY 2001 ($ in Thousands)

(U) $1,383 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) $1,061 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) $937 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. Continue compact environment anomaly sensor validation. Demonstrate new compact

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

DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603410F Space Systems Environmental Interactions Technology

PROJECT
2822

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

environment anomaly sensor capabilities for geosynchronous orbit environments on Air Force operational satellites. Begin ground tests of global particle enhancement and depletion technologies.

(U) $3,381 Total

(U) FY 2002 ($ 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.

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	4,027	3,412	3,746	
(U)	Appropriated Value	4,077	3,412		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-1			
	b. Small Business Innovative Research	-96			
	c. Omnibus or Other Above Threshold Reprogram	-105			
	d. Below Threshold Reprogram	-520			
	e. Rescissions	-43	-31		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-3,746	
(U)	Current Budget Submit/FY 2002 PBR	3,312	3,381	0	TBD

(U) Significant Program Changes:

In FY 2002, in order to align projects within the Air Force Research Laboratory organization, all efforts in this Program Element were transferred to PE 0603401F, Project 4400.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603410F Space Systems Environmental Interactions Technology**	PROJECT **2822**

(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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603444F MAUI SPACE SURVEILLANCE SYSTEM	4868

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4868	Maui Space Surveillance System	0	19,445	6,484	6,488	6,491	6,492	6,592	6,695	Continuing	TBD
	Quantity of RDT&E Articles	0	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. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) **A. Mission Description**

This program funds the operation and upgrading of the Maui Space Surveillance System (MSSS) in Hawaii. Note: In FY 2001, Congress added $15 million for the MSSS.

(U) FY 2000 ($ in Thousands)

(U) $0 Accomplished in PE 0305910F, Spacetrack.

(U) $0 Total

(U) FY 2001 ($ in Thousands)

(U) $2,050 Enhance operational and research utility of MSSS data products. Develop, analyze, and test non-imaging Space Object Identification (SOI) tools for the Advanced Electro-Optical System (AEOS) sensors. Conduct studies in the feasibility of daylight imaging on AEOS, in the use of the laser guidestar, and in applications for active tracking. Continue atmospheric characterization and advanced imaging algorithm development to support real-time post processing.

(U) $11,085 Provide technical support to operational users and visiting experimenters using the MSSS assets.

(U) $3,997 Conduct upgrades for MSSS. Complete Observatory Control System upgrades on the 0.8 meter beam director telescope and the 1.2 meter telescope. Complete adaptive optics upgrades, sensor enhancements, and tool development. Demonstrate AEOS/MSSS enhancements through characterization and test. These upgrades will significantly increase the ease-of-use and data turn-around for these telescopes.

(U) $2,313 Support the Near Earth Asteroid Tracking mission and follow-up role on AEOS and lost satellite search; continue non-imaging SOI efforts, and evaluation of MSSS systems to detect smaller/fainter objects.

(U) $19,445 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603444F MAUI SPACE SURVEILLANCE SYSTEM**	PROJECT **4868**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U)	$1,068	Enhance operational and research utility of Maui Space Surveillance System (MSSS) data products. Enhance Space Object Identification tools for Advanced Electro-Optical System (AEOS) sensors. Investigate advanced imaging concepts for AEOS/MSSS sensors to provide quicker and higher resolution images for operational customers.
(U)	$4,248	Provide technical support to operational users and visiting experimenters using the MSSS assets.
(U)	$1,168	Conduct upgrades for MSSS. Demonstrate AEOS/MSSS enhancements. Complete the AEOS wavefront sensor upgrade for imaging large targets and the infrared acquisition telescope to increase the probability of acquiring near-space object imagery.
(U)	$6,484	Total

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	0	4,625	4,627	
(U)	Appropriated Value	0	19,625		
(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		-180		
(U)	Adjustments to Budget Years Since FY 2001 PBR			1,857	
(U)	Current Budget Submit/FY 2002 PBR	0	19,445	6,484	TBD

(U) Significant Program Changes:

Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603444F MAUI SPACE SURVEILLANCE SYSTEM**	PROJECT **4868**

(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.

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

DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603601F Conventional Weapons Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	19,552	22,523	37,617	23,827	24,428	23,723	24,222	24,734	Continuing	TBD
670A	Ordnance Technology	7,009	22,523	12,968	14,295	14,655	14,233	14,530	14,836	Continuing	TBD
670B	Guidance Technology	12,543	0	24,649	9,532	9,773	9,490	9,692	9,898	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, Project 670A and Project 670B were combined into a single project. In FY 2002, Project 670B was separated from Project 670A for clarity in describing the different technology development and demonstration programs. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

The Conventional Weapons Technology program develops, demonstrates, and integrates ordnance and advanced guidance technologies for air-launched conventional weapons. The program includes two projects: (1) develops conventional ordnance technologies including warheads, fuzes, and explosives; and (2) develops advanced guidance technologies including seekers, navigation and control, and guidance.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	20,753	22,731	21,494	
(U)	Appropriated Value	21,033	22,731		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-28			
	b. Small Business Innovative Research	-495			
	c. Omnibus or Other Above Threshold Reprogram	-637			
	d. Below Threshold Reprogram	-101			

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology

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

		FY 2000	FY 2001	FY 2002	Total Cost
	e. Rescissions	-220	-208		
(U)	Adjustments to Budget Years Since FY 2001 PBR			16,123	
(U)	Current Budget Submit/FY 2002 PBR	19,552	22,523	37,617	TBD

(U) Significant Program Changes:

Fiscal Year 2002 increases are due to the recent DoD strategy review which increased funding for 63670B by $16M. The increase in funding will be used to enhance the Low Cost Autonomous Attack System (LOCAAS) Advance Technology Demonstration flight test program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology — PROJECT 670A

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
670A Ordnance Technology	7,009	22,523	12,968	14,295	14,655	14,233	14,530	14,836	Continuing	TBD

Note: In FY 2001, Project 670A and Project 670B were combined into a single project. In FY 2002, Project 670B was separated from Project 670A for clarity in describing the different technology development and demonstration programs.

(U) A. Mission Description

The Ordnance Technology project develops, demonstrates, and integrates ordnance technologies for enhancing the effectiveness of air-launched conventional weapons. The project develops conventional ordnance including warheads, fuzes, explosives, carriage and release, and munition integration technologies. This project improves capability for conventional ordnance supporting an Air Expeditionary Force.

(U) FY 2000 ($ in Thousands)

(U) $2,360 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, and advanced warhead shapes. These warhead technologies improved penetration and warhead metals designed for high impact loading and directional mass focusing. Also, these warhead technologies provided improved target penetration capabilities, enhanced kill probability against fragmentation sensitive targets, and reduced aircraft sorties that will improve pilot survivability and reduce aircraft attrition. Designed a warhead that is capable of defeating soft targets associated with chemical and biological production and storage facilities. Explored concepts for neutralizing chemical and biological agents with minimum collateral damage. Completed design of a tri-mode warhead and weapon electronics for lethal suppression of enemy air defenses, armor, and interdiction missions.

(U) $2,715 Developed and demonstrated 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. These advanced fuze technologies will improve munitions effectiveness, and allow smaller warheads and munition airframes, thereby increasing strike aircraft load-outs and improving sortie effectiveness. Fabricated brassboard multiple-event, hard-target fuze and evaluated its performance by laboratory testing under high-G shock conditions expected for future penetrating weapons. Evaluated capability of tactical laser radar seeker to provide accurate fuzing information for tri-mode warhead.

(U) $1,934 Developed innovative, air-delivered munition carriage and release equipment, miniature weapon release concepts, and airframe size reduction concepts such as folding fins. These innovative concepts 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. Conducted concept evaluations to establish a

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603601F Conventional Weapons Technology**	PROJECT **670A**

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

low-risk, operational concept for Unmanned Combat Air Vehicle (UCAV) weapons employment. Completed affordable small munition dispenser design, fabricated wind tunnel model of small munition dispenser, and evaluated performance with wind tunnel tests. Fabricated brassboard small munition dispenser test hardware for ground and flight test.

(U) $7,009 Total

(U) FY 2001 ($ in Thousands)

(U) $4,040 Develop and demonstrate advanced conventional armament warhead technologies. These warhead technologies 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 and biological defeat warhead to characterize effectiveness against production and storage capabilities. Continue developing and evaluating concepts for neutralizing a broad spectrum of chemical and biological agents. Fabricate the tri-mode warhead and associated weapon electronics, designed in FY 2000, for lethal suppression of enemy air defenses and weapons interdiction missions.

(U) $4,980 Develop and demonstrate advanced air-delivered munition fuze technologies. These fuze technologies will improve munitions effectiveness, and allow smaller warheads and munition airframes, thereby increasing strike aircraft load-outs 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 and release equipment, miniature weapon release concepts, and airframe size reduction concepts. The innovative concepts 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 and improving sortie effectiveness for current and future strike aircraft while reducing munition airlift requirements. Continue UCAV, miniature munition integration, and planning support for the flight test demonstration. Complete ground and flight test of brassboard small munition dispenser.

(U) $2,995 Develop and demonstrate advanced conventional armament seeker technologies. These advanced seeker technologies will be applied to the development of miniature munitions. The advanced seeker will have the capability to autonomously detect, acquire, and guide to targets of interest in adverse weather and battlefield conditions, thus increasing the probability of kill and minimizing collateral damage while providing increased weapons load-out and improving 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 laser radar terminal seeker for miniature munitions compatible with UCAV.

(U) $3,035 Develop and demonstrate advanced conventional armament navigation and control technologies to provide increased armament navigation

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology	PROJECT 670A

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

accuracy, improved standoff range, 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 an integrated laser radar (LADAR) terminal seeker and Global Positioning System/Inertial Navigation System (GPS/INS) navigation and control system.

(U) $4,984 Integrate advanced conventional guidance technologies to provide improved adverse weather performance, faster processing of target information, higher probability of target detection, and an operationally acceptable target false alarm rate. These advanced technologies will 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 GPS/INS guidance to validate design and determine target false alarm rate.

(U) $22,523 Total

(U) FY 2002 ($ in Thousands)

(U) $4,296 Develop and demonstrate advanced conventional armament warhead technologies, including heavy metal liners, dense metal cases, and less sensitive explosives. The goals of these efforts are to destroy hardened targets by more effectively penetrating protective surfaces and enhance kill mechanisms against softer surface targets. Fabricate and test an innovative warhead capable of defeating a broad range of soft targets associated with development, production, and storage of chemical and biological weapons. Design a weapon capable of high-speed penetration of extremely hard targets by combining new warhead case technology, insensitive explosive, and multiple-event fuze.

(U) $4,980 Develop and demonstrate advanced air-delivered munition fuze technologies and mass focusing warhead technology to improve munition effectiveness, allowing smaller warheads and munition airframes, thereby improving sortie effectiveness by increasing strike aircraft load-outs. Sled test the multiple-event, hard target fuze in an ordnance package. Continue cooperative program with the United Kingdom to design an integrated fuze, an improved target detection device, and a directional warhead package. Design a fuze using Microwave Monolithic Integrated Circuit technologies that will give burst accuracy of 0.5 meter for weapons that have closure rates up to 2,500 meters/sec.

(U) $3,692 Develop and demonstrate conventional munition subsystem and platform integration technologies. These technologies include innovative air-delivered munition carriage and release equipment, miniature weapon release concepts, and reduced airframe size providing the capability to safely carry, launch, and communicate among the aerospace vehicle and multiple miniature weapons. These will increase weapon load-outs and improve sortie effectiveness for current and future strike aircraft while reducing munition airlift requirements. Integrate subsystems by combining ordnance and guidance subsystem technology into an effective payload size. Continue to integrate Unmanned Combat Air Vehicle

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603601F Conventional Weapons Technology	PROJECT 670A

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

with miniature munition concepts and support integration and planning of a Unmanned Combat Air Vehicle flight test demonstration. Design a low-cost, precision-guided weapon with a Circular Error Probable of 1.4 meter.

(U) $12,968 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.

(U) E. Schedule Profile

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development				PE NUMBER AND TITLE 0603601F Conventional Weapons Technology							PROJECT 670B
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
670B	Guidance Technology	12,543	0	24,649	9,532	9,773	9,490	9,692	9,898	Continuing	TBD

Note: In FY 2001, Project 670A and Project 670B were combined into a single project. In FY 2002, Project 670B was separated from Project 670A for clarity in describing the different technology development and demonstration programs.

(U) **A. Mission Description**

The Guidance Technology project develops, demonstrates, and integrates affordable, autonomous, and adverse weather advanced guidance technologies for conventional armament delivered from manned and unmanned aerospace vehicles. This project includes development of conventional guidance including: terminal seekers; midcourse navigation sensors for standoff delivery weapons; and, target detection and identification processing algorithms for reducing target location error to improve target kill probability.

(U) FY 2000 ($ in Thousands)

(U) $3,899 Developed and demonstrated advanced conventional armament seeker technologies. The advanced seeker technologies 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, the miniature munitions provide the Air Force and Navy increased weapons load-out, improved sortie effectiveness, increased pilot survivability, and reduced aircraft attrition. Fabricated laser radar (LADAR) brassboard seekers to conduct ground and captive flight tests against fixed and mobile targets. Designed a tactical-sized seeker with increased range and resolution capability against a variety of ground targets in adverse terrain and weather conditions.

(U) $2,711 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 provided increased armament navigation accuracy, improved standoff range, and enhanced weapon control and operation in electronic jamming environments. Also, these technologies provided accurate and adverse weather standoff capability that will reduce aircraft attrition, increase pilot survivability, improve weapon accuracy, and increase probability of kill. Completed lattice wing design to extend range of small direct attack bomb. Fabricated lattice wing range extension kits and conducted flight tests to determine effectiveness.

(U) $5,933 Developed integrated advanced conventional guidance technologies, including seekers, navigation and control, and signal/image processing/algorithm technologies. Also, developed LADAR algorithms, super resolution techniques for millimeter wave seekers and synthetic aperture radars, optical processing techniques, and demonstrated advanced conventional armament guidance capabilities. These technologies provided improved adverse weather performance, faster processing of target information, higher probability of target detection, an operationally acceptable target false alarm rate, and more robust mission planning capabilities. Also, the technologies enhanced the effectiveness of miniature

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(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

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. Fabricated autonomous guidance search and attack test hardware to demonstrate a capability against ground mobile targets. Investigated optical correlator technology for improving terminal accuracy in standoff weapons.

(U) $12,543 Total

(U) FY 2001 ($ in Thousands)

(U) $0 This work was performed in Project 670A.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $2,551 Develop and demonstrate advanced conventional armament seeker technologies for miniature munitions' applications. These seeker technologies will autonomously detect, acquire, and guide to targets of interest in adverse weather and battlefield conditions. Also, the seeker technologies will increase the probability of kill and minimize collateral damage while providing increased weapons load-out and improved sortie effectiveness. Demonstrate laser radar (LADAR) terminal seeker for a miniature munition that will be effective against high-value fixed and mobile targets.

(U) $2,500 Develop and demonstrate advanced conventional armament navigation and control technologies to provide increased armament navigation accuracy, improved standoff range, enhanced weapon control, and operation in electronic jamming environments. Develop interface design between target detection device, fuze, directional warhead, and weapon terminal guidance seeker. Complete design and fabrication of an integrated LADAR terminal seeker and Global Positioning System/Inertial Navigation System (GPS/INS) navigation and control system.

(U) $3,598 Integrate advanced conventional guidance technologies including seekers, processors, controls, and algorithms. 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. 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 GPS/INS guidance to demonstrate design and determine target false alarm rate.

(U) $16,000 Enhance the current Low Cost Autonomous Attack System (LOCAAS) Advanced Technology Demonstration (ATD) program by adding more flight and ground testing. Additional LOCAAS ATD tasks include flight testing of a LOCAAS with a live warhead to demonstrate that the integrated technologies perform as expected; preparing the LOCAAS flight test vehicle for carriage and release from a tactical fighter aircraft;

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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

continuing automatic target recognition algorithm development; designing the Low Cost Autonomous Attack System datalink to improve cooperative attack and communicate bomb damage assessment to the command and control network; and performing an evaluation of using electronic safe and arm fuzing.

(U) $24,649 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.

(U) E. Schedule Profile

(U) Not Applicable.

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DATE
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603605F Advanced Weapons Technology

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	52,336	42,973	43,758	37,744	41,961	45,744	46,705	47,692	Continuing	TBD
3150	Advanced Optics Technology	18,248	15,244	764	782	4,285	5,159	5,267	5,378	Continuing	TBD
3151	High Power Solid State Laser Technology	6,835	3,817	5,993	8,545	9,800	10,182	10,396	10,616	Continuing	TBD
3152	High Power Microwave Technology	6,385	8,578	12,343	9,998	8,752	8,935	9,122	9,315	Continuing	TBD
3647	High Energy Laser Technology	20,868	15,334	24,658	18,419	19,124	21,468	21,920	22,383	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) A. Mission Description

This PE provides for the development and demonstration of advanced directed energy and optical concepts. In advanced optics, very long range imaging and space optics technologies are demonstrated. In solid state lasers, compact, reliable, relatively high power, cost-effective single devices and arrays of devices are demonstrated. In high power microwave, technologies such as narrow and wideband devices and antennas are demonstrated. In high energy lasers, technologies such as high power chemical lasers and beam control technologies are demonstrated. Note: Congress added $7 million for Field Laser Radar upgrades, $8 million for High Resolution Space Object Imaging (also known as GLINT), and $3 million for LaserSpark Missile Countermeasures 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.

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DATE
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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
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(U) C. Program Change Summary ($ in Thousands)

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	56,805	33,371	33,904	
(U)	Appropriated Value	57,495	43,371		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-1,355			
	c. Omnibus or Other Above Threshold Reprogram	-1,390			
	d. Below Threshold Reprogram	-1,811			
	e. Rescissions	-603	-398		
(U)	Adjustments to Budget Years Since FY 2001 PBR			9,854	
(U)	Current Budget Submit/FY 2002 PBR	52,336	42,973	43,758	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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603605F Advanced Weapons Technology	3150

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3150 Advanced Optics Technology	18,248	15,244	764	782	4,285	5,159	5,267	5,378	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 2000 ($ in Thousands)

(U) $360 Continued to develop NLO technologies for non-mechanical beam correction in laser beam projection and optical imaging. Investigated the use of a single NLO device to optically correct the aberrations of a one-meter diameter class bifocal relay mirror breadboard system. Tested the laboratory relay mirror breadboard system at operationally significant laser wavelengths for non-mechanical beam steering.

(U) $205 Continued to investigate advanced optical concepts necessary to deploy and use very large (10-meter diameter and larger) space-based optical mirrors for imaging, laser beam projection, and laser beam relay missions. Investigated and developed the materials and techniques for instilling mirror shape and curvature memory into thin membrane mirrors for space orbit deployment. Space mirrors must have and keep a predetermined shape and curvature. Pressure canopies causing optical distortions of space optical systems can, therefore, be eliminated.

(U) $296 Continued to investigate novel signature techniques for assessing the operational status of satellites out to geosynchronous earth orbit (GEO) to support space situational awareness. Continued the evaluation of techniques for identifying classes of satellites at GEO range. Transitioned successful identification techniques to the Air Force Space Command for operational use. Investigated new techniques for individual satellite identification and for health status assessments.

(U) $11,591 Continued to develop technologies for active imaging of geosynchronous space objects. Completed design, verified through simulation design parameters, and bought initial hardware for receiver for the Geo Light Imaging National Testbed at White Sands Missile Range, NM.

(U) $5,796 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. Continued to install a laser radar system on the Advanced Electro Optical System telescope on Maui, HI. Performed experiments for space applications such as high accuracy orbital measurements, imaging for target identification, and satellite status assessment.

(U) $18,248 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT **3150**

(U) A. Mission Description Continued

(U)	FY 2001 ($ in Thousands)	
(U)	$197	Develop nonlinear optics technologies for non-mechanical beam correction in 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)	$184	Investigate advanced concepts to deploy and use very large (greater than 10-meter diameter) space-based mirrors for applications such as imaging, laser beam projection, and laser beam relay. Continue to pursue component development of nonlinear optics materials and devices that can be scaled to much larger sizes with the required speed, resolution, and power handling capability for space relay mirror applications.
(U)	$7,927	Continue to develop technologies for active imaging of geosynchronous space objects. Continue development and integration of initial hardware for the Geo Light Imaging National Testbed at White Sands Missile Range, NM.
(U)	$6,936	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. Investigate laser imaging of ground targets from unmanned air vehicles or satellites for standoff intelligence detection.
(U)	$15,244	Total
(U)	FY 2002 ($ in Thousands)	
(U)	$552	Develop nonlinear optics technologies for non-mechanical beam correction in laser beam projection and optical imaging. Design and develop brassboard laser beam control system utilizing nonlinear optics technology for space relay mirror applications. This will use advanced optical concepts appropriate for a bifocal relay mirror concept.
(U)	$212	Investigate advanced concepts to deploy and use very large space-based optical mirrors that support missions such as imaging and laser beam projection and laser beam relay. Integrate advanced optical technology for laser beam steering and aberration correction into a one meter (or larger) diameter class lightweight, deployable mirror and field test the resulting optical system.
(U)	$764	Total

(U) B. Project Change Summary

Not Applicable.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603605F Advanced Weapons Technology**	PROJECT **3150**

(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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development		PE NUMBER AND TITLE 0603605F Advanced Weapons Technology									PROJECT 3151
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3151	High Power Solid State Laser Technology	6,835	3,817	5,993	8,545	9,800	10,182	10,396	10,616	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. 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 self-protection. This project leads the development of, and builds upon, a wide range of commercial advancements. Commercially available solid state lasers are widely used due to their low-cost, small size and weight, high reliability, and high efficiency in converting electricity to laser energy. This project preserves these attractive features while continually scaling output to higher powers and efficiencies and to military application-specific wavelengths. This project is divided into two technology areas. The first area investigates methods to develop low-cost, scalable, high power solid state lasers. This effort builds upon a strong industrial technology base. Secondly, wavelength specific solid state lasers for military applications such as infrared countermeasures are developed.

(U) FY 2000 ($ in Thousands)

(U) $3,695 Continued to 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. Demonstrated high electrical efficiency (approximately 20%), compact packaging, and high power density (10 milliwatts per cubic centimeter) to enable applications requiring laser mobility. Demonstrated a 100 watt, packaged fiber laser.

(U) $2,780 Continued to 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. Demonstrated and delivered to an Army-Air Force program, a one cubic foot system with reliable and scalable, two watt average power solid state lasers in bands II and IV, for current generation threats to aircraft platforms.

(U) $360 Continued to develop and demonstrate novel target coupling technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrated ultra-fast laser beam control and target coupling effects for countering focal plane array seekers.

(U) $6,835 Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3151

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U)	$1,982	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 a fiber laser module at several hundreds of watts of power.
(U)	$1,142	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. Continue development of a reliable four micron wavelength solid state laser, with a goal of achieving five watts average power, for countering current generation threats to aircraft platforms.
(U)	$693	Develop and demonstrate novel target coupling technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrate novel device structures and incoherent beam combining techniques for improving beam quality, required for fast jet aircraft and large aircraft self-protection.
(U)	$3,817	Total

(U) FY 2002 ($ in Thousands)

(U)	$2,112	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 30%) and compact packaging, exhibiting high power density (approaching one kilowatt per cubic foot) to enable applications requiring laser mobility. Demonstrate one kilowatt, packaged brassboard fiber laser module showcasing the building block technology of future directed energy, megawatt-class electric lasers. Demonstrate wavelength-versatile integrated laser/nonlinear optics at five watt power levels.
(U)	$2,835	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 multi-wavelength source (two and four microns) with sufficient brightness for countering current generation threats to aircraft platforms. Demonstrate sources in the 8-12 micron range for missile threat detection and remote sensing applications.
(U)	$1,046	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 multi-wavelength laser source with high beam quality based on novel device structures and incoherent beam combining techniques developed in FY 2001.
(U)	$5,993	Total

(U) B. Project Change Summary

Not Applicable.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3151

(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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology		PROJECT 3152

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3152	High Power Microwave Technology	6,385	8,578	12,343	9,998	8,752	8,935	9,122	9,315	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. This project will demonstrate the applicability of HPM technologies 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 2000 ($ in Thousands)

(U) $3,327 Continued to develop and demonstrate HPM technologies to degrade and/or destroy the electronic elements of an adversary's Integrated Air Defense System. Investigated and began development of models to quantify the effectiveness of a narrowband repetitively pulsed system against electronic targets of interest applicable to munitions or airborne platforms, and continued integration of pulse power and radio frequency source components for an integrated critical experiment with single shot technologies. Initiated a full power laboratory breadboard experiment to validate repetitively pulsed high power microwave weapon concepts.

(U) $2,358 Continued to develop and demonstrate wideband HPM technologies to disrupt and degrade an adversary's command and control and infrastructure. Conducted initial wideband field experiments with brassboard devices to demonstrate command and control warfare effectiveness. Conducted effects experiments to better define optimal source parameters for command control warfare applications. Evaluated technical capabilities of current HPM source concepts through field experiments. Conducted laboratory experiments to demonstrate brassboard compact devices critical to development of air-delivered submunitions. Developed an initial air-delivered HPM submunition payload design. Demonstrated technologies for potential transition. Applied computer codes to predict coupling to targets and validate their accuracy. Conducted validation of computer models developed under applied research funds.

(U) $700 Continued to develop and evaluate active denial technologies for non-lethal weapons applications. Began the development of beam transportation in a high specific power, non-lethal directed energy source technology for man-portable applications. Demonstrated subsystem-level vehicle-mounted non-lethal directed energy weapons technology.

(U) $6,385 Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3152

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands)

(U) $3,653 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 application development.

(U) $3,205 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) $1,220 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) $8,578 Total

(U) FY 2002 ($ in Thousands)

(U) $3,720 Develop and demonstrate narrowband HPM technologies to damage or destroy an adversary's electronic systems. Demonstrate pulsed power and narrowband HPM source capability applicable to munitions and airborne concepts. Continue to investigate and develop models to quantify the effectiveness of a narrowband repetitively pulsed system against electronic targets of interest applicable to munitions or airborne platforms. Select repetitively pulsed HPM technology for multi-gigawatt application development. Evaluate narrowband technologies to address aircraft protection against surface to air missiles.

(U) $3,500 Develop and demonstrate wideband HPM technologies to disrupt, degrade, damage, or destroy an adversary's command and control and infrastructure. Develop integrated compact source design(s) based on effects data and technology advances for improved effectiveness in HPM munitions and airborne electronic attack missions. Continue effects experimentation on an expanded set of targets to refine optimal source parameters, expand target set, and support susceptibility predictions. Begin building probability of effect database using experimental data from several programs. Transition selected technologies. Continue to refine modeling and simulation codes to more accurately predict wideband HPM coupling in realistic scenarios. Complete probability of effect models for engagement models.

(U) $2,123 Develop and evaluate active denial technologies for non-lethal weapons applications including man-portable applications. Continue analysis of

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603605F Advanced Weapons Technology	PROJECT 3152

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

		critical technologies for airborne active denial. Begin fabrication of critical subsystems (antenna, prime power, power conditioning, and other) for integrated man-portable system for Active Denial Applications.
(U)	$3,000	Develop the means to integrate high power microwave (HPM) devices onto unmanned aerial platforms, such as an unmanned combat air vehicle (UCAV). Perform integration, thermal control, and target studies for such concepts. Investigate the feasibility of using ultra-wideband HPM to geolocate and identify targets of interest, and perform battle damage assessment. Perform lethality assessments of HPM on targets of interest to gauge the military utility and effectiveness of the integrated HPM and UCAV concept.
(U)	$12,343	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

(U) Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)											DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development						PE NUMBER AND TITLE 0603605F Advanced Weapons Technology					PROJECT 3647
COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
3647	High Energy Laser Technology	20,868	15,334	24,658	18,419	19,124	21,468	21,920	22,383	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 developed and demonstrated include advanced high energy laser devices and laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most high energy laser applications. The beam control technology developed in this project has a significant benefit to the astronomy community. Detailed computational models to establish high energy laser weapon effectiveness and satellite and missile vulnerability are developed.

(U) FY 2000 ($ in Thousands)

(U) $473 Continued to develop and demonstrate the technology for scalable, high efficiency, high energy laser devices for potential weapon applications. Completed assessment of an efficient, wavelength-shifted chemical oxygen-iodine laser (COIL) device, for application as a moderate- to high-power illuminator laser. Using computer models, evaluated candidate advanced COIL concepts to identify promising approaches for significant improvements.

(U) $894 Continued to 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-defined the counterspace system-level lethality criterion for high energy lasers, based on the evaluation of data from individual satellite vulnerability assessments. Transitioned to the Space Warfare Center an improved tool for the analysis of high resolution optical images for space surveillance. Completed studies to evaluate capabilities for data fusion between optical imagery and radar data from space surveillance.

(U) $190 Continued to investigate and develop advanced, high energy laser optical components for future weapon systems. Continued 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) $8,363 Continued to perform atmospheric compensation/beam control experiments from large aperture ground-based platforms to support applications ranging from weaponization to space object identification. Characterized and optimized 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. Conducted satellite illumination experiments on a range of unaugmented space objects to evaluate and anchor detailed computer models. Demonstrated active (daylight) tracking of selected space objects at low bandwidth. Began investigation of advanced adaptive optics concepts

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued

with the potential to improve compensation performance at lower elevation angles. Continued the development of a 50-watt sodium-wavelength laser, for use as the high-altitude beacon for high-performance, full-aperture compensation of the Starfire Optical Range (SOR) 3.5 meter telescope.

(U) $8,523 Continued to 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. Continued evaluation of advanced concepts for active tracking and atmospheric compensation under propagation conditions representative of typical airborne laser engagement scenarios. Then conducted laboratory experiments under precisely controlled conditions to evaluate and optimize performance under realistic turbulence conditions. Conducted 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.

(U) $2,425 Continued to investigate the LaserSpark missile countermeasure technology. Examined the infrared countermeasures effectiveness of the multiple internal laser effects (MILE) associated with plasma/sparks. Performed laboratory testing of MILE on advanced focal plane array seeker mockups using properly formatted laboratory lasers. Completed effectiveness studies on seekers in operational scenarios. Performed initial design planning and coordination for a limited field demonstration of aimpoint control and countermeasure effectiveness on in-flight seekers.

(U) $20,868 Total

(U) FY 2001 ($ in Thousands)

(U) $664 Perform vulnerability assessments on potential high energy laser targets to provide critical design data for laser systems to defeat these targets. Review/develop the system-level deny/disrupt/damage/destroy criteria for counterspace high energy laser systems, based on new data from satellite vulnerability assessments. Transition an improved tool for the analysis of high-resolution optical images to the National Air Intelligence Center.

(U) $6,049 Perform atmospheric compensation/beam control experiments from ground-based platforms to support applications including antisatellite weapons, satellite tests and diagnostics, and high-resolution satellite imaging. Complete characterization of return signals from laser illuminated satellites to design system for active (laser-illuminated) tracking of unaugmented low earth orbit satellites. Analyze data from previous satellite imaging and tracking experiments for design of 24-hour laser beam control system. Begin design of target-loop atmospheric compensation for laser projection to satellites on weapons-class beam director (3.5-meter telescope). Model and analyze long-path atmospheric effects for design of multiconjugate adaptive optics for low-elevation compensation of lasers and imaging.

(U) $5,649 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 computer simulation of additional advanced concepts for active tracking and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
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(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

atmospheric compensation using adaptive optics under propagation conditions representative of typical airborne laser engagement scenarios. Conduct advanced active tracking and adaptive optics experiments using representative turbulence phase screens. Perform passive tracking demonstrations, anisoplanatism studies, and common-path/common-mode studies. Develop and integrate hardware for future static and dynamic active tracking and atmospheric compensation demonstrations using advanced concepts under propagation conditions scaled to represent those expected in airborne laser engagement scenarios.

(U) $2,972 Continue to investigate the LaserSpark missile countermeasure technology. Develop and demonstrate the infrared countermeasures effectiveness of the multiple internal laser effects (MILE) associated with plasma/sparks. Continue laboratory testing of MILE on advanced focal plane array seeker mockups using properly formatted laboratory lasers. Develop flyout simulations of MILE on conical scan and focal plane array seekers. Continue design planning and coordination for a limited field demonstration of aimpoint control and countermeasure effectiveness on in-flight seekers.

(U) $15,334 Total

(U) FY 2002 ($ in Thousands)

(U) $509 Perform vulnerability assessments on potential high energy laser targets to provide critical design data for laser systems to defeat these targets. Provide data from sure-safe analysis to Air Force Space Command, for setting standards for laser illumination of space objects. Improve the data fusion of optical and radar measurements of space objects.

(U) $9,664 Perform atmospheric compensation/beam control experiments from the Starfire Optical Range 3.5-meter telescope for applications including antisatellite weapons, satellite tests and diagnostics, and high-resolution satellite imaging. Complete sodium-wavelength laser to be used as mesospheric beacon for full compensation of large aperture telescopes. Demonstrate low-bandwidth active tracking of uncooperative satellites in the earth's shadow. Perform compensated laser propagation to satellite targets; use detailed measurements of energy and beam profile on target to characterize anisoplanatic effects and validate propagation models. Design and begin integration of integrated laser beam control system using active tracking and target return loop adaptive optics. Begin fabrication of scoring laser and sensors for integrated beam control demonstration. Begin design of Rayleigh beacon point-ahead atmospheric compensation system for laser projection to satellites on weapons-class beam director (3.5-meter telescope). Design multiconjugate adaptive optics system for low-elevation compensation of lasers and imaging.

(U) $12,372 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. Simulate advanced optical and beam control concepts for active tracking and atmospheric beam and image correction under conditions representative of those of airborne lasers. Perform advanced compensated beacon experiments. Conduct field demonstrations in support of advanced beam control concepts to increase energy on target by a factor of two in

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
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(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

moderate turbulent atmospheres and up to factors of four in strong turbulent atmospheres. Demonstrate advanced static and dynamic active tracking and atmospheric compensation methods under propagation conditions scaled to represent those expected in airborne laser engagements. Execute field tests of the shearing interferometer versus the Hartmann wavefront sensor. Update wave-optics computer simulations based on field test results to more effectively evaluate and improve subsequent advanced concepts.

(U) $2,113 Develop and demonstrate the technology for scalable, high energy laser devices with improved efficiency, for insertion in airborne lasers and other potential weapon applications. Evaluate and optimize multiple high pressure ejector nozzles performance using modeling and simulation and laboratory nozzle test stand. Investigate low flow rate basic hydrogen peroxide and zero-gravity generator concepts and complete the design of the most promising concept for fabrication and bench testing. Explore iodine injection and iodine generation methods and select the most promising for insertion into advanced chemical oxygen iodine test sequence utilizing a laboratory test stand.

(U) $24,658 Total

(U) B. Project Change Summary

Not Applicable.

(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 June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603723F Environmental Engineering Technology	2103

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2103	Environmental Quality Technology	5,313	991	0	0	0	0	0	0	0	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: 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). In FY 2001, Congress added another $1.0 million for joint environmental clean-up. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) **A. Mission Description**

This program develops and demonstrates advanced technologies to address Air Force-unique environmental compliance, site remediation, and pollution prevention problems. Note: In FY 2001, Congress added $1.0 million for Joint Environmental Clean-up.

(U) FY 2000 ($ in Thousands)

(U) $1,449 Developed novel reactor systems to reduce weapon system life cycle costs for logistics and sustainment. Developed rapid Mixed Base Hydrogen Peroxide production in support of directed energy weapon systems. Developed deployable waste management systems for Air Expeditionary Forces.

(U) $3,864 Eliminated hardware, software, and data format incompatibilities by defining an universal architecture for constructing modular monitoring networks applicable to fixed installations and deployed 'bare base' operations. Demonstrated an automated hazard warning and response capability suitable for use in fixed base and deployed operations. Validated the Environmental Systems Management Analysis and Reporting Network (E-SMART) as a viable architecture for warning of operational toxic materials.

(U) $5,313 Total

(U) FY 2001 ($ in Thousands)

(U) $991 Develop technologies for Joint Environmental Clean-up.

(U) $991 Total

(U) FY 2002 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603723F Environmental Engineering Technology	2103

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	5,435	0	0	
(U)	Appropriated Value	5,500	1,000		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-130			
	c. Omnibus or Other Above Threshold Reprogram				
	d. Below Threshold Reprogram				
	e. Rescissions	-57	-9		
(U)	Adjustments to Budget Years Since FY 2001 PBR			0	
(U)	Current Budget Submit/FY 2002 PBR	5,313	991	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). In FY 2001, Congress added another $1.0 million for joint environmental clean-up.

(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.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603723F Environmental Engineering Technology**	PROJECT **2103**

(U) D. Other Program Funding Summary ($ in Thousands)

(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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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603726F Aerospace Info Tech Sys Integration

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	8,522	7,361	0	0	0	0	0	0	Continuing	TBD
2810	Advanced Image/Information/Optical Memory Technology Applications	5,884	4,328	0	0	0	0	0	0	Continuing	TBD
2863	Integrated Photonics	2,638	0	0	0	0	0	0	0	Continuing	TBD
4850	Collaborative C2	0	3,033	0	0	0	0	0	0	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: Prior to FY 2001, the efforts in Project 4850 were performed in PE 0603253F, Projects 632735 and 63666A. In FY 2001, efforts in Project 2863 move into PE 0603203F, Project 665A. In FY 2002, efforts in Projects 2810 and 4850 move into PE 0603789F, Project 4072 and 4925, respectively, as part of the Air Force Science and Technology PE realignment. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(U) **A. Mission Description**

This program develops and demonstrates Aerospace Command, Control, Communications, and Intelligence (C3I) technologies for collaborative command and control (C2) 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.

(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.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration

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

		FY 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	7,828	7,429	8,047	
(U)	Appropriated Value	7,922	7,429		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-187			
	c. Omnibus or Other Above Threshold Reprogram	-180			
	d. Below Threshold Reprogram	1,049			
	e. Rescissions	-82	-68		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-8,047	
(U)	Current Budget Submit/FY 2002 PBR	8,522	7,361	0	TBD

(U) Significant Program Changes:

In FY 2002, efforts in this PE moves to PE 0603789F, Project 4072 and 4925.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001

BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
03 - Advanced Technology Development	0603726F Aerospace Info Tech Sys Integration	2810

COST ($ in Thousands)		FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2810	Advanced Image/Information/Optical Memory Technology Applications	5,884	4,328	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2002, efforts in this project move into PE 0603789F, Project 4072.

(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 2000 ($ in Thousands)

(U) $1,362 Developed and demonstrated advanced signal exploitation technologies. Developed and demonstrated advanced imagery and signal intelligence information, sensor fusion engine, and spatial database technologies to enhance warfighter mission planing, navigation, targeting, and terrain analysis. Developed and demonstrated 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) $1,442 Developed and demonstrated advanced data handling and event visualization technologies. Developed and demonstrated automated capabilities to locate, retrieve, process, distribute, and display intelligence and sensor data to improve the sensor exploitation process. Developed a decision support system to automate extraction, visualization, and analysis of information in text.

(U) $1,520 Developed and demonstrated advanced storage and memory technologies. Developed smart memory/associative recall information data handling, storage, and access technologies to enable advanced fusion processing techniques. Continued to develop and demonstrate optical disk and interface technologies that can be implemented in joint theater operations, including write-once, read-many devices.

(U) $1,560 Designed, developed, and demonstrated mission planning and rehearsal capabilities for theater battle management, including the demonstration of software for joint Command and Control (C2) requirements.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration	PROJECT 2810

(U) A. Mission Description Continued

(U) FY 2000 ($ in Thousands) Continued
(U) $5,884 Total

(U) FY 2001 ($ in Thousands)
(U) $1,130 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. Continue to develop planning and assessment technologies to support strategy development and campaign assessment in a distributed environment supporting the battlespace infosphere.
(U) $1,922 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, and situation assessment capability for decision support operations.
(U) $1,276 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) $4,328 Total

(U) FY 2002 ($ in Thousands)
(U) $0 Efforts move to PE 0603789F, Project 4072.
(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) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration	PROJECT 2810

(U) D. Acquisition Strategy

Not Applicable.

(U) E. Schedule Profile

(U) Not Applicable

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration	PROJECT 2863

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2863 Integrated Photonics	2,638	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, efforts in this project move into PE 0603205F, Project 665A.

(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 2000 ($ in Thousands)

(U) $282 Developed, integrated, demonstrated, and tested 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) $1,072 Developed and demonstrated microwave/millimeter-wave photonics processing and subsystems for advanced, optically-controlled, RF systems at increased frequencies.

(U) $700 Developed 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. Continued to develop a photonics True Time Delay processor.

(U) $584 Completed development and demonstration of three-dimensional optical information data handling, storage, and access technologies including erasable and read-only memories.

(U) $2,638 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Efforts move to PE 0603203F, Project 665A.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Efforts move to PE 0603203F, Project 665A.

(U) $0 Total

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603726F Aerospace Info Tech Sys Integration**	PROJECT **2863**

(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.

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BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration

PROJECT: 4850

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4850 Collaborative C2	0	3,033	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2002, efforts in this project move into PE 0603789F, Project 4925.

(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 2000 ($ in Thousands)
(U) $0 Previously accomplished in PE 0603253F, Projects 2735 and 666A.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $1,059 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 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 Aviation Administration and International Civil Aviation Organization directed Global Air Traffic Management requirements in fighter and bomber aircraft.
(U) $3,033 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603726F Aerospace Info Tech Sys Integration	PROJECT 4850

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)
(U) $0 Efforts move to PE 0603789F, Project 4925.
(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) 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603789F C3I Advanced Development

	COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
	Total Program Element (PE) Cost	18,879	19,289	32,273	34,497	32,521	29,621	30,245	30,884	Continuing	TBD
2335	Advanced C3 Technology	3,813	0	0	0	0	0	0	0	Continuing	TBD
4072	Dominant Battlespace Awareness	9,838	9,848	15,037	16,139	15,860	12,350	12,610	12,877	Continuing	TBD
4216	Battlespace Information Exchange	5,228	4,153	7,054	7,001	6,604	6,659	6,799	6,943	Continuing	TBD
4872	Dynamic Aerospace C2 & Execution	0	5,288	7,140	9,444	7,731	8,676	8,859	9,045	Continuing	TBD
4925	Collaborative C2	0	0	3,042	1,913	2,326	1,936	1,977	2,019	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

Note: In FY 2001, efforts in Project 2335 move into Project 4216. Prior to FY 2001, efforts previously accomplished in PE 0603728F move into Project 4872. In FY 2002, efforts previously accomplished in PE 0603726F, Project 4850, move into Project 4925, and efforts previously accomplished in PE 0603726F, Project 2810, move into Project 4072. These actions are part of the Air Force's Science and Technology PE realignment. FY 2003 - FY 2007 budget numbers do not reflect the DoD strategy review results.

(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. The Dominant Battlespace Awareness project 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. The Battlespace Information Exchange project will develop the reliable, secure, jam-resistant, inter-operable worldwide global information enterprise capabilities, providing the Air Force assured communications and reach-back capability in a Joint/coalition environment. The Dynamic Aerospace Command, Control, and Execution project provides the technology and demonstrations needed to allow the warfighter to plan, assess, execute, monitor, and re-plan on the compressed time scales required for tomorrow's conflicts, whether they be combat or peacekeeping missions. The Collaborative Command and Control project provides the technology and demonstrations needed to establish virtual, distributed command and control (C2) centers, allowing the majority of the C2 center resources to remain in CONUS, while only a small command element is deployed forward. The resultant

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BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603789F C3I Advanced Development

(U) A. Mission Description Continued

products of this program will be technologies needed to build the capability to dynamically plan and replan over a secure network.

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	17,193	19,468	20,059	
(U)	Appropriated Value	17,402	19,468		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions				
	b. Small Business Innovative Research	-410			
	c. Omnibus or Other Above Threshold Reprogram	-591			
	d. Below Threshold Reprogram	2,661			
	e. Rescissions	-183	-179		
(U)	Adjustments to Budget Years Since FY 2001 PBR			12,214	
(U)	Current Budget Submit/FY 2002 PBR	18,879	19,289	32,273	TBD

(U) Significant Program Changes:

In FY 2002, funds were added to increase emphasis on collaborative C2 and dominant battlespace awareness as part of the Air Force's Science and Technology PE realignment.

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

DATE **June 2001**

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603789F C3I Advanced Development

PROJECT
2335

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
2335 Advanced C3 Technology	3,813	0	0	0	0	0	0	0	Continuing	TBD

Note: In FY 2001, efforts in Project 2335 move to Project 4216.

(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 2000 ($ in Thousands)

(U) $1,466 Developed and demonstrated 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. Developed and demonstrated a user-friendly radio communications capability that can automatically sense and adapt to its environment and demand for service.

(U) $1,747 Demonstrated integrated and distributed networking and information system technologies to provide efficient, secure, interoperable, and deployable information systems. Developed and demonstrated a multi-level secure information system manager.

(U) $600 Demonstrated theater battle management and time-critical air operations technologies to provide field commanders essential operational decision support and rapid response capabilities. Completed Joint Defensive Planner demonstration. Completed initial replanning tool for Tactical Air Control Parties. Demonstrated initial decision aid capability to determine weather impacts on force and mission planning.

(U) $3,813 Total

(U) FY 2001 ($ in Thousands)

(U) $0 Effort moves to Project 4216.

(U) $0 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT 2335

(U) A. Mission Description Continued

(U) FY 2002 ($ 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 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) 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 June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4072**

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4072 Dominant Battlespace Awareness	9,838	9,848	15,037	16,139	15,860	12,350	12,610	12,877	Continuing	TBD

Note: Prior to FY 2002, a portion of this effort was accomplished in PE 0603726F, Project 2810.

(U) A. Mission Description

This project develops, integrates, and demonstrates advanced technologies as needed to achieve Dominant Battlespace Awareness (DBA) using information from all sources, exploiting government and commercial technologies. DBA is the information required to support dynamic planning and execution with the accuracy, fidelity, and timeliness needed to dominate in battle (reference Joint Vision 2010 and 2020). Technology development to achieve DBA includes: tasking information collectors (intelligence, surveillance, and reconnaissance platforms, national intelligence sources, etc,); correlating and geo-registering the collected data; exploiting the data to extract information of military significance; fusing information from multiple sources to create a digital representation of the battlespace; assessing the situation; and archiving the results for ready use by decision makers. This is a dynamic process that involves technologies for information access, extraction, fusion, processing, storage, and retrieval, as well as technologies for machine reasoning, pattern recognition, and timeline analysis.

(U) FY 2000 ($ in Thousands)

(U) $3,251 Developed, demonstrated, and transitioned passive exploitation systems to provide target identification for battlespace infosphere situational awareness. Developed and demonstrated technologies for over-the-horizon situational awareness through passive exploitation of signals emanating from weapon systems. Developed an integrated approach for positive target identification utilizing advanced resource management and cueing techniques.

(U) $3,169 Developed and demonstrated an all-source advanced capability for the detection and tracking of time-critical targets. Developed fusion systems and architectures capable of exploiting multiple sources to find, fix, track, and identify moving air and ground targets. Developed fusion algorithms and tools to exploit fused sensor information to provide higher levels of intelligence such as enemy force structures, lines of communication, and possible courses of action. Continued development of affordable teraflop signal processor technology. Demonstrated a two times improvement in high performance computing software affordability. Demonstrated a two times reduction in communication requirements through on-board data reduction.

(U) $3,418 Developed advanced fusion technology to evaluate the capability of Unmanned Combat Aerial Vehicles (UCAV) to operate in a Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated command, control and communications (C3) network. Developed 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 UCAV C3 network. Demonstrated technology to guarantee secure and robust communication capability of the UCAV system.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4072**

(U) <u>A. Mission Description Continued</u>

(U) <u>FY 2000 ($ in Thousands) Continued</u>

(U)	$9,838	Total

(U) <u>FY 2001 ($ in Thousands)</u>

(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)	$1,755	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 four times affordability improvement 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 two times 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)	$3,215	Continue to develop advanced fusion technology to evaluate the capability of Unmanned Combat Aerial Vehicles (UCAV) to operate in a Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated Command, Control, Communications (C3) network. Develop and demonstrate command and control (C2) technologies for the dynamic C2 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 C2 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.
(U)	$9,848	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT 4072

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $3,341 Develop and demonstrate advanced signal and data exploitation technologies for detection, tracking, identification, and targeting of time-critical targets, and information extraction technologies for situational awareness. Develop tools to extract information from data derived from acoustic, image, and signal intelligence. Continue to develop and demonstrate information extraction tools that automatically extract events and their relationships from free form text, allowing the warfigther more time to perform analysis. (Prior to FY 2002, a portion of this effort was accomplished in PE 0603726F, Project 2810.)

(U) $6,632 Develop and demonstrate advanced data and information fusion capabilities to support multi-source missions, new sensor types, cognitive models, and automated fusion process management. Continue to develop and demonstrate an all-source advanced capability for the detection and tracking of time-critical targets. Continue to 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. (Prior to FY 2002, a portion of this effort was accomplished in PE 0603726F, Project 2810.)

(U) $1,268 Develop and demonstrate advanced data handling and event visualization technologies. Continue to develop and demonstrate automated capabilities to access, extract, process, and display fused multi-source intelligence for near-real-time situational awareness. Develop timeline, event and motion pattern recognition tools for analysis, visualization and decision aids to detect enemy activity. Develop and demonstrate probabilistic approaches for accumulation of data/information to support target/activity identification and situation awareness. Initiate development of a capability for precise geo-location and identification of targets exploiting multi-sensor data. Continue to develop the technologies to use multiple source correlation of sensor reports to optimize allocation and tasking of sensor resources.

(U) $1,850 Complete the development of advanced fusion technology to evaluate the capability of Unmanned Combat Aerial Vehicles (UCAV) to operate in a Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated Command, Control, Communications (C3) network. Demonstrate, through flight test, the concept of single vehicle distributed control by performing a handoff between the friendly area of operations controller and the area of responsibility controller (two different ground stations). Demonstrate, through flight test, the software elements for both the air vehicle and Mission Control Station required for the dynamic command and control of multiple vehicles by one controller.

(U) $1,946 Continue the development and demonstration of 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. Demonstrate multi-vehicle flight operations: escort formations; collision avoidance; auto routing; and dynamic retasking among others. Demonstrate multiple re-planned weapon drops.

(U) $15,037 Total

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BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT 4072

(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) 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603789F C3I Advanced Development

PROJECT
4216

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4216 Battlespace Information Exchange	5,228	4,153	7,054	7,001	6,604	6,659	6,799	6,943	Continuing	TBD

Note: In FY 2001, efforts in Project 2335 move into this Project.

(U) A. Mission Description

This project develops and demonstrates advanced communications technologies to implement a secure information grid for the worldwide information exchange of near-real-time multimedia (i.e., voice, data, video, and imagery) information in a joint/coalition environment. This secure information grid will be rapidly deployable, mobile, interoperable, and seamless between aircraft, either en-route or in theater, and command and control (C2) centers. It will: a) provide interoperability across echelon, Service, and multi-national force boundaries; b) support mobile C2, sensor-to-shooter operations, and the battle management decision process; and c) provide in-transit visibility of en-route aircraft, cargo, mission status, and reachback capabilities for aircraft to CONUS operations centers (i.e., updating information and mission changes to en-route aircraft). Technology developments include an information assurance decision support system, advanced information management, multi-level secure communications, secure survivable networks, and communications transmission systems.

(U) FY 2000 ($ in Thousands)

(U) $1,799 Designed, developed, integrated, and demonstrated advanced expert system decision algorithms to prioritize and control resources for global reach in a mobility environment. Designed and developed intelligent agent and information structure management techniques. Developed an Intelligent Information Manager agent to throttle and regulate mission information flow among Air Mobility Command (AMC) components based on changing system capabilities.

(U) $1,805 Designed, developed, integrated, and demonstrated modular, reprogrammable radio communications technologies for commercial and military global reach in an airborne mobility environment. Continued the development and demonstration of a user-friendly, assured multiband and wideband wireless intelligent networking capability that automatically senses and adapts to its environment and demand for service. Developed 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) $1,624 Designed, developed, integrated, and demonstrated advanced protocol network and commercial management technologies to validate communications between air platforms and C2 centers at Scott Air Force Base for global reach in a mobility environment. Developed 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) $5,228 Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4216**

(U) A. Mission Description Continued

(U)	FY 2001 ($ in Thousands)	
(U)	$851	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 Air Mobility Command (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)	$817	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.
(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)	$4,153	Total

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4216**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands)

(U) $1,234 Develop, integrate, and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach in a mobility environment. Demonstrate an intelligent information manager agent that will throttle and regulate mission information flow among Air Mobility Command (AMC) components based on changing system capabilities. Integrate in an AMC airlifter the airborne components of Intelligent Information Manager (IIM), Integrated Network Controller (INC), and the Global Media Access Controller (GMAC) to produce a combined commercial/military global communications system, a dynamically switched network, and an intelligent heterogeneous database access interface to prioritize and control resources in a mobility environment.

(U) $1,235 Develop, integrate, and demonstrate advanced network protocols and commercial management technologies to provide communications from deployed aircraft and ground elements to the AMC Tanker Airlift Control Center (TACC), as well as, in-transit visibility at the TACC of all aircraft, personnel, and cargo. Demonstrate technology to dynamically reconfigure the network and communications systems to optimally match the requirements for information transfer with changing transmission path availability. Integrate and demonstrate the ground-based components of the IIM, INC, and GMAC in AMC's TACC and AMC's forward deployed unit, the Tanker Airlift Control Element, resulting in a seamless information infrastructure providing total asset visibility and enhanced situation awareness.

(U) $696 Develop and demonstrate improved global networking and resource management technologies that provide reliable, efficient, secure, interoperable, and dynamic deployable communications to Air Combat Command. Continue to develop the ability to manage and control adaptive communications controller system(s) and to integrate additional and emerging media types for increased bandwidth capabilities. Continue development of mechanisms that intelligently and dynamically negotiate quality of service and bandwidth between Command and Control (C2) applications and network transport services. Continue development of affordable multi-level secure network management capabilities and incorporate additional management mechanisms to affect commander's control of all information grid network resources.

(U) $1,408 Develop and demonstrate intelligent wireless networking technologies to provide seamless and assured connectivity to all aerospace forces while reducing the forward-deployed footprint. Develop and demonstrate technology to support an en-route and in-theater information grid for the worldwide exchange of near-real-time multimedia (i.e., voice, data, video, and imagery). Continue to develop and demonstrate dynamic intelligent bandwidth management concepts and militarized protocols for highly dynamic and ad-hoc wireless network topologies.

(U) $1,219 Develop and demonstrate theater battle management and time-critical air operations technologies to provide field commanders essential operational decision support and rapid response capabilities. Continue to develop space weather impact decision aid capability. Continue to develop master caution panel capability to centrally monitor and manage command and control assets within the air operations center C2 process. Develop interface methodologies for seamless integration of theater battle management applications into the joint battlespace information environment.

(U) $1,262 Develop and demonstrate an information assurance decision support system to provide real time defensive courses-of-action (COA) relating to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4216**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

intrusion detection, intrusion response, and information system recovery. Develop data correlation and data fusion tools for detection of large-scale coordinated attacks, and provide automatic forensics analysis of attack information.

(U) $7,054 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) 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 June 2001

BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development	PROJECT 4872

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4872 Dynamic Aerospace C2 & Execution	0	5,288	7,140	9,444	7,731	8,676	8,859	9,045	Continuing	TBD

Note: Prior to FY 2001, efforts were previously accomplished in PE 0603728F.

(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 (C2) decision making. It provides the technology and demonstrations needed to enable the warfighter to plan, assess, execute, monitor, and replan on the compressed time scales required for tomorrow's conflicts, whether they be combat or operations other than war. It will develop and demonstrate a new generation of planning assessment technologies that enable a new paradigm of effects-based operations, allowing the aerospace commanders to determine the desired operational effects and prosecute the mission accordingly. It will develop innovative capabilities capable of realizing a strategy to task approach to aerospace warfare exploiting a link between command, strategy, and assessment functions. It will develop and demonstrate distributed C2 technologies that provide the commander and staff with seamless access to tailored multi-media, multi-spectral data within a mobile, dynamic C2 center. Knowledge-based intelligent information technologies will be developed to support robust, real-time, large-scale Air Force C2 systems. The resultant products of the project will be the capabilities required to dynamically plan and execute missions, which is a key component of battlespace infosphere concept set forth in the Air Force Scientific Advisory Board Reports, 'Information Management to Support the Warrior' and 'Building the Joint Battlespace Infosphere.'

(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 C2 centers. Develop technology that integrates offensive, defensive, and support elements into an aerospace command center that provides the EAF a cohesive environment for planning, execution, and assessment.

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BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4872**

(U) A. Mission Description Continued

(U) FY 2001 ($ in Thousands) Continued

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) $2,097 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) $5,288 Total

(U) FY 2002 ($ in Thousands)

(U) $1,632 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. Continue to 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. Continue to 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. Develop effects-based tools to operate in the battlespace infosphere that will allow the commander and his/her staff to make decisions with uncertain, ambiguous, or vague information during the course of an air campaign.

(U) $1,474 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. Continue to 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 within the battlespace infosphere. Continue to develop technology that integrates offensive, defensive, and support elements into an aerospace command center that provides the Expeditionary Aerospace Force (EAF) a cohesive environment for planning, execution, and assessment. Develop and demonstrate the techniques to produce and manage information objects within the battlespace infosphere from numerous web-enabled information sources, to customize information products, and to deliver decision-quality information to any warfighter.

(U) $4,034 Develop and demonstrate knowledge-based intelligent information tools to support robust, real-time, large-scale aerospace C2 systems. Demonstrate knowledge-based C2 technologies in support of network intrusion detection. Continue to develop and integrate planning and information-based intelligent agents for adaptive replanning. Continue to develop and demonstrate the initial improved integrated flight

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)	DATE June 2001	
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4872**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

management capability that will 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 Air Mobility Command's info-centric environment.

(U) $7,140 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) 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 June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603789F C3I Advanced Development / PROJECT 4925

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4925 Collaborative C2	0	0	3,042	1,913	2,326	1,936	1,977	2,019	Continuing	TBD

Note: Prior to FY 2001, efforts were previously accomplished in PE 0603253F, Projects 2735 and 666A. In FY 2001, efforts were accomplished in PE 0603726F, Project 4850.

(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 demonstrate 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 will facilitate an affordable implementation of the battlespace infosphere concept set forth in the Air Force Scientific Advisory Board Reports, 'Information Management to Support the Warrior' and 'Building the Joint Battlespace Infosphere.'

(U) FY 2000 ($ in Thousands)
(U) $0 Effort was accomplished in PE 0603253F, Projects 2735 and 666A.
(U) $0 Total

(U) FY 2001 ($ in Thousands)
(U) $0 Effort was accomplished in PE 0603726F, Project 4850.
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $998 Develop and demonstrate next generation distributed collaborative environments and integrated aerospace information architectures. Continue to develop collaborative technologies for split aerospace operations; coalition warfare; simulation-based acquisition; platform information mining; blended air/ground decision aiding; and information migration.
(U) $1,045 Develop communication technology to increase aerospace platform information transfer capacity. Continue to develop the 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. Develop the design of a high capacity, bandwidth efficient, modulation/network and phased array antenna control technology for point-to-point and multiple platform connectivity.
(U) $999 Develop and demonstrate embedded information system technologies to support a transparent framework for seamless, rapid insertion of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)		DATE June 2001
BUDGET ACTIVITY **03 - Advanced Technology Development**	PE NUMBER AND TITLE **0603789F C3I Advanced Development**	PROJECT **4925**

(U) A. Mission Description Continued

(U) FY 2002 ($ in Thousands) Continued

battlespace infosphere technology. Develop techniques for inserting battlespace infosphere technology that do not require a comprehensive re-test of the entire command and control (C2) system. Develop capability for modernization of aerospace and C2 platforms to support system-of-systems interoperability within the battlespace infosphere.

(U) $3,042 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) 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
June 2001

BUDGET ACTIVITY
03 - Advanced Technology Development

PE NUMBER AND TITLE
0603876F Space Based Laser

PROJECT
4779

COST ($ in Thousands)	FY 2000 Actual	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	Cost to Complete	Total Cost
4779 Space Based Laser	68,926	72,544	0	0	0	0	0	0	0	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0	0

All Air Force funding for this PE has been transterred to BMDO.

(U) A. Mission Description

The Space Based Laser (SBL) project was created to investigate the feasibility of providing the nation with a highly effective, continuous, global boost phase intercept option for both national and theater 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 space control, air defense, global surveillance, and target detection and designation. Beginning with the FY02 budget, all SBL activities and associated funding are transferred to BMDO.

The SBL project 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, PE 0603173C in FY 2000, PE 0603174C 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 combined AF/BMDO budget ends with FY01 funding and for FY02 and out, all funds transfer to BMDO who continues to fund through space flight testing. The Integrated Flight Experiment (IFX) is a critical step in proving the feasibility of destroying ballistic missiles in their boost phase from space.

Technology risk reduction and component demonstration prior to flight hardware development are important parts of the IFX program. Ground experiments will demonstrate major risk area engineering design units (gain generator, resonator, beam control). The IFX will culminate in thespace vehicle integration, performance of a series of on-orbit experiments, and demonstration of SBL boost phase intercept feasibility.

The Air Force contributed funds to the Space Based Laser project from FY 1999 - FY 2001. This project is classified as Budget Activity 3 because the Integrated Flight Experiment (IFX) is a technology experiment.

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

DATE		June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603876F Space Based Laser	PROJECT 4779

(U) A. Mission Description Continued

(U)	FY 2000 ($ in Thousands)	
(U)	$61,763	Began IFX Development
(U)	$581	Began Architecture & Affordability Study
(U)	$750	Began Advanced Mirror System Development
(U)	$457	Began Lethality, Analysis & Architecture (AFSPC and AFRL efforts)
(U)	$5,375	Provided IFX Program Support
(U)	$68,926	Total

(U)	FY 2001 ($ in Thousands)	
(U)	$64,844	Continue IFX Development
(U)	$500	Continue Advanced Mirror System Development
(U)	$250	continue Lethality, Analysis & Architecture (AFSPC and AFRL efforts)
(U)	$6,950	Provide IFX Program Support
(U)	$72,544	Total

(U)	FY 2002 ($ in Thousands)	
(U)	$0	No activity
(U)	$0	Total

(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 2000	FY 2001	FY 2002	Total Cost
(U)	Previous President's Budget (FY 2001 PBR)	72,864	63,216	63,141	TBD
(U)	Appropriated Value	73,840	73,216		
(U)	Adjustments to Appropriated Value				
	a. Congressional/General Reductions	-576			
	b. Small Business Innovative Research	-2,684			
	c. Omnibus or Other Above Threshold Reprogram				

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

DATE		June 2001
BUDGET ACTIVITY 03 - Advanced Technology Development	PE NUMBER AND TITLE 0603876F Space Based Laser	PROJECT 4779

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

		FY 2000	FY 2001	FY 2002	Total Cost
	d. Below Threshold Reprogram	-1,365	-159		
	e. Rescissions	-289	-513		
(U)	Adjustments to Budget Years Since FY 2001 PBR			-63,141	
(U)	Current Budget Submit/FY 2002 PBR	68,926	72,544	0	TBD

(U) Significant Program Changes:

FY00: $875K in Below Threshold Reprogrammings was executed to support higher priority Air Force efforts.

FY01: $10M congressional add in FY 2001 to support acceleration of the IFX and its integrated test facility (included under IFX development).

FY02 and out: All funds transferred toBMDO

(U) D. Other Program Funding Summary ($ in Thousands)

(U) RDT&E, BMDO, R-29, Support Technologies-Adv Tech Dev

(U) E. Acquisition Strategy

Not Required

(U) F. Schedule Profile

(U) Not Required

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