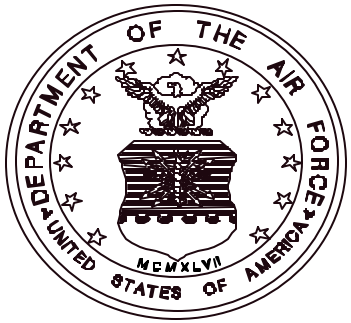
UNCLASSIFIED

# DEPARTMENT OF THE AIR FORCE

# FISCAL YEAR 2003 PRESIDENT'S BUDGET

# RESEARCH, DEVELOPMENT, TEST AND EVALUATION

# DESCRIPTIVE SUMMARIES




## FEBRUARY 2002

## VOLUME I

## BUDGET ACTIVITY 1 - 3

UNCLASSIFIED

**Fiscal Year 2003 President's Budget**

**RDT&E Descriptive Summaries, Volume I**

**February 2002**

## INTRODUCTION AND EXPLANATION OF CONTENTS

1. (U) GENERAL This document has been prepared to provide information on the United States Air Force (USAF) Research, Development, Test and Evaluation (RDT&E) program elements and projects in the FY 2003 President's Budget. All formats in this document are in accordance with the guidelines of the DoD 7000.14R, Financial Management Regulation, Volume 2B, Chapter 5, with the exception of the R-3 exhibit. The USAF could not support the new 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 FY 2003 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.

   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 7000.14R, Financial Management Regulation, Volume 2B, Chapter 5, Section 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 (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| **BUDGET ACTIVITY #1: BASIC RESEARCH (Volume I)** | |
| | N/A |
| **BUDGET ACTIVITY 2: APPLIED RESEARCH (Volume I)** | |
| 0602102F Materials | In FY 2003, Project 4347, Materials for Structures, Propulsion and Subsystems, were transferred to PE 0602500F, Project 5025, Space Materials Development, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 4348, Materials for Electronics, Optics and Surveillance, efforts were transferred to PE 0602500F, Project 5025, Space Materials Development, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5015, Rocket Materials Technology, efforts were transferred to PE 0602500F, Project 5025, Space Materials Development, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 4349, Materials Technology for Sustainment, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5025, Space Materials Development, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5015, Rocket Materials Technology, efforts were transferred from PE 0602203F, Aerospace Propulsion, Project 4847, Rocket Propulsion Technology. |
| 0602201F Aerospace Flight Dynamics | In FY 2003, Project 2403, Flight Control and Vehicle-Pilot Interface, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5030, Applied Space Access Vehicle Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities.. |
| 0602202F Human Effectiveness Applied Research | In FY 2003, Project 7184, Crew System Interface and Biodynamics, efforts were transferred to Project 7757, Bioeffects and Protection, to align resources with the Air Force Research Laboratory organization. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| | In FY 2003, Project 7757, Bioeffects and Protection, efforts were transferred from Project 7184, Crew System Interface and Biodynamics, to align resources with the Air Force Research Laboratory organization. |
| | In FY 2003, Project 7184, Crew System Interface and Biodynamics, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5024, Human Centered Applied Space Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0602203F Aerospace Propulsion | In FY 2003, Project 3012, Advanced Propulsion Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5025, Space Materials Development, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 4847, Rocket Propulsion Technology, efforts were transferred to PE 0602102F, Materials, Project 5015, Rocket Materials Technology. |
| | In FY 2003, Project 4847, Rocket Propulsion Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0602204F Aerospace Sensors | In FY 2003, Project 2002, Electronic Component Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Projects 5028, Space Sensors, Photonics and RF Processes, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 2002, Electronic Component Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Projects 5029, Space Sensor and Countermeasure Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 6095, Sensor Fusion Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Projects 5028, Space Sensors, Photonics and RF Processes, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| | In FY 2003, Project 6095, Sensor Fusion Technology, were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5029, Space Sensor and Countermeasure Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 7622, RF Sensors and Countermeasures Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5029, Space Sensors and Countermeasures Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 2002, Electronic Component Technology, efforts were transferred to Project 5016, Photonic Component Technology. |
| | In FY 2003, Project 5016, Photonic Component Technology, efforts were transferred from Project 2002, Electronic Component Technology. |
| | In FY 2003, Project 7622, RF Sensors and Countermeasure Technology, efforts were transferred to Project 5017, RF Processing for ISR Sensors. |
| | In FY 2003, Project 5017, RF Processing for ISR Sensors, efforts were transferred from Project 7622, RF Sensors and Countermeasures Technology. |

## PROGRAM ELEMENT COMPARISON SUMMARY

## INTRODUCTION AND EXPLANATION OF CONTENTS

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| 0602500F Multi-Disciplinary Space Technology | In FY 2003, this is a new PE.<br><br>In FY 2003, Project 5023, Laser & Imaging Space Technology, efforts were transferred from PE 0602605F, Directed Energy Technology, Project 4866, Laser & Imaging Technology, in conjunction with the Space Commission recommendation to consolidate space unique activities.<br><br>In FY 2003, Project 5024, efforts were transferred from PE 0602202F, Human Effectiveness Applied Research, Project 7184, Crew System Interface and Biodynamics, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5025, Space Materials Development, efforts were transferred from PE 0602102F, Materials, Project 4347, Materials for Structures, Propulsion and Subsystems, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5025, Space Materials Development, efforts were transferred from PE 0602102F, Materials, Project 4348, Materials for Electronics, Optics and Surveillance, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5025, Space Materials Development, efforts were transferred from PE 0602102F, Materials, Project 4349, Materials Technology for Sustainment, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5025, Space Materials Development, efforts were transferred from PE 0602102F, Materials, Project 5015, Rocket Materials Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5026, Rocket Propulsion Component Technology, efforts were transferred from PE 0602203F, Aerospace Propulsion, Project 4847, Rocket Propulsion Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| | In FY 2003, Project 5027, High Speed Airbreathing Propulsion Technology, efforts were transferred from PE 0602203F, Aerospace Propulsion, Project 3012, Advanced Propulsion Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5028, Space Sensors, Photonics and RF Processes, efforts were transferred from PE 0602204F, Aerospace Sensors, Project 2002, Electronic Component Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5029, Space Sensor and Countermeasure Technology, efforts were transferred from PE 0602204F, Aerospace Sensors, Project 2002, Electronic Component Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5029, Space Sensor and Countermeasure Technology, efforts were transferred from PE 0602204F, Aerospace Sensors, Project 6095 Sensor Fusion Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5029, Space Sensor and Countermeasure Technology, efforts were transferred from PE 0602204F, Aerospace Sensors, Project 7622, RF Sensors and Countermeasures Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5030, Applied Space Access Vehicle Technology, efforts were transferred from PE 0602201F, Aerospace Vehicle Technologies, Project 2403, Flight Control/Vehicle-Pilot Interface, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0602601F Space Technology | In FY 2003, Project 1010, Space Survivability & Surveillance, efforts were transferred to Project 5018, Spacecraft Protection Technology. |
| | In FY 2003, Project 5018, Spacecraft Protection Technology, efforts were transferred from Project 1010, Space Survivability & Surveillance. |

## PROGRAM ELEMENT COMPARISON SUMMARY

## INTRODUCTION AND EXPLANATION OF CONTENTS

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| 0602605F Directed Energy Technology | In FY 2003, Project 4866, Laser & Imaging Technology, efforts were transferred to PE 0602500F, Multi-Disciplinary Space Technology, Project 5023, Laser & Imaging Space Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| **BUDGET ACTIVITY #3: ADVANCED TECHNOLOGY DEVELOPMENT (Volume I)** | |
| 0603112F Adv Materials For Weapon Sys | In FY 2003, Project 2100, Laser Hardened Materials, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5032, Advanced Space Materials, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 3946, Materials Transition, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology , Project 5032, Advanced Space Materials, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0603203F Advanced Aerospace Sensors | In FY 2003, Project 69DF, Target Attack and Recognition Technology, efforts were transferred to Project 5019, Advanced RF Technology for ISR Sensors, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 665A, Advanced Aerospace Sensors Technology, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5034, Advanced Space Sensors, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Projects 665A, Advanced Aerospace Sensors Technology, were transferred to Project 5019, Advanced RF Technology for ISR Sensors, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0603216F Aerospace Prop and Power Technology | In FY 2003, Project 4922, Space and Missile Rocket Propulsion, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technologies, Project 5033, Rocket Propulsion Demonstration, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |

## PROGRAM ELEMENT COMPARISON SUMMARY

## INTRODUCTION AND EXPLANATION OF CONTENTS

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| 0603270F Electronic Combat Technology | In FY 2003, Project 431G, RF Warning and Countermeasures Technology, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5034, Advanced Space Sensors, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 691X, EO/IR Warning and Countermeasures Technology, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5034, Advanced Space Sensors, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0603231F Crew System and Personnel Protection Technology | In FY 2003, Project 3257, Helmet-Mounted Sensory Technology, efforts were transferred to Project 5020, Directed Energy Protective Systems, in order to align resources with the Air Force Research Laboratory organization.<br><br>In Fy 2003, Project 5020, Directed Energy Protective Systems, efforts were transferred from Project 3257, Helmet-Mounted Sensory Technology, in order to align resources within the Air Force Research Laboratory organization. |
| 0603401F Advanced Spacecraft Technology | In FY 2003, Project 4400, Space Systems Protection, efforts were transferred from Project 5021, Space Systems Survivability, due to a realignment of work within the project.<br><br>In FY 2003, Project 5021, Space Systems Survivability, efforts were transferred to Project 4400, Space Systems Protection, due to a realignment of work within the project. |
| 0603500F Multi-Disciplinary Advanced Development Space Technology | In FY 2003, this is a new PE.<br><br>In FY 2003, Project 5031, Advanced Optics and Laser Space Technology, efforts were transferred from PE 0603605F, Advanced weapons Technology, Project 3150, Advanced Optics Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities.<br><br>In FY 2003, Project 5031, Advanced Optics and Laser Space Technology, efforts were transferred from PE 0603605F, Advanced Weapons Technology, Project 3647, Hi Energy Laser Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| | In FY 2003, Project 5032, Advanced Space Materials, efforts were transferred from PE 0603112F, Advanced Materials for Weapon Systems, Project 2100, Laser Hardened Materials, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5032, Advanced Space Materials, efforts were transferred from PE 0603112F, Advanced Materials for Weapon Systems, Project 3946, Materials Transition, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5033, Rocket Propulsion Demonstration, efforts were transferred from PE 0603216F, Aerospace Propulsion and Power Technology, Project 4922, Space and Missile Rocket Propulsion, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5034, Advanced Space Sensors, efforts were transferred from PE 0603203F, Advanced Aerospace Sensors, Project 665A, Advanced Aerospace Sensors Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5034, Advanced Space Sensors, efforts were transferred from PE 0603270F, Projects 691X, EO/IR Warning and Countermeasures Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| | In FY 2003, Project 5034, Advanced Space Sensors, efforts were transferred from PE 0603270, Electronic Combat Technology, Projects 431G, RF Warning and Countermeasures, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0603605F Advanced Weapons Technology | In FY 2003, Project 3150, Advanced Optics Technology, efforts were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5031, Advanced Optics and Laser Space Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| | In FY 2003, Project 3647, Hi Energy Laser Technology, were transferred to PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5031, Advanced Optics and Laser Space Technology, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| **BUDGET ACTIVITY #4: DEMONSTRATION AND VALIDATION (DEM/VAL) (Volume II)** | |
| 0603438F Space Control Technology | In FY 2003, Project 2611, Technology Insertion Plan & Analysis, efforts were transferred to PE 0604421F, Counterspace Systems, Project A001, Counter Satellite Communications System, in order to perform Engineering and Manufacturing Development activities. |
| | In FY 2003, Project 2611, Technology Insertion Plan & Analysis, efforts were transferred to PE 0604421F, Counterspace Systems, Project A002, Counter Surveillance Reconnaissance System, in order to perform Engineering and Manufacturing Development activities. |
| | In FY 2003, Project 2611, Technology Insertion Plan & Analysis, efforts were transferred to PE 0604421F, Counterspace Systems, Project A003, Rapid Identification Detection and Reporting System, in order to perform Engineering and Manufacturing Development activities. |
| 0603845F Advanced Wideband System (AWS) | In FY 2003, Project 4944, Advanced Wideband System, includes new start efforts. |
| 0603790F NATO Cooperative R&D | In FY 2003, Project 64NATO, NATO Cooperative R&D, efforts were transferred to PE 0603791F, International Space Cooperative R&D, Project 5035, International Space Cooperative R&D, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0603791F International Space Cooperative R&D | In FY 2003, this is a new PE. |
| | In FY 2003, Project 5035, International Space Cooperative R&D, efforts transferred from PE 0603790F, NATO Cooperative R&D, Project 64NATO, NATO Cooperative R&D, in conjunction with the Space Commission recommendation to consolidate all space unique activities. |
| 0603851F ICBM - Dem/Val | In FY 2003, Project 1020, ICBM Guidance Applications, includes new start efforts. |
| | In FY 2003, Project 1023, Rocket System Launch Program, includes new start efforts. |

## PROGRAM ELEMENT COMPARISON SUMMARY

## INTRODUCTION AND EXPLANATION OF CONTENTS

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| 0603858F Space Based Radar Dem/Val | In FY 2003, this is a new PE.<br><br>In FY 2003, Project A004, SBR Concept & Technical Development, efforts were transferred from PE 0604251F, Space-Based Radar EMD, Project 5009, SBR Concept and Technical Development, in order to correct a database error which loaded the funding in the wrong PE. |
| 0604327F Hardened Target Munitions | In FY 2003, Project 4641, GBU-28 Upgrade, includes new start efforts. |
| **BUDGET ACTIVITY #5: ENGINEERING & MANUFACTURING DEVELOPMENT (EMD) (Volume II)** | |
| 0207434F Link 16 Support & Sustainment | In FY 2003, this is a new PE.<br><br>In FY 2003, Project 5049, JINTACCS, efforts transferred from PE 0604779F, Tactical Data Link Interoperability, Project 2189, JINTACCS, in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise.<br><br>In FY 2003, Project 5050, TCL System Integration, efforts were transferred from PE 0604754F, Tactical Data Link Integration, Project 4749, Link 16 System Integration, in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise.<br><br>In FY 2003, Project 5051, Family of Interoperable Operational Pictures (FIOP), efforts were transferred from PE 0604754F, Tactical Data Link Integration, Project 4992, Family of Interoperable Operational Pictures (FIOP), in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise. |
| 0401318F CV-22 | In FY 2003, Project 4103, CV-22, includes new start efforts. |
| 0604226F B-1B | In FY 2003, Project Number 4596, B-1B, includes new start efforts. |
| 0604240F B-2 Advanced Tech Bomber | In FY 2003, Project 3843, B-2 Advanced Technology Bomber, includes new start efforts. |
| 0604251F Space Based Radar EMD | In FY 2003, Project 5009, SBR Concept and Technical Development, efforts were transferred to PE 0603858F, Space Based Radar Dem/Val, Project A004, SBR Concept & Technical Development. |

## PROGRAM ELEMENT COMPARISON SUMMARY

## INTRODUCTION AND EXPLANATION OF CONTENTS

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| 0604421F Counter Space Systems | In FY 2003, this is a new PE.<br><br>In FY 2003, Project A001, Counter Satellite Communications System, efforts were transferred from PE 0603438F, Space Control Technology, Project 2611, Technology Insertion Plan & Analysis, in order to begin system Engineering and Manufacturing Development activities.<br><br>In FY 2003, Project A002, Counter Surveillance Reconnaissance System, efforts were transferred from PE 0603438F, Space Control Technology, Project 2611, Technology Insertion Plan & Analysis, in order to begin system Engineering and Manufacturing Development activities.<br><br>In FY 2003, Project A003, Rapid Attack Identification Detection & Reporting System (RAIDRS), includes new start efforts.<br><br>In FY 2003, Project A003, Rapid Attack Identification Detection & Reporting System (RAIDRS), efforts were transferred from PE 0603438F, Space Control Technology, Project 2611, Technology Insertion Plan & Analysis, in order to begin system Engineering and Manufacturing Development activities. |
| 0604617F Agile Combat Support | In FY 2003, Project 2895, Civil Engineering Readiness, includes new start efforts. |
| 0604735F Combat Training Ranges | In FY 2003, Project 2286, Combat Training Ranges, includes new start efforts. |
| 0604754F Tactical Data Link Integration | In FY 2003, Project 4749, Link 16 System Integration, efforts were transferred to PE 0207434F, Link 16 Support and Sustainment, Project 5050, TCL System Integration, in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise.<br><br>In FY 2003, Project 4992, Family of Interoperable Operational Pictures (FIOP), efforts transferred to PE 0207434F, Link 16 Support and Sustainment, Project 5051, Family of Interoperable Operational Pictures (FIOP), in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise. |
| 0604779F Tactical Data Link Interoperability | In FY 2003, Project 2189, JINTACCS, efforts transferred to PE 0207434F, Link 16 Support and Sustainment, Project 5049, JINTACCS, in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise. |

## PROGRAM ELEMENT COMPARISON SUMMARY

## INTRODUCTION AND EXPLANATION OF CONTENTS

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | | REMARKS |
|---|---|---|
| 0604851F | ICBM - EMD | In FY 2003, Project 4823, Environmental Control System (ECS) Replacement Program, includes new start efforts. |
| **BUDGET ACTIVITY #6: MANAGEMENT & SUPPORT (Volume II)** | | |
| 0604256F | Threat Simulator Development | In FY 2003, Project 3321, EW Ground Test Resources, includes new start efforts. |
| 0604759F | Major Test and Evaluation Investment | In FY 2003, Project 4597, Air Force Test Investments, includes new start efforts. |
| **BUDGET ACTIVITY #7: OPERATIONAL SYSTEMS DEVELOPMENT (Volume III)** | | |
| 0101120F | Advanced Cruise Missile (ACM) | In FY 2003, Project 4798, Life Extension Program, was renamed (formerly Life Extension Study). This action did not change program content.<br><br>In FY 2003, Project 4798, Life Extension Program, includes new start efforts. |
| 0207134F | F-15E Squadrons | In FY 2003, Project 670131, F-15E First Shooter (ALR-56C Processor Upgrade), includes new start efforts. |
| 0207138F | F-22 Squadrons | In FY 2003, Project 4785, F-22, includes new start efforts. |
| 0207423F | Advanced Communications Systems | In FY 2003, Project 4935, Joint Tactical Radio Systems (JTRS), includes new start efforts. |
| 0207445F | Fighter Tactical Data Link | In FY 2003, this is a new PE.<br><br>In FY 2003, Project 5043, Fighter Tactical Data Link includes a new start efforts.<br><br>In FY 2003, Project 5043, Fighter Tactical Data Link, efforts were transferred from PE 0207131F, A-10 Squadrons, Project 4809, A-10 Squadrons, in order to comply with CSAF 17 Apr 01 direction to consolidate tactical data link/Link 16 funding and manage tactical data links as an enterprise. |
| 0207449F | Multi-Sensor Command and Control Constellation (MC2C) | In FY 2003, this is a new PE. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | | REMARKS |
|---|---|---|
| | | In FY2003, Project 5064, Airframe, efforts were transferred from PE 0207581F, Joint Stars, Project 0003, JSTARS, in order to support transition to a new platform.<br><br>In FY2003, Project 5065, Sensors, efforts were transferred from PE 0207581F, Joint Stars, Project 0003, JSTARS, in order to support transition to a new platform. |
| 0207581F | JOINT STARS | In FY 2003, Project 0003, JSTARS, efforts were transferred to PE 0207449F, Multi-Sensor Command and Control Constellation (MC2C), Project 5064, Airframe, in order to support transition to a new platform.<br><br>In FY 2003, Project 0003, JSTARS, efforts were transferred to PE 0207449F, Multi-Sensor Command and Control Constellation (MC2C), Project 5065, Sensors, in order to support transition to a new platform. |
| 0303131F | Minimum Essential Emergency Communications Network (MEECN) | In FY 2003, Project 4610, Minuteman MEECN Program (MMP), was renamed (formerly MEECN EHF). This action did not change program content. |
| 0303141F | Global Combat Support System (GCSS) | In FY 2003, Project 4655, Integrated Logistics System - Supply (ILS-S), efforts were transferred to PE 0708611, Support Systems Development, Project 5044, Log Application Integrated Logistics System - Supply (LAILS-S) in order to align functional application development efforts into separate functional PE's.<br><br>In FY 2003, 4904, Logistics Integration efforts transferred to PE 0708611F, Support Systems Development (SSD), Project 5042, Log Application Logistics Integration (LALI), in order to align functional application development efforts into separate functional PE's.<br><br>In FY 2003, Project 4905, GCSS-AF Architectural Development, efforts were transferred to Project 5046, System Engineering and Integration (SE&I), in order to provide logical program grouping and allow for more effective oversight of this project.<br><br>In FY 2003, Project 5046, SE&I, efforts were transferred from Project 4905, GCSS-AF Architectural Development.<br><br>In FY 2003, Project 4906, GCSS-AF Domain Integration, efforts were transferred to Project Number 5046, System Engineering and Integration (SE&I), in order to provide logical program grouping and allow for more effective oversight of this project. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| | In FY 2003, Project 5046, SE&I, efforts were transferred from Project 4906, GCSS-AF Domain Integration. |
| | In FY 2003, Project 4907, Financial Information Resource System (FIRST), efforts were transferred to PE 0901538F, FIRST, Project 5036, FIRST. |
| 0303601F MILSATCOM Terminals | In FY 2003, Project 2487, Milsatcom Terminals, includes new start efforts. |
| 0305148F Air Force Tactical Measurement & Signatures | In FY 2003, this is a new PE. |
| | In FY 2003, Project 5053, Air Force Tactical Measurement & Signatures, includes new start efforts. |
| 0305182F Spacelift Range System | In FY 2003, Project 4137, Range Standardization and Automation (RSA), was renamed Launch and Test Range System (LTRS) Modernization, to better depict on-going efforts. |
| 0305205F Endurance Unmanned Aerial Vehicles | In FY 2003, Project 4883, JTC/SIL MUSE, efforts were transferred from PE 0308601F, Modeling and Simulation Support, Project 5052, JTC/SIL MUSE, in order to comply with 1999 PBD 220. |
| 0305207F Manned Reconnaissance System | In FY 2003, Project 4754, Cobra Ball, includes new start efforts. |
| 0308601F Modeling and Simulation Support | In FY 2003, Project 5052, JTC/SIL MUSE, were efforts transferred from PE 0305205F, Endurance Unmanned Aerial Vehicles, Project 4883, JTC/SIL MUSE in order to comply with 1999 PBD 220. |
| 0401130F C-17 Aircraft Squadrons | In FY 2003, Project 2569, C-17, includes new start efforts. |
| 0401839F Airlift/Other Tactical Data Link | In FY 2003, this is a new PE. |
| 0708012F Logistic Support Activities | In FY 2003, Project 5054, Core Automated Maintenance System (CAMS) Modernization, efforts were transferred from PE 0708611F, Support Systems Development, Project 4654, Integrated Maintenance Data System (IMDS), in order to modernize the CAMS system to a level where it can be converted to IMDS. |

| PROGRAM ELEMENT (by BUDGET ACTIVITY) | REMARKS |
|---|---|
| 0708611F Support Systems Development | In FY 2003, Project 4654, Integrated Maintenance Data Systems, efforts transferred to PE 0708012F, Logistics Support Activities, Project 5054, CAMS, in order to provide funding to modernize the project.<br><br>In FY 2003, Project 5042, Log Application Logistics Integration (LALI), efforts were transferred from PE 0303141F, Global Command Support System (GCSS), 4904, Logistics Integration in order to align functional application development efforts into separate functional PE's.<br><br>In FY 2003, Project 5044, Log Application Integrated Logistics System - Supply (LAILS-S), efforts were transferred from PE 0303141F, Global Combat Support System (GCSS), 4655, Integrated Logistics System-Supply (ILS-S), in order to align functional application development efforts into separate functional PE's.<br><br>In FY 2003, Project 5042, Log Application Logistics Integration (LALI), efforts transferred to PE 0303141F, Global Combat Support System, Project 4904, Logistics Integration , in order to align functional application development efforts into separate functional PE's. |
| 0905138F Financial Information Resources System (FIRST) | In FY 2003, this is a new PE.<br><br>In FY 2003, project 5036, Financial Information Resource System (FIRST), efforts were transferred from PE 0303141F, GCSS-AF, project 4907, Financial Information Resource System (FIRST), in order to provide logical program grouping and allow for more effective oversight of this project. |

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 206,638 | 226,322 | 219,144 | 228,597 | 232,642 | 236,796 | 241,347 | Continuing | TBD |
| 2301 | Physics | 24,704 | 24,084 | 22,801 | 23,368 | 24,287 | 24,783 | 25,285 | Continuing | TBD |
| 2302 | Solid Mechanics and Structures | 11,114 | 11,439 | 11,881 | 12,049 | 11,987 | 12,222 | 12,464 | Continuing | TBD |
| 2303 | Chemistry | 25,852 | 28,806 | 29,578 | 29,904 | 31,023 | 31,621 | 32,218 | Continuing | TBD |
| 2304 | Mathematical and Computer Sciences | 32,061 | 35,079 | 33,169 | 34,879 | 34,576 | 35,253 | 35,923 | Continuing | TBD |
| 2305 | Electronics | 23,444 | 27,498 | 24,565 | 26,494 | 26,305 | 26,803 | 27,300 | Continuing | TBD |
| 2306 | Materials | 13,621 | 16,355 | 15,004 | 17,574 | 18,464 | 18,791 | 19,122 | Continuing | TBD |
| 2307 | Fluid Mechanics | 9,395 | 9,954 | 10,599 | 11,274 | 12,147 | 12,383 | 12,630 | Continuing | TBD |
| 2308 | Propulsion | 20,937 | 23,104 | 21,190 | 21,635 | 22,102 | 22,505 | 22,914 | Continuing | TBD |
| 2311 | Space Sciences | 14,408 | 16,690 | 15,531 | 16,066 | 16,605 | 16,938 | 17,279 | Continuing | TBD |
| 2312 | Biological Sciences | 13,114 | 13,844 | 14,383 | 14,730 | 15,025 | 15,324 | 15,629 | Continuing | TBD |
| 2313 | Human Performance | 13,747 | 12,885 | 13,044 | 13,113 | 12,471 | 12,706 | 12,965 | Continuing | TBD |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4113 | External Research Programs Interface | 4,241 | 6,584 | 7,399 | 7,511 | 7,650 | 7,467 | 7,618 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

**(U) A. Mission Description**

The Defense Research Sciences program comprises extramural research activities in academia and industry and in-house investigations performed 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 2002, Congress added $2.0 million for the Center for Adaptive Optics, $2.5 million for Coal-Derived Jet Fuel, $1.3 million for Focused Ion Beam Systems, $1.0 million for the California Science Center, and $0.75 million for the Center for Solar Geophysical Interactions.

**(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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 212,688 | 220,869 | 213,788 | |
| (U) | Appropriated Value | 213,649 | 228,419 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -2,097 | | |
| | b. Small Business Innovative Research | -5,050 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -1,961 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 5,356 | |
| (U) | Current Budget Submit/FY 2003 PBR | 206,638 | 226,322 | 219,144 | TBD |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>01 - Basic Research | PE NUMBER AND TITLE<br>0601102F Defense Research Sciences |

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

(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 $4.2M reflects zero percent real growth.

D. Execution - Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2301

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2301 Physics | 24,704 | 24,084 | 22,801 | 23,368 | 24,287 | 24,783 | 25,285 | Continuing | TBD |

**(U) A. Mission Description**

Physics research aims to revolutionize advances in laser technologies, sensors and imaging, miniature satellites, and communications. It expands fundamental knowledge of optics, electromagnetics, as well as microwaves and plasmas. The goals are to enable and enhance technologies critical to Air Force lasers, optics, avionics, and microwaves and to improve technologies associated with non-intrusive / non-destructive testing and analysis. Research topics focus on revolutionary improvements in electromagnetic countermeasures, protection against nuclear weapons effects, communications, small satellites, and novel sensors. The primary areas of research investigated by this project are laser and optical physics; atomic, molecular, and imaging physics; and plasma physics.

(U) FY 2001 ($ in Thousands)

(U) $9,662 Performed laser and optical physics research for new technologies associated with laser devices and controls towards enabling spoofing and fatal damage of infrared-seeking missiles, high performance radars, and new directed energy weapons. Continued to investigate semiconductor and solid state lasers and laser arrays through experiments and system modeling to advance laser technology. Investigated a new high-power laser to replace oxygen-iodine for next generation airborne lasers. Examined pico-second and femto-second (extremely fast) lasers for generation and control of millimeter waves and wideband optical modulation to enhance high-performance radars. Expanded studies of micro-electro-mechanical systems (MEMS) and laser photochemical processes to enable specialized devices for micro-satellite applications.

(U) $7,450 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. Explored physics issues relating to plasma processing of materials at atmospheric pressures to contribute to higher frequency, more efficient, high power microwave systems. 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. Investigated the feasibility of using collisional ionized gas volumes to protect friendly assets from directed energy.

(U) $4,175 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, precision navigation, and the neutralization of biological threats. Investigated the trapping and cooling of atoms and ions to enrich high-resolution spectroscopy. Characterized interactions of atoms in strong fields to discover novel lasers for Air Force applications. Continued to examine isomeric, very high density energy storage for flash radiation devices and to make long flight missions possible without refueling.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

| | | |
|---|---|---|
| (U) | $3,417 | Studied the performance of the new 30-meter infrared adaptive optical telescope at the Center for Astronomical Active Optics. Continued research on adaptive optics to enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers. |
| (U) | $24,704 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $9,936 | 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. |
| (U) | $7,748 | 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) | $4,419 | 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) | $1,981 | Continue to enhance the research performance of the new 30-meter infrared adaptive optical telescope at the Center for Astronomical Active Optics. Continue research studies on adaptive optics to enable adaptive telescopes for laser beam projection into space, space reconnaissance, space power collectors, and space-based lasers. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2301 |

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

(U) FY 2002 ($ in Thousands) Continued

(U) $24,084 Total

(U) FY 2003 ($ in Thousands)

(U) $10,261 Conduct laser and optical physics research to study the effect of combining high power solid state lasers with integrated nonlinear and pulse forming optics. Study concepts to achieve high output powers at wavelengths required for space applications. Continue studies of large aperture adaptive telescopes for very high resolution deep space imaging. Explore large, light-weight adaptive optics for space surveillance and high energy laser relay applications. Study laser micro-machining techniques for producing specialized space micro-systems for multi-functional micro- and nano-satellites.

(U) $7,981 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 and surveillance. Explore physics topics relating to the dynamic molecular interactions in combustion and high energy density propellants. Examine the detailed physics of material, surface, and air breakdown in the presence of strong electric fields. These fundamental findings will facilitate creation of more compact, lighter weight, portable pulsed power systems to power future directed-energy weapons systems.

(U) $4,559 Study atomic, molecular, and imaging physics to evaluate the interaction of atoms, molecules, and ions to provide basic information to improve explosives and fuels, enhanced space surveillance, superior communications, precision navigation, and the neutralization of biological threats. Investigate fundamental interplay between atoms and strong electromagnetic fields to create new classes of lasers for Air Force applications. Develop isomeric, high energy density storage for flash radiation devices to diminish or eliminate refueling requirements on long endurance flights. Continue basic research of holographic films for correction of distortion and aberration in space surveillance telescopes. Measure UV emission cross sections from electron impact to provide fundamental data needed in satellite surveillance.

(U) $22,801 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2301 |

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

(U) PE 0602605F, Directed Energy Technology.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2302

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2302 | Solid Mechanics and Structures | 11,114 | 11,439 | 11,881 | 12,049 | 11,987 | 12,222 | 12,464 | Continuing | TBD |

**(U) A. Mission Description**

Solid Mechanics and Structures basic research aims to dramatically improve the behavior of aerospace materials and structures via better description of wear and damage dynamics. It expands fundamental knowledge of the aeroelastic and acoustic behavior of airframes and engine structures as well as the fluid behavior of launch vehicles and space structures. The goals are cost-effective development and safe, reliable operation of superior Air Force weapons and defensive systems. Research topics include: the design of advanced material structures on the micro- and nano-scale; modeling and simulation of the dynamic behavior of aircraft, missiles, and large space structures; and technology integration for the performance and survivability enhancement of these systems. The primary areas of research investigated by this project are mechanics of composite materials, structural mechanics, and structural dynamics.

(U) FY 2001 ($ in Thousands)

(U) $2,332 Studied 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. Continued 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. Continued 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) $7,157 Conducted 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 improve the design and performance prediction of aerospace systems. Identified fundamental structural design characteristics underpinning the life cycle of airframe structures. Developed techniques to analyze vehicle integrity and significantly increase the structural longevity of Air Force weapons.

(U) $1,625 Performed 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. Devised fundamental mechanics principles and life-span prediction methodologies to significantly enhance design and life cycle management methodologies of Air Force weapon systems. Investigated 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) $11,114 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2302 | |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,401 | 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) | $4,970 | 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) | $4,068 | 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. 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) | $11,439 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,495 | Research mechanics of advanced materials to accelerate their use as composites, high-temperature alloys, and ceramic matrix composites. Results will have direct application in aerospace vehicles, turbine engines, space systems, and weapons systems. Develop methods to synergistically combine multiscale modeling and information technology to design new materials and structures. Establish foundations of nanomechanics which transitions between continuum mechanics and atomistic modeling. Apply multifunctional mechanics with nonlinear behavior to design multifunctional materials and structures used in advanced aerospace systems such as micro-satellites and micro-vehicles. |
| (U) | $5,109 | Conduct research into the structural and material aspects of high-cycle metal fatigue and other aging mechanisms of aircraft. Develop fundamental computer simulations to predict structural response to assorted stimuli. Explore metal fatigue-generation caused by vibration of compressor and turbine blades and blade motion/fluid flow coupling. Study material science to quickly and inexpensively identify and mitigate |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2302 |

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

(U) FY 2003 ($ in Thousands) Continued

material degeneration and degredation. Develop novel system techniques to analyze vehicle integrity to significantly increase the robustness of Air Force weapon systems.

(U) $4,277 Conduct structural mechanics research to examine innovative adaptive structure concepts for deployment of space-based systems and multi-mission unmanned aerial vehicles (UAV). Investigate the behavior of distributed sensor and actuator systems to improve the design and performance characterization of aerospace systems. Develop models to predict the interaction between structural motion and high-speed aerodynamics characteristic of UAVs. Exploit the mechanical and dynamic behavior of micro- and nano-scale structures to achieve exceptional capabilities in micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems.

(U) $11,881 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: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2303

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2303 Chemistry | 25,852 | 28,806 | 29,578 | 29,904 | 31,023 | 31,621 | 32,218 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $11,434 Performed molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow, and developed predictive tools for designing new materials and processes for advanced propellants and high-energy lasers. Evaluated methods for predicting molecular-level energy transfer and chemical reactivity to simulate signatures and interactions of aerospace vehicles in extreme environments. Examined the use of molecular nano-clusters for use as catalysts and sensors. Developed new high energy density materials for rocket propellants and novel chemical laser systems.

(U) $8,686 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. Improved spectral sensitivity of photo refractive polymers for crucial infrared applications. Investigated polymer coatings to enable smart skins and advanced sensors for air and space weapon systems. Evaluated the stability of functional polymers in space environments to enhance survivability of vehicles exposed to space radiation. Continued to seek fundamental knowledge to formulate materials that have optical transitions suitable for highly efficient optical limiting properties.

(U) $5,732 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 for formulation of novel lubricants. Continued investigation of surface chemical processes and structures to enhance performance, reduce maintenance, and increase the longevity of air and space systems. Developed predictive and experimental models for

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

molecular lubrication in high-temperature, high-wear environments. Explored the reactions and mechanisms for protection of aluminum aircraft from corrosion. Examined surface structures with enhanced energy-densities for significantly improved weapon system energy storage and delivery.

(U) $25,852 Total

(U) FY 2002 ($ in Thousands)

(U) $11,801 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) $9,120 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 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) $5,903 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) $1,982 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2303 |

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

(U) FY 2002 ($ in Thousands) Continued

scramjets and combined-cycle engines for space applications.

(U) $28,806 Total

(U) FY 2003 ($ in Thousands)

(U) $12,135 Conduct molecular dynamics and theoretical chemistry research to identify and predict techniques to control molecular reactivity and energy flow. Results will enable development of next generation predictive tools for designing new materials and processes for advanced, super energetic propellants and high-energy lasers. Explore uses of ion and plasma chemistry for flow control applications. Model interactions between aerospace systems and the space environment. Investigate concepts of reactive energetic nano-structures for applications to propulsion and munitions. Develop and validate theoretical methods to predict and design behavior and properties of nano-structures. Model chemically reacting flows associated with hypersonic vehicles. Research new chemical sources of electronic excited states needed to fuel chemical laser systems.

(U) $9,377 Conduct polymer chemistry research to improve fundamental understanding of chemical structures, reactivity, and processing conditions to develop advanced polymeric materials. Research findings aimed at significantly improving Air Force systems performance and life-spans. Explore magnetic, conductive, and optical properties of coating materials to achieve smart skin concepts with on-demand tunable properties. Investigate biologically inspired polymer concepts to achieve previously unattainable material properties and complex supramolecular structures. Explore molecular conformational changes to achieve controllable mechanical actuation in polymeric materials.

(U) $6,066 Investigate the chemistry of surface and interfacial processes for accurate detection and prevention of corrosion and degradation of air and space systems. Explore physical properties of novel lubricants. Create new low-friction long-life coatings and surface structures for terrestrial and space environments. Research novel three-dimensional surface nano-structures for sensor, optical, and power applications. Probe nano-scale surface structures with enhanced energy-densities for better weapon system energy storage and delivery. Develop theoretical and predictive methods for surface and interfacial chemical processes.

(U) $2,000 Research novel chemical synthesis and detection techniques, chemical theory, and modeling and simulation focused on revolutionary breakthroughs in new fuels and rocket propellants that are more energetic, are environmentally benign, have reduced signatures, and are less sensitive to accidental detonations. Identify and investigate applications of these potential fuels in flight vehicles so as to enhance 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) $29,578 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2303 | |

**(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**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2304

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2304 | Mathematical and Computer Sciences | 32,061 | 35,079 | 33,169 | 34,879 | 34,576 | 35,253 | 35,923 | Continuing | TBD |

**(U) A. Mission Description**

Mathematical and computer sciences research develops novel techniques for mathematical modeling and simulation, algorithm development, complex systems control, and innovative analytical and high performance computing methods for aerospace systems. Basic research provides fundamental knowledge enabling improved performance and control of aerospace systems through accurate models and computational tools, artificial intelligence, and improved programming techniques and theories. The primary areas of research investigated by this project are dynamics and control, physical mathematics and applied analysis, computational mathematics, optimization and discrete mathematics, signals communication and surveillance, as well as complex systems and software.

(U) FY 2001 ($ in Thousands)

(U) $6,603 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 engine performance. Continued creating control algorithms for optical components to handle extreme atmospheric turbulence encountered in target acquisition by deployable laser platforms. Expanded active and adaptive control algorithms to enable autonomous air, space, and ground operations.

(U) $6,576 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. Continued automatic large knowledge base construction from multiple, variant sources and automatic knowledge acquisition to enhance Air Force intelligence operations. Refined distributed, automatic resource management approaches for advanced methods of mobile agent resource allocation and protection.

(U) $6,461 Conducted physical mathematics, applied analysis, and electromagnetics research to devise accurate models of physical phenomena to enhance controls and signal processing techniques. Investigated the feasibility of coherently propagating short laser pulses through the air for superior accuracy in laser-guided munitions. Predicted nonlinear optical effects within semiconductor lasers and through other nonlinear optical media for applications in laser beam control and stability. Formulated optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Devised methods to penetrate tree cover and recognize targets.

(U) $4,675 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 and formulated real-time problem solving strategies to support dynamic planning and execution.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2304 | |

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

(U) FY 2001 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $3,493 | Performed computational mathematics research to devise unique simulations and designs of advanced Air Force systems. Continued integrating new multidisciplinary design optimization strategies with high-order, time-accurate solvers for superior design of jet engines, aircraft wings, and other aerospace components. Devised methods to reduce computation time for chemical laser simulations from months to days. Investigated failure modes of bonded composite materials by inserting novel computational methods into mission support software tools. |
| (U) | $2,609 | Studied 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. Investigated irreducible expansions of signals, soft thresholding, and efficient source-channel coding in wireless communication to achieve major improvements in cost versus performance trade-offs. Expanded probabilistic process theory, functional analysis techniques, and information theory to eliminate current limits of sensing and communication system performance. |
| (U) | $1,644 | Researched 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. Devised accurate flow solvers for optimal design of aircraft wings and novel aerospace components. Refined plasma-aerodynamic optimization techniques to enable design of superior aerospace vehicles. |
| (U) | $32,061 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $6,950 | 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) | $6,950 | 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 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) | $6,618 | Conduct physical mathematics/applied analysis and electromagnetics research to devise accurate models of physical phenomena to enhance |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

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) $4,634 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) $3,640 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) $2,649 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) $1,982 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) $1,656 Explore mathematical and computational methods of external aerodynamics associated with hypersonic weapon release. Expand plasma 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

vehicles.

(U) $35,079 Total

(U) FY 2003 ($ in Thousands)

(U) $7,131 Perform dynamics and control research to develop new techniques for design and analysis of control systems. Research findings will significantly enhance capabilities and performance of aerospace vehicles. Focus of the research is on cooperative control in dynamic, uncertain, adversarial environments with applications to swarms of smart munitions, unmanned aerial vehicles (UAVs), and constellations of small satellites. Explore means to improve control of nonequilibrium behavior of complex, unsteady fluid systems (chemically reacting flows) with applications to combustion and materials processing. Foster advances in image processing and sensor technology that can be utilized in controller design for UAVs, smart munitions, nondestructive testing of aging or stealth aerospace vehicles. Design computational models to analyze biological processes for adaptation to aerospace systems.

(U) $7,131 Conduct research in complex systems and software, artificial intelligence, automatic knowledge acquisition, and high performance knowledge bases to allow rigorous construction of highly complex battlefield information systems. Explore methods to enhance research in information operations, including support for language-based security, mobile code security, protected execution, and dynamic, adaptive intrusion detection for protection of future battlespace/infosphere systems and networks. Develop new computational techniques/software in extremely large (10,000,000+ axioms) knowledge bases to provide deep, adaptive, expert decision support to battlefield commanders.

(U) $6,799 Conduct research in physical mathematics and applied analysis and in electromagnetics to develop accurate models of physical phenomena to enhance the fidelity of simulations and predictability of devices. Investigate the properties of coherently propagating short laser pulses through the air in relationship to the superior accuracy of laser guided munitions and electronic warfare. Develop algorithms to simulate nonlinear optical effects within semiconductor lasers and nonlinear optical media. Formulate optimal electromagnetic wave propagation/scattering codes to provide accurate and timely target recognition. Evaluate methods to penetrate tree cover with wide band radar to recognize and track targets. Study feasibility of designing reconfigurable warheads by suitable placement/time of microdetonators. Pursue description of dynamics of internal stores released from transonic platforms.

(U) $4,809 Conduct research in optimization and discrete mathematics to validate and further advance mathematical methods for solving complex problems in logistics, engineering design, and strategic/tactical planning for battlespace information management. Evaluate 'anytime' algorithms -- those that produce a feasible, but not necessarily optimal, solution. Examine new modeling techniques and computer algorithms for various urgent Air Force problems such as target tracking, mobilization planning, and manufacturing.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2304 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $4,478 | Perform computational mathematics research to create unique simulations and designs of advanced Air Force systems. Devise means to integrate new multidisciplinary design optimization strategies with high-order, time-accurate solvers in order to design superior jet engines, aircraft wings, munitions, and other aerospace components. Develop new algorithms for unsteady reactive flow, munition penetration and fragmentation, and plasmadynamics for directed energy weapons. Develop quantum computing algorithms, architectures, and implementations to enable exponential improvements in speed, accuracy, and fidelity of fluid dynamics simulations, signal processing, and data mining. |
| (U) | $2,821 | Investigate signals communication and surveillance to expand the capability of critical mobile, networked communications, and surveillance/reconnaissance and targeting systems through examination of fundamental principles governing signal analysis. Areas of study include linear operator theory, generalized functions and probability, harmonic methods, and asymptotic expansions. Explore source-channel encoding methods for robust wireless communication using optical transmission phenomenology. Develop a rigorous basis for and delineate the domain of applicability of self learning, trial and error (heuristic) methods such as super-resolution imaging. Research technologies with higher information rates and higher reliability of communications. |
| (U) | $33,169 | 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: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences | PROJECT: 2305 |

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2305 Electronics | 23,444 | 27,498 | 24,565 | 26,494 | 26,305 | 26,803 | 27,300 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $7,658 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) $7,572 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) $4,457 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) $3,757 Performed quantum electronic solids research to investigate superconducting, magnetic, and nanoscopic materials and devices for advanced sensing communications, 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2305 |

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

(U) FY 2001 ($ in Thousands) Continued

approaches to measure active corrosion in aircraft structures to extend performance lifespan.

(U) $23,444 Total

(U) FY 2002 ($ in Thousands)

(U) $7,991 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) $7,762 Conduct optoelectronic materials research for detection and emission of optical radiation from far infrared to the ultraviolet spectral range to 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) $4,602 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) $3,875 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) $1,981 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

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) $1,287 Establish focused ion beam research associated with system optimization and characterization. Investigate properties for establishing and regulating the narrowest beam diameter at relatively high energy. Investigate the effects and benefits derived from a wide range of isotopes provided by various liquid metal ion sources. In addition research means to enable advancing computing, sensing, and image processing associated with ion beam research.

(U) $27,498 Total

(U) FY 2003 ($ in Thousands)

(U) $8,883 Conduct research on military space platform unique electronic circuits aimed at greatly reducing component size and weight while increasing reliability. Expand study of intense radio frequency pulse effects on electronic circuits and systems. Design, fabricate, and evaluate wide bandgap semiconductor materials to achieve an unique combination of high radio frequency power output, high efficiency, low noise, robustness, and radiation hardness. Devise nano-satellite electronic device concepts and initiate efforts to identify electronic approaches to increasing spacecraft survivability. Conduct research on the interaction of systems and sensors with the space environment. Develop models to predict the effects of terrestrial and space backgrounds and radiation on sensor performance in order to promote secure, wide bandwidth communication through the atmosphere and ionosphere as well as between satellites.

(U) $7,861 Conduct optoelectronic materials research for detection and emission of optical radiation from the far infrared to ultraviolet spectral range to achieve spectral dominance of the battlespace. Investigate unique non-linear optical materials to protect critical optical systems from laser radiation. Assess basic electronic mechanisms to improve the efficiency and reduce the cooling requirements of lasers and detectors. Synthesize laser materials to degrade or blind an adversary's detection and tracking capabilities. Create fast multiband detectors for characterization of the battlespace, surveillance, target tracking, and target signatures. Develop nano-fabrication technology for unique optoelectronic material properties.

(U) $2,334 Conduct research in optoelectronic information processing to explore the design, development, and application of novel optoelectronic materials and devices to enhance critical communication system accuracy and speed. Examine complex semiconductor structures and develop optical materials for use in high bandwidth, multi-wavelength modulators and detectors for secure satellite imaging and faster data transfer rate communication systems. Explore optoelectronic nanotechnologies: nanophotonics, nanoelectronics, and nanosensors and opportunities in terahertz technologies.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2305 | |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $3,930 | Perform quantum electronic solids research to investigate superconducting, magnetic and nanoscopic materials for advanced sensing, communications, and signal processing. Investigate superconducting quantum systems for adaptation to quantum computing and encryption. Develop high-current, high-temperature superconducting cables and tapes for enhanced power generation and storage on Air Force directed energy weapons and space platforms. Develop new high-temperature magnetic materials with sufficient mechanical strength for use in aircraft with higher electric workloads. |
| (U) | $1,557 | Perform research in optoelectronic memory technologies and persistent spectral hole-burning systems for data storage and processing. Develop page-oriented or holographic memory configurations in two or three dimensions. Explore capabilities to buffer, store, and retrieve data at rates and quantities anticipated for multispectral devices. Develop new technogies to increase capabilities in high speed image capture, data storage and processing for surveillance, target discrimination, and autonomous navigation. |
| (U) | $24,565 | 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.

(U) PE 0603789F, C3I Advanced Development.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2306

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2306 Materials | 13,621 | 16,355 | 15,004 | 17,574 | 18,464 | 18,791 | 19,122 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $4,429 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. Sought fundamental knowledge to formulate ultra-high temperature materials systems based on carbides for rocket propulsion applications.

(U) $7,211 Conducted metallic materials research to evaluate novel metallic systems for propulsion and airframe applications. Explored thermal and mechanical stability of refractory metal systems for very-high temperature aircraft applications. Evaluated tailorable transition-phase materials for superior thermal barrier coatings.

(U) $1,981 Studied organic matrix composites to expand knowledge of polymer matrix composites and increase the strength and life-span of air and space vehicle structures. Explored thermal cycling effects of polymer matrix composites down to cryogenic temperature range to better understand durability issues in liquid fuel tank environments. Investigated innovative fiber sizing techniques to minimize moisture degradation of mechanical and electromagnetic properties in glass fiber reinforced composite structures.

(U) $13,621 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2306 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,743 | 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) | $7,473 | 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) | $2,157 | 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) | $1,982 | 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) | $16,355 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,952 | Perform ceramic and non-metallic materials research to design new materials and composites for very-high temperature, hostile environment air and space applications. Optimize thermal and mechanical stability of very-high temperature oxide composites and eutectics for aircraft and jet engine blade applications. Develop concepts for the application of advanced fundamental knowledge to create ultra-high temperature materials systems based on carbides for rocket propulsion applications. Design and optimize multifunctional ceramic materials to enable structurally enhanced fuell cells, sensors, and actuators. |
| (U) | $7,802 | Conduct metallic materials research to develop affordable and durable metallic systems for advanced engines and aerospace structural applications. Investigations focus on mechanical and thermal stability of composites, metal refractory alloys, and intermetallics for very-high temperature aircraft applications. Develop functionally gradient structures for superior thermal barrier coatings. Create advanced metals for |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2306 |

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

(U) FY 2003 ($ in Thousands) Continued

multifunctional space systems.

(U) $2,250 Perform organic matrix composites research to advance polymer matrix composites knowledge to increase the strength and life-span of aerospace structural materials. Analyze effects of cyclic thermal loads on polymer matrix composites down to cryogenic temperatures to increase durability in liquid fuel tank materials. Develop new fiber sizing techniques in glass fiber reinforced structures to minimize degradation of mechanical and electromagnetic properties due to moisture.

(U) $15,004 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0603211F, Aerospace Structures.
(U) PE 0708011F, Industrial Preparedness.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602601F, Space Technology.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2307

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2307 Fluid Mechanics | 9,395 | 9,954 | 10,599 | 11,274 | 12,147 | 12,383 | 12,630 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $2,349 Performed 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. Continued to devise design tools for flow control to minimize flow separation and air vehicle drag. Continued to develop fluid/structural interaction design tools to predict vehicle failure modes in rapid maneuvers.

(U) $2,818 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. Advanced concepts for hypersonic flow control, including plasma and magneto-hydrodynamic techniques. Developed high-speed flow prediction codes to quantify thermal stresses.

(U) $2,350 Sought fundamental knowledge of turbulence and flow control to enhance the performance, controllability, and stability in air vehicles. Evaluated novel micro-electro-mechanical systems (MEMS), actuators, and investigate 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 with a goal of substantial drag reduction.

(U) $1,878 Studied rotating flows to evaluate internal flow characteristics for enhancing the performance and reliability/maintainability of airbreathing propulsion systems. Evaluated 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) $9,395 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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)

(U) $2,490 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) $2,987 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) $2,487 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 with significantly reduced power requirements.

(U) $1,990 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) $9,954 Total

(U) FY 2003 ($ in Thousands)

(U) $2,649 Perform unsteady aerodynamics research to provide fundamental knowledge of high-speed air flows to optimize current Air Force air vehicle designs and enable revolutionary future weapon systems. Investigate unsteady, complex, three-dimensional flows to refine the control and flight performance of unmanned air vehicles. Investigate rapid maneuver unmanned air vehicle aerodynamics. Investigate highly separated flow situations occurring in complex air vehicle and weapon systems.

(U) $3,181 Investigate complex phenomena in hypersonic flows to enable the design of future Air Force trans-atmospheric vehicles and flight control systems. Complete development of hypersonic flow control concepts, including plasma and magneto-hydrodynamic techniques. Develop high-speed flow prediction codes to quantify thermal stresses and design mitigation techniques for hypersonic flight vehicles.

(U) $2,649 Explore fundamental knowledge of turbulence in coordinated experimental and computational simulation efforts. Investigate new areas and

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2307 | |

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

(U) FY 2003 ($ in Thousands) Continued

methods of flow control on aircraft wings and jet engines to enhance the performance, controllability, and stability in air vehicles. Develop reduced order models for turbulent flow control applications and affordable engineering predictive models for the air vehicle design process. Assess quality of promising flow control actuation concepts on realistic geometries. Continue investigating flow control coupling mechanisms in turbulent flows to enable agile flight vehicles.

(U) $2,120 Study complex rotating flow phenomena as they relate to turbomachinery and jet engine applications. Evaluate unsteady flow phenomena and develop understanding of forcing modes in turbomachinery to predict and avoid high cycle and thermal failures in jet engines. Investigate application of Large Eddy Simulation techniques to explore complex gas turbine engine flow fields and heat transfer effects. Evaluate flow control measurement and actuation devices for use in harsh environments such as turbine engines.

(U) $10,599 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: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2308

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2308 Propulsion | 20,937 | 23,104 | 21,190 | 21,635 | 22,102 | 22,505 | 22,914 | Continuing | TBD |

**(U) A. Mission Description**

Propulsion research seeks fundamental knowledge to enable and enhance efficient utilization of energy in airbreathing engines, chemical and non-chemical rockets, and combined cycle propulsion systems for access to space. Basic research thrusts include airbreathing propulsion, space power and propulsion, high altitude signature characterization and contamination, propulsion diagnostics, and thermal management of space-based power and propulsion systems. Two key basic research areas include reacting flows and non-chemical energetics. Study of chemically reacting flows involves the complex coupling between energy release through chemical reaction and the flow processes that transport chemical reactants, products, and energy. Study of non-chemical energetic systems include plasma and beamed energy propulsion for orbit raising space missions and efficient ultra-high energy techniques for space-based energy utilization. Primary areas of research investigated by this project are space power, propulsion, combustion, and diagnostics.

(U) FY 2001 ($ in Thousands)

(U) $7,048 Performed space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Increased thrust and control of micro-satellite and nano-satellite propulsion systems to enable high-precision clusters of cooperating autonomous micro-satellites. Examined self-consuming satellites and mechanical-electric energy conversion to increase payload and thrust capabilities. Continued 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. Studied experimental and numerical characteristics of high-altitude ultraviolet and infrared signatures and satellite contamination to develop techniques to protect space assets.

(U) $6,577 Studied combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Enhanced computer models to increase efficiency by predicting unsteady behavior such as combustion instability. Examined primary and secondary atomization and mixing of fuels to optimize fuel injection to increase thrust output.

(U) $4,384 Investigated advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Obtained essential data through multiplexed diode-laser spectroscopy that enabled simultaneous detection of temperature and pressure within chemical propulsion systems to increase their thrust and efficiency.

(U) $2,928 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. Produced small quantities (50 gallons) of coal-derived fuel for large-scale combustion, fuel system fouling, and ignition experiments.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 2308 |

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

(U) FY 2001 ($ in Thousands) Continued

(U) $20,937 Total

(U) FY 2002 ($ in Thousands)

(U) $7,263 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 micro-satellite constellations. Develop novel space diagnostic techniques and 100 gram class sensors for accurate measurements on micro- and nano-satellites.

(U) $6,915 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.

(U) $4,470 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) $1,980 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) $2,476 Continue researching coal-derived jet fuels 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. Investigate potential for coal-derived fuel production scale-up.

(U) $23,104 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2308 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $7,484 | Explore space power and propulsion research to investigate novel propulsion mechanisms to enable superior satellite propulsion performance. Study means to improve thrust and control of propulsion systems to develop high-precision constellations of cooperating micro-satellites. Expand understanding of mechanical-electric energy conversion to increase payload and thrust. Study feasibility of excess silicon as a space propellant in developing concepts for self-consuming satellites. Continue researching new engine concepts such as pulsed detonation engines, hybrid rockets, and combined cycle engines. Create advanced supercritical combustion models and leverage computational capability to enhance the design of new engines. Research plasma turbulence and its effect on the transport coefficients to develop a new class of more versatile plasma thrusters. |
| (U) | $7,100 | Study combustion to evaluate airbreathing propulsion systems for hypersonic, supersonic, and subsonic flight to enhance air warfare capabilities. Develop enhanced computer models that predict unsteady behavior, such as combustion instability, to increase combustion efficiency and reduce fuel consumption. Advance the state of Large Eddy Simulation methods for turbulent combustion by incorporating upgraded subgrid-scale models for chemistry and fuel droplets. |
| (U) | $4,606 | Investigate advanced diagnostics systems for data reduction and interpretation to create concepts for novel propulsion system applications. Study laser-induced fluorescence and absorption spectroscopic measurements in relation to infrared and ultraviolet excitation wavelength regimes. |
| (U) | $2,000 | Study methods for enabling and improving aerodynamics for next generation aerospace vehicles for long range strike. Further expand research studies 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%. Demonstrate plasma control effects and evaluate means 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) | $21,190 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2308 | |

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Space Technology.

(U) PE 0603211F, Aerospace Structures.

(U) PE 0602269F, Hypersonic Technology Program.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2311

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2311 Space Sciences | 14,408 | 16,690 | 15,531 | 16,066 | 16,605 | 16,938 | 17,279 | Continuing | TBD |

**(U) A. Mission Description**

Space Sciences research provides fundamental understanding of the space environment for optimum design of Air Force systems operating in near-Earth orbit, geosynchronous orbit, and deep space. The goal is to enable greater, more cost-affordable, protection of space assets from space debris, solar wind, solar flares, cosmic rays, and geomagnetic storms. Basic research focuses 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. In order to enhance the effectiveness of Air Force global dominance through space operations, methods are developed to forecast the turbulent plasma phenomena that mediate the flow of energy through space. The primary areas of research investigated by this project are solar physics and astrophysical observation techniques, solar wind transport and magnetospheric physics, ionospheric physics and scintillation, and energization processes in the Earth's radiation belts.

(U) FY 2001 ($ in Thousands)

(U) $5,762 Continued 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. Discovered the physics of solar plasma arcades, solar flares, and coronal mass ejections to establish the physical basis for solar disturbance models. Continued investigating sunspots, solar oscillation modes, and solar magnetic fields to enable forecasting of solar eruptions and predict risk to critical Air Force space operations.

(U) $4,322 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. Integrated solar magnetic field and coronal data to discover the science underpinning solar ejection paths and devised accurate modeling techniques. Evaluated effects of the solar wind, the interplanetary magnetic field, and the Earth’s magnetosphere to enhance space weather specification and forecast models.

(U) $4,324 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 and magnetohydrodynamic fluid flow for formulation of an accurate geomagnetic substorm onset model to calculate radiation effect longevity in the Earth’s satellite environment. Related fundamentals of turbulence and ionospheric scintillation to enhance design and operation of surveillance, geolocation, and communication satellites.

(U) $14,408 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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)

| | | |
|---|---|---|
| (U) | $3,751 | 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) | $3,734 | 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) | $4,482 | 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) | $2,990 | 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 energy deposited in near-Earth space by cosmic rays and energetic particles from deep space to identify risks to Air Force systems. |
| (U) | $743 | Research space weather phenomena through the investigation of several solar variables observed from thousands of sun-like stars. Model the evolution of our sun. Research supported through the Center for Solar Geophysical Interactions at the Mt. Wilson Observatory. |
| (U) | $990 | Support basic research and educational outreach projects at the California 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 atmospheric conditions, weather phenomena, and expand into biological sensory systems. |
| (U) | $16,690 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2311 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,856 | Analyze solar phenomena to characterize and model solar phenomena for enhanced prediction of large-scale disruptions in the space environment, and to advance development of protective spacecraft structures and defensive operational techniques. Explore technology requirements to enable development of a new ground-based Advanced Technology Solar Telescope. Advance adaptive optics techniques in solar observations. Investigate scientific analysis of space-based data. Continue investigating solar dynamo, solar oscillation modes, solar flares, coronal mass ejections, and solar magnetic field helicity to enable forecasting of solar eruptions and predict environmental risks to critical Air Force space operations. |
| (U) | $3,856 | Develop mitigation techniques for ionospheric scintillation and plasma turbulence to enhance global surveillance, geolocation, and communication. Develop data assimilation techniques to modernize ionospheric and space weather forecasting. Continue to observe atmospheric gravity wave interactions from high and low geomagnetic latitudes, as well as tropical observation sites, using light detection and ranging (LIDAR) techniques in order to develop seasonal and climatic models of ionospheric phenomena. |
| (U) | $4,628 | Study ionospheric scintillation and turbulence to enhance global surveillance, geolocation, and communication. Develop data assimilation techniques to modernize ionospheric and space weather forecasting. Continue to observe atmospheric gravity wave interactions from high-latitude and tropical observation sites using LIDAR techniques in order to develop seasonal and climatic models of ionospheric phenomena. |
| (U) | $3,191 | Predict threats to Air Force space assets by cataloging and tracking the populations of Near Earth Objects and space debris particles derived from comets and asteroids. Develop advanced astronomical instrumentation and observational methods. Explore laser guide-star development for observations of Near Earth Objects and ballistic and orbital targets over the tropics. Investigate the variable energy deposited in near-Earth space by energetic particles from deep space and by cosmic rays to quantify risks to Air Force systems. |
| (U) | $15,531 | 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2311 | |

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2312

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2312 Biological Sciences | 13,114 | 13,844 | 14,383 | 14,730 | 15,025 | 15,324 | 15,629 | Continuing | TBD |

**(U) A. Mission Description**

Biological Science research aims to provide the fundamental knowledge necessary to enable Air Force technologies and understanding in chemical and physical agent toxicity, biomimicry for electromagnetic sensors, biomolecular materials, biochromatics and luminescence, as well as neuroscience and chronobiology. The goal is to exploit biological properties so as to control and manipulate operational environments. Research topics in toxicology explore the interaction of Air Force chemicals and physical agents (lasers and microwaves) with human tissues and associated effects to enable safety assessment strategies in order to ensure the hazard-free development and use of future aerospace materials and directed energy systems. Research in biomimetic sensors strives to mimic the biological detection systems of organisms at the molecular level in development of novel man-made sensors. Basic research in biocatalysis characterizes cellular enzymes that will catalyze the synthesis of chemical feedstocks used in the safe production of space and aerospace materials. Research in neuroscience and chronobiology provides new strategies to prevent impaired operational performance due to jet lag and shift-work, night operations, and the loss of life and/or aircraft due to stress, inattention, or lack of vigilance. The primary areas of research investigated by this project are bioenvironmental sciences, biocatalysis, chronobiology and neural adaptation, and biomimetic sensors.

(U) FY 2001 ($ in Thousands)

(U) $6,428 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 and began to identify specific protein targets responsible for triggering the toxic responses. Explored in vitro biodynamic alterations that together with biokinetic parameters aid in predicting toxicity and integrate into the computational design of new, safer, aerospace materials. Examined the effects of novel forms of directed energy (microwaves and lasers) on gene expression and identified specific sub-cellular targets of directed energy.

(U) $3,283 Researched biocatalysis to discover and characterize enzymes from living cells used as biocatalysts to reduce cost, increase efficiency, and assure safety for synthesizing chemical feedstocks for manufacturing aerospace materials. Sub-cloned various bacterial enzymes to enhance the level of gene expression so the enzymes could be produced in sufficient yields for additional research and biotechnology development. Identified and isolated bacteria strains capable of performing efficient biochemical reaction mechanisms to reduce cost and increase efficiency of aerospace materials synthesis.

(U) $1,834 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 February 2002 |
|---|---|
| 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

environment, and individual performance capabilities to improve skilled human performance. Interpreted the mechanism by which serotonin regulates the circadian clock, determined if modafinil prevents adverse effects on performance without disrupting sleep, and investigated the combination of countermeasures such as optimally-timed rest periods and wake promoting compounds.

(U) $1,569 Investigated biomimetic sensors to develop understanding of visual, auditory, and vestibular systems, and identified methods to enhance these systems. Analyzed, predicted, and modeled biological characteristics, behaviors, and functions for development of novel processes and mechanisms for physical and chemical system requirements. Isolated and began to model alternate mechanisms of near ambient infrared sensing systems in snakes and beetles to enable room-temperature, compact infrared sensors. Investigated and adapted chromophores and photoluminescent characteristics in microbial and protein-based biological systems for insights to military sensor applications.

(U) $13,114 Total

(U) FY 2002 ($ in Thousands)

(U) $6,783 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) $3,462 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) $1,937 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) $1,662 Conduct biomimetic research to enable the development of novel sensors, engineering processes, and mechanisms. Investigate fundamental

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2312 | |

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

(U) FY 2002 ($ in Thousands) Continued

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) $13,844 Total

(U) FY 2003 ($ in Thousands)

(U) $7,047 Study bioenvironmental sciences to investigate the biological effects produced by exposure to aerospace chemicals and directed energy systems used by the military to assure the safety, health, and high performance of the warfighter before, during, and after mission-directed activities. Continue to identify organ-specific molecular pathways altered by JP-8 jet fuel exposures and evaluate various biomolecular indicators and mediators of the toxic response for use as potential biomarkers of human exposure and to enable the development of protective strategies. Explore mechanisms and develop novel molecular descriptors that will help integrate in vitro toxicity data into a mathematical format for use in the rapid computational prediction of toxicity of aerospace chemicals and new forms of directed energies. Investigate the biological effects of chronic low level exposures to directed energy by profiling and modeling intracellular molecular responses and identifying potentially harmful extra-cellular mediators.

(U) $3,596 Research biocatalysis to discover and characterize enzymes from living cells that can be used as biocatalysts to reduce cost, increase efficiency, and assure safety in the process of synthesizing chemical feedstocks used in the manufacture of aerospace materials. Continue the essential and fundamental process of enzyme discovery and characterization. Genetically modify the natural biocatalytic potential of enzymes to meet various synthetic manufacturing requirements by extending substrate ranges and specificities or altering reaction rates. Explore alternative metabolic engineering techniques for maintaining or enhancing reaction rates during large scale production.

(U) $2,014 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. Explore the mechanism by which serotonin influences the circadian clock. Conduct studies using optimally-timed rest periods and wake promoting compounds to extend waking activity. Develop a mathematical model to recommend the best use of light exposure, caffeine, modafinil, and brief naps to counter the effects of jet lag and sustained sleep deprivation.

(U) $1,726 Continue to conduct biomimetic research to enable the development of novel sensors, engineering processes, and mechanisms. Model the

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 2312 | |

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

(U) FY 2003 ($ in Thousands) Continued

fundamental principles, processes, and designs of infrared sensitive biosystems at the sub-cellular, molecular and genomic levels to enable the further development of infrared materials, devices, and systems with enhanced structural and functional capabilities. Identify, model, and construct alternative biomimetic, near ambient infrared sensing devices. Probe and manipulate the functionality of alternative sensors for time-response characteristics. Adapt biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems.

(U) $14,383 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0602204F, Aerospace Sensors.
(U) PE 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: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 2313

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2313 Human Performance | 13,747 | 12,885 | 13,044 | 13,113 | 12,471 | 12,706 | 12,965 | Continuing | TBD |

**(U) A. Mission Description**

Human Performance research aims to provide the fundamental knowledge necessary to examine all aspects of human information processing critical to Air Force operations. The goal is to develop useful quantitative models of the way people: perceive, navigate, and manipulate their environment; make decisions in complex tasks under stress or uncertainty; and adapt to extreme sensory, biophysical, or cognitive workloads. Sensory research emphasizes visual, auditory, vestibular, and kinesthetic systems and their optimal integration. Basic research topics focus investigations on the scientific foundation for several developing Air Force technologies including the design of interactive displays, simulators, intelligent control systems, sensors and fused-image displays, and adaptive systems for operator and team training. The primary areas of research investigated by this project are sensory and perceptual systems, cognition, and team performance.

(U) FY 2001 ($ in Thousands)

(U) $3,449 Performed sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Refined theories of visual search and scene analysis, control of attention, perception of orientation, and localization of sound for optimal cockpit performance. Analyzed the perceptual and cognitive requirements for accurate simulation of virtual environments and for effective design of informative displays. Gained understanding of human multisensory integration to enable the design of automated sensing devices.

(U) $4,853 Conducted cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew member interactions. Enhanced human performance via intelligent systems that aid human behavioral and cognitive functions or compensate for human limitations. Developed and tested training protocols to maximize team effectiveness under stress and sustained operation.

(U) $4,468 Studied cognitive workload to formulate behavioral and physiological measures of cognitive workload, alertness, and vulnerability to sleep loss to enable cognitive performance modeling and prediction. Invented innovative approaches to understanding individual skill differences and created new training and selection systems relevant to modern, technology-dependent environments. Studied behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $977 Supported 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 included research to increase the fundamental understanding of the upper atmosphere.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

(U) $13,747 Total

(U) FY 2002 ($ in Thousands)

(U) $3,480 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) $4,895 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) $4,510 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) $12,885 Total

(U) FY 2003 ($ in Thousands)

(U) $3,522 Perform sensory and perceptual system research to investigate sensory and perceptual systems to enhance human-machine interaction in Air Force weapon systems. Critically test theories of sensory and perceptual systems for enhanced human-machine interaction and sensor processing in Air Force weapon systems. Discover improved methods for evaluating design options for visual displays used in scene analysis and command and control in several task domains. Evaluate theories and models of perception and cognition for accurate simulation and fused sensor processing. Using performance metrics, critically test theories of sensory integration for image understanding.

(U) $4,957 Conduct cognition research to measure and analyze cognitive dimensions of human performance in complex command and control tasks with multiple crew-member interactions. Extend models of cognitive dimensions of human performance in complex command and control tasks to inform studies of automated decision making. Test models of enhanced human performance aided or augmented by intelligent systems. Determine mechanisms affecting training effectiveness for operator and team performance under stress and sustained operation.

(U) $4,565 Study cognitive workload by using developed metrics to critically test behavioral and physiological theories of cognitive workload, alertness, and vulnerability to sleep loss in several domains of operator performance. Develop theories for modeled relationships between individual skill

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| | PROJECT: 2313 |

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

(U) FY 2003 ($ in Thousands) Continued

differences and interactions with envisioned training pedagogies. Determine behavioral and physiological measures to avert human error in conditions of information overload and fatigue.

(U) $13,044 Total

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

Not Applicable.

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

(U) Related Activities:

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

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 01 - Basic Research

PE NUMBER AND TITLE: 0601102F Defense Research Sciences

PROJECT: 4113

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4113 | External Research Programs Interface | 4,241 | 6,584 | 7,399 | 7,511 | 7,650 | 7,467 | 7,618 | Continuing | TBD |

**(U) A. Mission Description**

External research programs interface optimizes interactions between the international and domestic research community and Air Force researchers. These professional interchanges and collaborations stimulate scientific and engineering education beneficial to the Air Force, increase the awareness of Air Force basic research priorities, and attract talented scientists and engineers to address Air Force needs. Consideration is provide to enhance educational interactions with historically black colleges and universities (HBCU) and minority institutions (MI). The primary elements of this effort are international strategy, international technology liaison, and scientist and engineer research interchange.

(U) FY 2001 ($ in Thousands)

(U) $1,400 Supported 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. Provided 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) $1,664 Supported international technology liaison missions to identify unique international research capabilities making 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 commitments to NATO-affiliated research institutes, such as the Von Karman Institute.

(U) $1,177 Supported 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. 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) $4,241 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences / PROJECT: 4113 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,170 | 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) | $2,569 | 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) | $1,845 | 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) | $6,584 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,441 | 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 the Air Force Materiel Command to coordinate international participation among appropriate U.S. Department of Defense organizations. |
| (U) | $2,886 | Support international technology liaison missions to identify unique international research capabilities, and make them available to the U.S. Air Force. Through the European Office of Aerospace Research and Development and the Asian Office of Aerospace Research and Development 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) | $2,072 | Support scientist and engineer education at U.S. colleges and universities, including historically black colleges and universities (HBCU) and minority institutions (MI), to assure the Air Force of continuing availability of superior scientific and engineering talent by supporting exceptional individuals and forging associateships between premiere scientists and the Air Force Research Laboratory. Improve awareness of Air Force research needs throughout the civilian scientific community while simultaneously identifying and recruiting the best scientific talent |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 01 - Basic Research | PE NUMBER AND TITLE: 0601102F Defense Research Sciences |
| PROJECT: 4113 | |

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

(U) FY 2003 ($ in Thousands) Continued

to participate in critical Air Force research.

(U) $7,399 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0601103D, University Research Initiative.
(U) PE 0602102F, Materials.
(U) PE 0602202F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602204F, Aerospace Avionics.
(U) PE 0602269F, Hypersonic Technology Program.
(U) PE 0602601F, Space Technology (formerly Phillips Lab).
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702F, Command, Control and Communication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 91,975 | 97,989 | 75,272 | 77,104 | 78,329 | 79,204 | 82,135 | Continuing | TBD |
| 4347 | Materials for Structures, Propulsion, and Subsystems | 62,036 | 61,777 | 40,907 | 42,634 | 42,701 | 43,104 | 45,036 | Continuing | TBD |
| 4348 | Materials for Electronics, Optics, and Survivability | 9,932 | 14,950 | 12,616 | 12,707 | 13,033 | 13,158 | 13,530 | Continuing | TBD |
| 4349 | Materials Technology for Sustainment | 20,007 | 19,850 | 18,064 | 18,089 | 18,386 | 18,548 | 18,991 | Continuing | TBD |
| 4915 | Deployed Air Base Technology | 0 | 1,412 | 2,345 | 2,236 | 2,515 | 2,582 | 2,647 | Continuing | TBD |
| 5015 | Rocket Materials Technology | 0 | 0 | 1,340 | 1,438 | 1,694 | 1,812 | 1,931 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, Project 4397 efforts transferred from PE 0602102F into Project 4915, Deployed Air Base Technology. In FY 2003, space unique tasks in Projects 4347 and 4348 will be transferred to PE 0602500F, Project 5025 in conjunction with the Space Commission recommendation to consolidate all space activities. In FY 2003, non-space unique tasks (and other aerospace materials related technology) will be transferred into Project 5015, Rocket Materials Technology, from PE 0602203F, Aerospace Propulsion, Project 4847, Rocket Propulsion Technology.

**(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 which: (1) develop structural, propulsion, and sub-systems materials and processes technologies; (2) develop electronic, optical, and survivability materials and processes technologies; (3) develop sustainment materials and processes technologies; and (4) develop air base operations technologies including power generation, deployable shelters, and fire fighting. Note: In FY 2002, Congress added $3.0 million for the Metals Affordability Initiative, $6.0 million for advanced physical vapor silicon carbide crystal device technology, $2.0 million

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |

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

for durable hybrid coatings for aircraft systems, $3.4 million for carbon foam development for aircraft and spacecraft, $1.0 million for environmentally sound coatings, $1.7 million for free electron laser, and $4.3 million for titanium matrix composites. This explains the perceived overall decrease in the Materials program in FY 2003 and out.

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

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

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 96,422 | 77,164 | 78,037 | |
| (U) | Appropriated Value | 97,315 | 98,564 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -575 | | |
| | b. Small Business Innovative Research | -2,265 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | -2,182 | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -893 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -2,765 | |
| (U) | Current Budget Submit/FY 2003 PBR | 91,975 | 97,989 | 75,272 | TBD |

(U) Significant Program Changes:

In FY 2003, the decrease in this program is due to the transfer of space unique tasks in conjunction with the Space Commission recommendation to consolidate all space unique activities. Additionally, in FY 2002, this program received Congressional Adds which explains the perceived decrease in FY 2003.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT: 4347

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4347 | Materials for Structures, Propulsion, and Subsystems | 62,036 | 61,777 | 40,907 | 42,634 | 42,701 | 43,104 | 45,036 | Continuing | TBD |

Note: In FY 2003, space unique tasks in Project 4347 will be transferred to PE 0602500F, Project 5025, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

Develops materials and processing technology base for aircraft 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 aerospace 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, 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. Alternative or replacement materials are developed to maintain the performance of aging operational systems. Friction and wear resistant materials, paints, coatings, and other pervasive 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 2002, Congress added $3.0 million for Metals Affordability Initiative, $2.0 million for durable hybrid coatings for aircraft systems, $3.4 million for carbon foam development for aircraft and spacecraft, $4.3 million for titanium matrix composites, $1.7 million for free electron laser, and $1.0 million for environmentally sound coatings which explains the perceived decrease in FY 2003.

(U) FY 2001 ($ in Thousands)

(U) $4,982 Developed enabling polymeric materials technologies for diverse, high-payoff Air Force system needs including structural applications. Evaluated suitable polymers and conductive elastomers as base materials for low-observable gap sealants, thin wires, and electrostatic discharge coatings. Evaluated toughened and nanostructured polymers for thin films to enable inflatable membrane structures such as deployable mirrors for surveillance and space counterforce applications. Developed new methods for rapid fabrication of nanometer to micron three-dimensional structures and rapid composite repair.

(U) $10,064 Developed and transitioned 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. Developed advanced lubricant materials for high-speed bearing and rotating components (gyroscopes) in spacecraft and fabricate optically tailorable thermal control coatings with controlled

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| PROJECT: 4347 | |

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

(U) FY 2001 ($ in Thousands) Continued

emissivity for spacecraft thermal control. Validated feasibility of electrically conductive elastomers for use in low-observable gap treatments and develop analytical techniques to predict the optical properties of specialty coatings. Developed permanent corrosion resistant primer resins and environmentally safe corrosion protection with a 30-year life for aircraft platforms.

(U) $18,282 Developed 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. Validated 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. Developed composite material degradation mechanisms to improve life prediction for aircraft environmental control systems and hot, exhaust-washed structures and engine components. Validated 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. Evaluated novel product forms (foams, nanomaterials) for lightweight, tough, and affordable structural materials.

(U) $23,081 Developed and transitioned 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. Transitioned wrought gamma titanium aluminides with a 200°F higher temperature capability for demonstration in advanced gas turbine engine critical components. Developed specific molybdenum-based and niobium-based intermetallic alloys with the potential of achieving a 300°F temperature capability increase over turbine blade materials. Developed life prediction and design methods to better predict the impact of high cycle fatigue damage on critical engine components. Developed life prediction methodologies and inspection technologies to extend turbine engine rotor life, establish retirement for cause criteria, and enable repair processes for critical components. Optimized and transitioned process technologies, such as permanent mold casting, laser forming, and roll forming to enable the production of affordable and high quality metallic components. Optimized 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) $5,627 Developed ceramics and ceramic matrix composites technologies for enhanced performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures. Determined the durability of ceramics under service life conditions to guide further materials development and to assess useable life. Tested 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| | PROJECT: 4347 |

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

(U) FY 2001 ($ in Thousands) Continued

composites for space mirror applications. Validated 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. Validated repair techniques for radar absorbing material coatings and quantifying the shelf life of the repair constituents. Validated advanced constituent, oxidation resistant, interface coatings through fiber and composite testing.

(U) $62,036 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 photovoltaic advanced solar cells. Optimize light-absorbing polymeric materials for incorporation into paint formulations for corrosion characterization applications.

(U) $14,086 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 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) $10,875 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE February 2002 |
|---|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602102F Materials | PROJECT<br>4347 |

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

(U) FY 2002 ($ in Thousands) Continued

treatments for friction, stiction, and wear control in micro-scale devices and micromechanical applications.

(U) $24,578 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) $4,112 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) $61,777 Total

(U) FY 2003 ($ in Thousands)

(U) $2,761 Develop enabling polymeric materials for diverse aerospace structural applications including enhanced aircraft canopies, micromechanical devices, advanced wiring concepts, and improved low-observable platforms. Demonstrate feasibility of nanostructured materials for temperature resistent applications and evaluate applicability for gas and fluid containment components for pervasive Air Force aerospace subcomponent applications. Demonstrate and transition new methods for rapid fabrication of micron three-dimensional structures for Air Force micromechanical devices. Demonstrate and transition use of hybrid thin wires for Air Force aerospace component applications. Demonstrate light-absorbing polymeric materials for incorporation into paint formulations for corrosion characterization applications. Investigate new methods for room temperature cure of resins for advanced Air Force composite applications. Evaluate the use of conductive materials for low-observable gap-sealants in Air Force aircraft applications.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| PROJECT: 4347 | |

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

(U) FY 2003 ($ in Thousands) Continued

(U) $8,059 Develop affordable, advanced organic matrix composite structural materials and technologies for Air Force systems applications including lightweight structures for aerospace subcomponents and other structures requiring thermal and/or structural management for environmental control. Develop composite material degradation mechanisms to improve life prediction for aircraft environmental control systems and hot, exhaust-washed structures and engine components. Develop next generation high temperature organic matrix composites for aerospace platforms. Continue processing and fabrication of novel product foams such as nanomaterials, nanotubes, and carbon foams for lightweight, tough, and affordable structural materials.

(U) $6,802 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. Develop electrically conductive elastomers for use in low-observable gap treatments. Develop advanced analytical techniques to predict the optical properties of specialty coatings. Test permanent corrosion resistant primer resins and environmentally safe corrosion protection with a 30-year life. Establish baseline for nanostructured multifunctional coatings to control friction and wear in extreme environments. Develop surface treatments for friction, stiction, and wear control in micro devices.

(U) $17,729 Develop and transition affordable lightweight metallic materials, behavior and life prediction technology, higher temperature intermetallic alloys, and metals processing technology to enable enhanced performance, lower acquisition cost, increased durability, and improved reliability for Air Force weapon systems. Transition life prediction methodology and surface treatments needed to prevent High Cycle Fatigue damage in integrally bladed rotors. Develop processing methods for second-generation alloys with the potential of achieving a 300°F temperature capability increase over current turbine blade materials. Develop computational methods for modeling the mechanical properties of specific metallic alloys. Optimize and transition advanced affordable process technologies to enable more affordable production of complex structural metal components for Air Force aerospace vehicles.

(U) $3,421 Develop ceramics and ceramic matrix composites technologies for revolutionary performance and supportability improvements in advanced propulsion systems and high temperature aerospace structures. Test advanced ceramic composites for exhaust and hot section components under real and simulated service life conditions, using the data for durability assessment and life prediction development. Demonstrate highly durable thermal protection materials for aerospace vehicles with aircraft-like operability through hot acoustic and other specialized testing. Demonstrate radar absorbing material coating repair for superalloy and/or titanium alloy substrates. Evaluate more durable ceramic composites based on emerging fibers and advanced interface coatings.

(U) $2,135 Develop and transition materials processing technologies involving process models, multi-objective optimization methods, and advanced non-invasive sensors. Investigate the feasibility of using evanescent microwave or inelastic photon (Raman) imaging of the surface and near-surface region as a process sensor. Evaluate new techniques for generating large-scale dynamic and phase behavior simulations for

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

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

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

(U) FY 2003 ($ in Thousands) Continued

nanomaterial process design. Transition an interactive design-manufacturing environment which allows rapid design interaction between multiple sites over the internet web.

(U) $40,907 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 0603211F, Aerospace Systems
(U) PE 0603202F, Aeropropulsion Subsystem Integration.
(U) PE 0603216F, Aeropropulsion and Power Technology
(U) PE 0602500F, Multi-disciplinary Space Technology
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT: 4348

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4348 Materials for Electronics, Optics, and Survivability | 9,932 | 14,950 | 12,616 | 12,707 | 13,033 | 13,158 | 13,530 | Continuing | TBD |

Note: In FY 2003, space unique tasks in Project 4348 will be transferred to PE 0602500F, Project 5025, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

Develops materials technologies for surveillance and terrestrial situational awareness systems and subsystems for aircraft and missile applications. Develops materials for protection of aircrews, sensors, and aircraft from laser and high power microwave directed energy threats. Develops sensor modules, microwave devices, infrared detectors, and infrared countermeasures 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 2002, Congress added $6.0 million for advanced silicon carbide crystal device tecnology which explains the perceived decrease in FY 2003.

(U) FY 2001 ($ in Thousands)

(U) $4,408 Developed materials and process technologies for power control and microwave devices to provide improved performance, affordability, and operational capability of surveillance and situational awareness systems. Developed materials and materials processes to provide increased reliability and temperature capability while reducing power consumption, weight, cost, cooling, complexity, and size. Developed bulk and epitaxial materials with improved performance at and above the X-band wavelength region to enable improved power control devices. Evaluated sensor materials for defect density, doping, and stoichiometry through advanced process control techniques.

(U) $2,908 Developed enabling infrared (IR) detector materials and process technologies to enable improved performance, affordability, and operational capability of surveillance and situational awareness systems. Evaluated alternative materials to fabricate IR detector focal plane arrays at very long wavelengths. Demonstrated multi-layered and hyperspectral/multi-spectral IR detector materials that respond to combinations of wavelengths within spectral bands and between spectral bands. Developed new processing techniques to improve yield in small lot manufacturing.

(U) $2,006 Developed materials technology to enhance the safety and survivability of aircrews against heat seeking IR missile and laser threats. Developed new nonlinear-optical materials to replace state-of-the-art lithium niobate for infrared countermeasure devices. Demonstrated

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| | PROJECT: 4348 |

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

(U) FY 2001 ($ in Thousands) Continued

second generation, nonlinear absorbers as IR materials; designed a gradient limiter device, transition damage tolerant, biological limiter host materials for protection of personnel eyes, viewing systems, and night vision goggles; and established a hardened night vision goggle testbed.

(U) $610 Developed enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensor systems against laser threats. Evaluated liquid crystal materials for autonomous tunable filters to block unknown wavelengths. Evaluated switchable (hologram) narrow notch filters to provide day and night sensor agile jamming protection. Demonstrated dual wavelength, high optical density switchable filter stacks for laser eye protection.

(U) $9,932 Total

(U) FY 2002 ($ in Thousands)

(U) $8,163 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 infrared detector (IR) materials and materials processing technologies to enable improved performance, affordability, and operational capability of surveillance, tracking, targeting, and situational awareness systems. Develop alternative 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE February 2002 |
|---|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602102F Materials | PROJECT<br>4348 |

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

(U) FY 2002 ($ in Thousands) Continued

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) $14,950 Total

(U) FY 2003 ($ in Thousands)

(U) $2,955 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 Air Force surveillance, targeting/tracking, situational awareness and lethal and non-lethal weapon systems. Demonstrate and validate materials and materials processing technologies to enable increased Air Force systems reliability and temperature capability while reducing power consumption, weight, cost, cooling, complexity, and size. Develop and transition materials and materials processes to provide presently unattainable performance for power control systems, advanced radar, and electronic countermeasures. Scale up and transition 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) $3,077 Develop, demonstrate and transition infrared (IR) detector materials and materials processing technologies to enable improved performance, affordability, and operational capability of Air Force surveillance, tracking, targeting, and situational awareness systems. Demonstrate the process control required for growth of complex IR detector materials that are responsive to multiple wavelengths within and between spectral bands. Transition new processing techniques to improve detector materials yield and affordability in small lots. Investigate IR detector materials that provide enhanced real-time tracking capability.

(U) $5,589 Develop, demonstrate, and transition materials technology to enhance the safety and survivability of aircrews and related assets against heat seeking missiles and laser threats. Develop growth and processing techniques for large nonlinear crystals for generating higher power mid-IR laser radiation for future infrared countermeasures. Incorporate promising nonlinear absorbing materials into candidate host materials and demonstrate their performance in the Air Force Optical Limiting Testbed for the protection of personnel eyes, viewing systems, and night vision goggles.

(U) $995 Develop and transition enabling materials technologies to enhance the survivability and mission effectiveness of Air Force sensors, viewing systems, and night vision goggles against laser threats. Demonstrate liquid crystal materials employed in autonomous tunable filters to block near-infrared wavelengths. Develop high optical density, multiple wavelength switchable filter stacks on curved substrates.

(U) $12,616 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE February 2002 |
|---|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602102F Materials | PROJECT<br>4348 |

**(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) PE 0602500F, Multi-disciplinary Space Technology
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT: 4349

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4349 | Materials Technology for Sustainment | 20,007 | 19,850 | 18,064 | 18,089 | 18,386 | 18,548 | 18,991 | 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 aerospace systems. Various NDI/E methods are essential to ensure optimum quality in the design and production of aircraft, propulsion, and missile systems. These NDI/E methods are also essential to monitor and detect the onset of any service-initiated damage and/or deterioration due to aging of operational systems.

(U) FY 2001 ($ in Thousands)

(U) $4,301 Developed and transitioned 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. Transitioned enhanced laser-generated ultrasound capabilities to detect the onset of hidden corrosion between metallic structural elements. Initiated development of an NDI/E response computer simulation model for integrated product design. Developed and designed laboratory scale capability to evaluate remote inspection capabilities for crack detection within complex structures. Evaluated 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) $2,911 Developed and transitioned enabling technologies to reduce the Air Force maintenance burden due to low-observable requirements. Established baseline capability for NDI/E point inspection devices to verify repair quality. Assembled an integrated low-observable repair kit. Demonstrated high temperature and/or ultraviolet gap sealants and conductive elastomers. Developed ultrasonically applied and/or removed thermoplastic radar absorbing material (RAM) repairs, high temperature RAM coating repairs, and radar absorbing structure field level repairs.

(U) $4,627 Developed and transitioned support capabilities, information, and processes to resolve problems in the use of materials and provide electronic and structural failure analysis of components. Performed failure analysis and materials investigations for field, acquisition, and depot organizations. Transitioned electrostatic discharge protection materials technologies for space and low-observable applications. Evaluated testing techniques needed for analyzing structural failures of replacement materials for aging Air Force systems.

(U) $8,168 Developed and transitioned support capabilities, information, and processes to resolve problems in the use of materials, in the repair of aircraft

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| | PROJECT: 4349 |

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

(U) FY 2001 ($ in Thousands) Continued

structures, and to reduce aircraft corrosion. Established residual stresses baseline criteria of High Cycle Fatique and foreign object damage in turbine engine blade materials. Evaluated advanced composite materials compatibility with laser effluents as an alternative to metallic materials for high energy chemical oxygen-iodine laser devices. Developed improved gap-filler materials for low-observable platforms and test on-aircraft processed adhesive and patch repair of high-temperature composite aircraft structures. Developed capabilities to evaluate corrosion and erosion resistance of new and emerging materials used in operationally fielded Air Force systems. Validated technical understanding of corrosion.

(U) $20,007 Total

(U) FY 2002 ($ in Thousands)

(U) $4,443 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) $4,778 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) $7,501 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| | PROJECT: 4349 |

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

(U) FY 2002 ($ in Thousands) Continued

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) $19,850 Total

(U) FY 2003 ($ in Thousands)

(U) $5,088 Develop non-destructive inspection/evaluation (NDI/E) technology to identify and characterize damage in complex, low-observable (LO) materials and structures. Develop inspection for aging aerospace structures and propulsion systems. Evaluate methods to rapidly detect and characterize multi-site damage and cracks in large area, aging structures. Evaluate computer simulations and models of non-destructive evaluation 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 NDE methods. Evaluate methods to detect and characterize the severity of fretting fatigue in engine components. Evaluate NDE/I methods to characterize the LO properties of paints and coatings during and after application.

(U) $2,588 Develop and transition enabling technologies to reduce the Air Force maintenance burden due to LO requirements. Validate capability for NDE point inspection devices and verify repair quality. Demonstrate an integrated LO repair kit. Transition high temperature and/or ultraviolet gap sealants and conductive elastomers. Transition ultrasonically applied and/or removed thermoplastic radar absorbing material (RAM) repairs, high temperature RAM coating repairs, and radar absorbing structure field level repairs.

(U) $4,089 Develop 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 (ESD) protection materials technologies and techniques for LO applications. Continue experimental evaluation of testing techniques needed for analyzing structural failures of replacement materials for aging Air Force systems.

(U) $6,299 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. Publish residual stresses baseline criteria of high cycle fatigue foreign object damage in turbine engine blade materials. Transition advanced composite materials compatibility with laser effluents as an alternative to metallic materials for high-energy

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials |
| | PROJECT: 4349 |

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

(U) FY 2003 ($ in Thousands) Continued

chemical oxygen-iodine laser devices. Transition improved gap-filler materials for LO platforms and demonstrate 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. Publish baseline for improved corrosion management procedures.

(U) $18,064 Total

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

Not Applicable.

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

(U) Related Activities:

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

(U) PE 0603211F, Aerospace Structures

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT: 4915

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4915 Deployed Air Base Technology | 0 | 1,412 | 2,345 | 2,236 | 2,515 | 2,582 | 2,647 | Continuing | TBD |

Note: In FY 2002, Project 4397, efforts transferred from PE 0602102F, into Project 4915.

**(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 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) $885 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 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) $1,412 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602102F Materials | 4915 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $1,697 | Develop new deployable airbase systems to reduce airlift, setup times, manpower requirements and sustainment costs in support of AEF technologies. Develop an integrated deployable fuel cell, solar power, and heat pump system that decreases maintenance and mean time between failure, increases operating efficiency, and reduces sustainment costs for air mobile systems performance. |
| (U) | $158 | Develop affordable, deployable technologies that ensure military readiness, maintain aerospace missions, support weapon systems sustainment, and ensure deployablity. Continue development of safe, cost-effective disposal of problem Air Expeditionary Force (AEF) wastes for low-observable material waste treatment. |
| (U) | $490 | Develop cost-effective technologies to provide force protection and survivability to AEF deployed warfighters and materials. Continue development of atmospheric threat prediction models and deployable sensors systems to protect AEF forces from toxic industrial materials. Develop effective advanced fire fighting agents and equipment and advanced blast protection materials to protect deployed warfighters. |
| (U) | $2,345 | 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) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602102F Materials

PROJECT: 5015

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5015 Rocket Materials Technology | 0 | 0 | 1,340 | 1,438 | 1,694 | 1,812 | 1,931 | Continuing | TBD |

Note: In FY 2003, space unique tasks in Project 5015 will be transferred to PE 0602500F, Project 5025, in conjunction with the Space Commission recommendation to consolidate all space unique activities. In FY 2003, non-space unique tasks (and other aerospace materials related technology) will be transferred into this project from PE 0602203F, Project 4847.

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2003 ($ in Thousands)
(U) $1,340 Develop and demonstrate pervasive materials and processing technology for aerospace engine components and sub-components to dramatically improve affordability, performance, and reliability of current and future Air Force aerospace systems. Evaluate chemistry/heat treatment combination for new compatible alloys for aerospace propulsion housing components. Identify and develop pervasive zero erosion materials for multiple aerospace engine and missile applications. Identify and evaluate pervasive high temperature catalyst materials that will enable the use of high performance monopropellants for aerospace propulsion systems.
(U) $1,340 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602102F Materials | PROJECT: 5015 |

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

Not applicable.

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

(U) Related Activities:

PE 0602500F, Multi-disciplinary Space Technology
PE 0602102F, Materials
PE 0602302F, Aerospace Propulsion

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 51,909 | 98,785 | 78,789 | 108,212 | 106,663 | 109,238 | 109,540 | Continuing | TBD |
| 2401 | Structures | 47,859 | 32,791 | 26,292 | 42,354 | 42,999 | 43,266 | 42,766 | Continuing | TBD |
| 2403 | Flight Controls and Pilot-Vehicle Interface | 0 | 35,236 | 25,585 | 34,398 | 32,531 | 33,322 | 32,598 | Continuing | TBD |
| 2404 | Aeromechanics and Integration | 0 | 29,570 | 26,912 | 31,460 | 31,133 | 32,650 | 34,176 | Continuing | TBD |
| 4397 | Air Base Technology | 4,050 | 1,188 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, selected efforts from Project 2401 have transferred into Projects 2403 and 2404 within this PE. In FY 2002, Project 4397 efforts transferred to PE 0602102F, Project 4915. In FY 2003, only the space-unique efforts in Project 2403 transferred to PE 0602500F, Project 5030, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

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 2002, Congress added $0.7 million for advanced comprehensive engineering simulator development and $2.9 million for weapon systems logistics, deployed base systems technology, and force 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 aerospace vehicle technologies.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 53,183 | 97,465 | 64,274 | |
| (U) | Appropriated Value | 53,675 | 99,415 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -630 | | |
| | b. Small Business Innovative Research | -1,274 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -492 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 14,515 | |
| (U) | Current Budget Submit/FY 2003 PBR | 51,909 | 98,785 | 78,789 | TBD |

(U) Significant Program Changes:

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

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies

PROJECT: 2401

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2401 Structures | 47,859 | 32,791 | 26,292 | 42,354 | 42,999 | 43,266 | 42,766 | Continuing | TBD |

**(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.

(U) FY 2001 ($ in Thousands)

(U) $3,742 Developed methods to predict and to suppress structural damage due to high cycle fatigue that reduce operations and support costs and provide higher aircraft availability. Continued development of durability patches for structures experiencing premature failure due to high cycle fatigue. Continued technology improvements of airframe structural vibration suppression techniques which delay the onset of high cycle fatigue failures.

(U) $5,148 Developed and demonstrated new control techniques to enable safe, highly autonomous mixed-fleet and multi-unmanned air vehicle operations for increased combat effectiveness. Continued unmanned aerospace vehicle development to ensure safe operation and allow precision close operations of mixed manned and unmanned air vehicles. Developed adaptive flight control algorithms for autonomous vehicle operations. Initiated development of advanced system for automatic Unmanned Air Vehicle in-flight refueling.

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

(U) $3,163 Developed new flight control design methods and criteria that provide air combat advantage by increasing performance and decreasing vulnerability and cost. Initiated 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 Developed advanced flight control technology to enable aircraft-like operations for affordable on-demand military access to space. Developed technology concepts for integration of vehicle management system with vehicle health management/prognostics. Completed aerospace vehicle requirements definition study and conceptual design.

(U) $2,879 Continued development of a signature-compatible, integrated high lift device that will improve aerodynamic performance and survivability

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies | PROJECT: 2401 |

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

(U) FY 2001 ($ in Thousands) Continued

with lower cost of ownership than conventional flight control devices. Performed analytical design of subscale aerospace vehicle model for future powered testing and analysis.

(U) $3,786 Developed computational tools and techniques for predicting and optimizing aerodynamic and structural performance of advanced manned and unmanned aerospace vehicles. Continued development of next generation, multi-disciplinary optimization computer design code integrating aerodynamics, structures, thermal management, signatures, and flight controls. Completed 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) $4,831 Developed and demonstrated affordable aerospace vehicle aerodynamic technologies that increase aerospace vehicle performance. Initiated 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 Evaluated 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. Initiated development of full wing span structurally integrated with a low frequency multifunctional antenna to increase radio frequency performance and reduce weight.

(U) $3,155 Improved 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 consisted of design, fabrication, and assessment of high temperature composite and metallic aerospace vehicle structures.

(U) $8,290 Investigated modification and repair techniques to retrofit fail-safety into aging aircraft to increase availability and reduce operations and support costs. Developed composite and metallic bonded repair techniques which provide for damage tolerance where none now exists. Investigated low-cost structural modifications to aging systems which provide fail-safety in critical areas of the aircraft.

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

(U) $2,000 Expanded aeronautical research efforts to focus on developing technologies for integrated design solutions for optimal signature, aerodynamics, and sensor performance of future aircraft.

(U) $47,859 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies |
| 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) | $17,911 | 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) | $32,791 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $6,896 | 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) | $2,373 | Develop analytical certification methodologies for the incorporation of advanced methods, concepts, and manufacturing technologies into legacy aircraft components and future vehicle designs. Improve the air-worthiness certification process for aircraft subjected to dynamic aeroelastic loads with high fidelity models. |
| (U) | $2,292 | 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 survivability of future systems. Concepts include adaptive structures for varying moldline, subsystems |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies / PROJECT: 2401 |

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

(U) FY 2003 ($ in Thousands) Continued

hardware, and antennae contained within loadbearing structures.

(U) $14,731 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 primary structures, hybrid structures, unitized structures, joining concepts, and cryogenic/non-cryogenic tank structures.

(U) $26,292 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 0603112F, Advanced Materials for Weapon Systems
(U) PE 0603211F, Aerospace Technology Dev/Demo
(U) PE 0603333F, Unmanned Air Vehicle Dev/Demo
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies

PROJECT: 2403

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2403 Flight Controls and Pilot-Vehicle Interface | 0 | 35,236 | 25,585 | 34,398 | 32,531 | 33,322 | 32,598 | Continuing | TBD |

Note: Beginning in FY 2002, selected efforts from Project 2401 have been moved into Projects 2403 and 2404. In FY 2003, the space unique tasks in Project 2403 will be transferred to PE 0602500F, Project 5030, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

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. Note: In FY 2002, Congress added $.7 million for advanced comprehensive engineering simulator.

(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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies |
| | PROJECT: 2403 |

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

(U) FY 2002 ($ in Thousands) Continued

| | | |
|---|---|---|
| (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) | $8,717 | 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) | $743 | Initiate Congressional directed effort for advanced comprehensive engineering simulator. |
| (U) | $35,236 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $5,289 | Develop and assess advanced control mechanization to provide highly reliable operation for manned and unmanned systems at significantly reduced size, weight, and cost. Demonstrate validation and verification techniques for complex, adaptive, and autonomous control software. Assess mirco-effector technologies for lightweight, long endurance air vehicle applications. Develop real-time fault compensation using an integrated prognostic health management system. |
| (U) | $6,411 | Develop and assess novel control automation techniques and algorithms to enable the safe and interoperable application of unmanned vehicle systems. Concepts will also provide mission responsiveness and adaptability for improved operational effectiveness of manned and unmanned systems as well as mixed air vehicle operations. Conduct feasibility assessments of automated refueling systems concept. Develop reliability and performance analysis of self-organizing, distributed control of multi-unmanned vehicle packages. |
| (U) | $3,658 | Develop improved flight control design methods and criteria that provide air combat advantage by increasing performance and decreasing vulnerability and cost. Complete development of adaptive guidance and control architectures for high-speed vehicles. Develop cooperative |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies | PROJECT: 2403 |

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

(U) FY 2003 ($ in Thousands) Continued

control theory to optimize multi-ship trajectories.

(U) $10,227 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. Complete the development of virtual simulation for unmanned air vehicles used in validating autonomous control algorithms for mixed manned and unmanned air vehicle operations. Continue to enhance simulation and analysis capabilities through incorporation of cost models to determine the affordability of new technologies. Continue development of capability to virtually simulate future strike aircraft.

(U) $25,585 Total

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

Not Applicable.

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

(U) Related Activities:

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

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603211F, Aerospace Technology Dev/Demo.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies

PROJECT: 2404

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2404 Aeromechanics and Integration | 0 | 29,570 | 26,912 | 31,460 | 31,133 | 32,650 | 34,176 | Continuing | TBD |

Note: 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 2001 ($ in Thousands)

(U) $0 Effort moved to Project 2401.

(U) $0 Total

(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) $10,045 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies / PROJECT: 2404 |

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

(U) FY 2002 ($ in Thousands) Continued

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) $29,570 Total

(U) FY 2003 ($ in Thousands)

(U) $8,768 Develop and assess aeronautical technologies that enable broad use of unmanned air vehicles in future missions to reduce life cycle costs and decrease human risk. 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) $4,087 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 the current aircraft to enhance their warfighting ability.

(U) $12,363 Develop and assess aerospace technologies that enable high-speed flight to permit global reach. Develop experimental capability to generate and control plasma flows. Develop analytic methods for modeling the plasma flow field over high-speed vehicles to significantly reduce drag. Continue development of complex configurations that mitigate the extreme thermal environment under which high-speed aerospace vehicles operate. Continue development of techniques to carry and deploy weapons from aerospace vehicles operating at high speeds and high temperatures.

(U) $1,694 Develop and evaluate critical aeronautical technologies that enable directed energy weapons to be carried on future air vehicles to improve combat effectiveness. Continue development of aircraft techniques to enhance energy beam transmission through the complex, turbulent aerodynamic environment surrounding aircraft enabling the use of directed energy weapons from high-speed, maneuvering aircraft.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies |
| | PROJECT: 2404 |

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

(U) FY 2003 ($ in Thousands) Continued
(U) $26,912 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0603211F, Aerospace Technology Dev/Demo.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602201F Aerospace Vehicle Technologies

PROJECT: 4397

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4397 Air Base Technology | 4,050 | 1,188 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

In FY 2002, Project 4397, efforts transferred to 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.

(U) FY 2001 ($ in Thousands)

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

(U) $536 Developed utilities, automation, and waste management technologies that reduce airlift requirements and improve air base operations and survivability for agile combat support. Began evaluation of new ground power generation concepts that are highly efficient and lightweight.

(U) $88 Evaluated air transportable protective shelter technologies that are lightweight, structurally strong, and are affordable and suitable for Aerospace Expeditionary Force operations. Continued technology demonstration program for lightweight air inflatable shelters for aircraft and flightline personnel.

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

(U) $4,050 Total

(U) FY 2002 ($ in Thousands)

(U) $1,188 Continue Congressionally directed effort for weapon systems logistics, deployed base systems technology, and force protection.

(U) $1,188 Total

(U) FY 2003 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602201F Aerospace Vehicle Technologies | 4397 |

**(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.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 65,810 | 70,155 | 66,000 | 75,500 | 78,337 | 80,164 | 82,068 | Continuing | TBD |
| 1123 | Warfighter Training | 11,561 | 14,528 | 11,606 | 13,672 | 13,988 | 14,832 | 15,475 | Continuing | TBD |
| 1710 | Deployment and Sustainment | 6,471 | 8,016 | 7,735 | 8,495 | 8,418 | 9,703 | 9,581 | Continuing | TBD |
| 7184 | Crew System Interface & Biodynamics | 36,494 | 33,673 | 30,323 | 37,189 | 40,114 | 41,142 | 42,092 | Continuing | TBD |
| 7757 | Bioeffects and Protection | 11,284 | 13,938 | 16,336 | 16,144 | 15,817 | 14,487 | 14,920 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

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

**(U) A. Mission Description**

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |

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

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

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

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

(U) Significant Program Changes:

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

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1123

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 1123 Warfighter Training | 11,561 | 14,528 | 11,606 | 13,672 | 13,988 | 14,832 | 15,475 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

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

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

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

(U) $11,561 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 1123 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $5,006 | Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Explore federation connectivity options for training systems operating at different levels of security classification. Develop behavioral models to simulate the threat operators in the command and control chain. Explore PC-based, high-resolution, real-time image generator and ultra-high resolution laser projector concept for DMT simulators. |
| (U) | $6,536 | Develop tools and strategies for identifying and improving combat mission training, rehearsal, and operations for distributing training and performance support methods and technology exemplars to operational forces. Research will produce the empirical and analytical basis for better training guidelines when warfighters train in DMT environments. Complete development of methods to identify and validate mission essential competencies for air superiority and global attack, and begin extending methods to new domains of space operations, information warfare, information operations, and command and control. Develop and validate curriculum for Air Superiority DMT implementation at operational mission training centers, and within large-scale exercises at command and control simulation facilities. Conduct usability assessments of enhanced instructor operator station tools to embed instructional principles in DMT simulations, and complete a 'first look' assessment of operational deployment impacts on retention and decay of mission essential competencies and potential contributions of specific curricula for refresher training in pre- and post-deployment applications at mission training centers. |
| (U) | $2,986 | Develop training technologies in command and control centers that support theatre air operations centers. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. Develop tools that will provide real-time performance support with automated remediation leading to a reduction in training costs with no reduction in training effectiveness. Integrate command and control systems into the DMT environment. Develop embedded training tools and simulations for command and control information systems. |
| (U) | $14,528 | Total |

(U) FY 2003 ($ in Thousands)

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 1123 |

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

(U) FY 2003 ($ in Thousands) Continued

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

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

(U) $3,439 Develop training technologies in command and control centers that support theatre air operations centers. Technologies will enhance aerospace operations through the development of training principles, guidelines, and criteria. Validate mission essential competencies for selected Air Operations Center individuals and teams. Determine feasibility of using enhanced performance assessment tools in command and control training exercises.

(U) $11,606 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602233N, Human Systems Technology.

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

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

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

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

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

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

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

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 1710

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 1710 Deployment and Sustainment | 6,471 | 8,016 | 7,735 | 8,495 | 8,418 | 9,703 | 9,581 | Continuing | TBD |

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

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

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

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

(U) $6,471 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 1710 |

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

(U) FY 2002 ($ in Thousands)

(U) $1,989 Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs. Develop software tools to automatically generate maintenance procedures from weapon system design descriptions. Define functional requirements for theater sustainment and distribution decision support tools. Develop artificial intelligence software architectures for improved depot repair forecasting and more timely efficient home-based support for the warfighter. Develop advanced computer models for representing human cognition in simulations.

(U) $2,126 Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force (AEF) operations. Conduct feasibility studies and devise preliminary plans for presenting various types of information to maintenance and logistics personnel, such as aircraft status, supply status, and diagnostics data. The focus will be on display techniques for the support of the logistics commanders and their staff. Investigate the feasibility of developing a distributed logistics training capability to support the logistics community.

(U) $3,901 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Demonstrate and apply methods to quantify skin toxicity risks from fuels and solvents used in flight operations and maintenance processes. Develop a biologically-based model for validation of exposure standards for Air Force missile fuel oxidizer. Begin to develop innovative biotechnology techniques.

(U) $8,016 Total

(U) FY 2003 ($ in Thousands)

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

(U) $1,837 Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for AEF operations. Continue to conduct feasibility studies and devise preliminary plans for the presentation of various types of information to maintenance and logistics personnel to include both the information presented and the platforms to be used. Begin work to define the technology requirements and component research areas to support a completely automated maintenance environment.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

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

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

(U) FY 2003 ($ in Thousands) Continued

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

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

Not Applicable.

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

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 7184

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 7184 Crew System Interface & Biodynamics | 36,494 | 33,673 | 30,323 | 37,189 | 40,114 | 41,142 | 42,092 | Continuing | TBD |

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

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

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

(U) $3,175 Developed cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Developed and demonstrated new user-computer interface for all-source intelligence analysts for faster and more accurate decision-making. Continued research on speech signal processing and speech-based countermeasures for information operations.

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 7184 |

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

(U) FY 2001 ($ in Thousands) Continued

primary flight reference on heads-up displays.

(U) $4,227 Developed visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and developed an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Established helmet-mounted display symbology specifications for strike missions. Conducted study to determine the influence of helmet visor transmissivity and reflectivity on visual target detection.

(U) $2,533 Developed advanced audio displays including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Completed a feasibility demonstration of an integrated 3-D audio headset with noise reduction and CD quality digital audio. Developed acoustic processing algorithms and an intuitive human-centered interface to add a new capability for remote threat detection in perimeter defense. Developed preliminary auditory symbology design criteria for improving situational awareness using 3-D audio displays.

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

(U) $6,213 Developed aviation safety enhancing technologies to alleviate warfighter fatigue, counter spatial disorientation, and improve pilot performance under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions, reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Expanded the capabilities of the fatigue avoidance scheduling tool to predict the effects of pharmaceutical countermeasures on fatigue, and initiated efforts to extend the management of fatigue so as to apply its impact on decision making as a component of Information Warfare strategy. Evaluated effectiveness of candidate techniques to improve spatial orientation capabilities in aircrew wearing night vision goggles. Conducted evaluation of feasibility of employing innovative pressure application techniques and advanced materials to improve pilot performance by reducing the bulk, weight, and thermal burden of existing acceleration protection ensembles.

(U) $3,835 Progressed solid state electrolyte oxygen generation technologies for aircraft and ground-based oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Continued research to improve oxygen production efficiency, lower

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 7184 |

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

(U) FY 2001 ($ in Thousands) Continued

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

(U) $3,063 Provided human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle program. The Unmanned Combat Air Vehicle (UCAV) program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.

(U) $1,439 Conducted international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Performed international laboratory experiment in each country using real-time simulators employing distributed interactive simulation technology. Demonstrated feasibility of an integrated multi-sensory crew station for Virtual Air Commanders tailored for early warning and control mission.

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

(U) $36,494 Total

(U) FY 2002 ($ in Thousands)

(U) $4,093 Develop interface technologies for crew station and equipment accommodation, multi-sensory adaptive controls and displays, and performance metrics. Determine the feasibility of extending real-time workload classification technology into unmanned combat aerial vehicle operations, and evaluate reduced crew operation in a multi-sensory unmanned aerial vehicle control station. Complete databases for cockpit accommodation and NATO three-dimensional human population as core elements for an intelligent, on-line physical accommodation information system to optimize equipment fit. Perform laboratory experiments using a virtual air command station to determine human interface design requirements for airborne early warning and control.

(U) $5,707 Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Continue to devise user-computer interface concepts for intelligence analysts, investigate a display interface for integrated asset management, analyze decision-support aids for Air Operations Centers, and provide a laboratory demonstration of a rapid shared display for command center situation awareness. Begin analysis and definition of human-machine interfaces and decision support tools for global attack. Begin development of operator interface

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 7184 |

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

(U) FY 2002 ($ in Thousands) Continued

concepts and descriptive performance metrics in support of the Targets Under Trees program. Continue research on speech signal processing and speech-based countermeasures for information operations, including a concept demonstration of an intelligent voice jammer.

(U) $3,788 Develop concepts for integrating human computer interface technologies, models of human behavior, and real-time simulations to affordably quantify operational benefit from new interface technologies. Produce design guidelines for an integrated control interface for unmanned vehicles. Continue to develop operator-vehicle interface concepts for exploiting real-time, off-board data and demonstrate payoffs for mobility/special operations missions in laboratory simulations. Complete a feasibility evaluation for validating a digital model of human decision-making behavior.

(U) $4,484 Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding of the effects of vision through display optics, vehicle transparencies, and synthetic vision. Conduct study on replacing the heads-up display with a helmet-mounted display, establish color contrast guidelines, and develop frames of reference and symbology for attitude displays. Establish design guides for windscreens and night vision displays. Determine resolution and brightness requirements for large flat-panel displays.

(U) $2,939 Develop advanced audio displays including three-dimensional (3-D) audio, active noise reduction, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Plan system integration and laboratory test as initial implementation for an acoustic remote threat detection in perimeter defense. Conduct research on (50 dB) hearing protection technologies for improved performance in high performance aircraft. Develop human performance standards for helmet-mounted cueing systems in vibratory environments.

(U) $996 Develop integrated human-centered information warfare technologies to assess and predict human performance under information warfare conditions and to influence an adversary's decision-making function. This research will provide information warriors with human perception management tools and the means to evaluate the effectiveness of information warfare strategies on the human target set. Cognitive modeling efforts will model effects of cross-cultural communications on human decision-making behavior. Auditory and visual technologies will be applied to develop perception management tools for offensive counter-information applications.

(U) $3,288 Develop human injury and protective systems design criteria for use against hazards encountered in crash environments and emergency escape. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including crashes, emergency escape, and parachute opening shock. Begin developing injury assessment toolbox to be used in conducting injury risk assessment on personal protection and life support equipment, and seat and cockpit systems. Develop analysis techniques for evaluating data from ejection seat recorder. Conduct laboratory studies on adaptable restraint system technologies for application across Air Force airlift aircraft.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 7184 |

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

(U) FY 2002 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $8,378 | Develop aviation safety technologies to alleviate/mitigate warfighter fatigue, counter spatial disorientation, and improve pilot performance at high altitude and under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions. This research will also reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Extend fatigue management technologies to provide operational commanders and mission planners with the capability to evaluate effects of alternative schedules on crew performance and mission effectiveness. Conduct fatigue countermeasures research to evaluate the operational efficacy of emerging alertness enhancing medications such as modafinil. Conduct spatial disorientation countermeasures research efforts to improve primary flight displays and reduce pilot workload through development of more intuitive symbology and improve pilot training through development of ground-based and flight-based spatial orientation training practices. Focus acceleration protection research efforts on defining physiological and performance effects of thrust-vectored flight and assessing the effects of pharmaceutical fatigue countermeasures on flight safety and pilot effectiveness in the high performance/high demand cockpit of modern fighter aircraft. |
| (U) | $33,673 | Total |

(U) FY 2003 ($ in Thousands)

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 7184 |

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

(U) FY 2003 ($ in Thousands) Continued

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

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

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

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

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research / PROJECT: 7184 |

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

(U) FY 2003 ($ in Thousands) Continued

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

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

(U) $30,323 Total

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

Not Applicable.

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

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

**(U) D. Acquisition Strategy**

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research | PROJECT: 7184 |

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research

PROJECT: 7757

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

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

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $4,024 Conducted laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while researching countermeasures for optical hazards/threats, with and without laser eye protection. Initiated work with the United States Marine Corps Joint Non-Lethal Weapons Directorate to develop non-lethal laser use guidelines in compliance with DoD/International Policy while enhancing effectiveness. Completed the personnel biological effects model to assess combat vulnerability to emerging optical threats. Developed and demonstrated technology to produce a safe, active lasing experience into aircrew simulators, leading to development and refinement of engagement tactics, countermeasures, and training requirements. Expanded research in optical technology development for information warfare. Completed experiments with Federal Aviation Administration on safe active lasing.

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

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

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| | PROJECT: 7757 |

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

(U) FY 2001 ($ in Thousands) Continued

(U) $11,284 Total

(U) FY 2002 ($ in Thousands)

(U) $5,581 Conduct laser optical bioeffects laboratory experiments and field research, enabling exploitation of laser technology while researching countermeasures for optical hazards/threats with and without laser eye protection. Assess bioeffects of agile laser technologies. Provide guidance for non-lethal laser illuminator employment. Demonstrate technologies for safe, active lasing in aircrew simulators, supporting improved engagement tactics, countermeasures, and laser safety training requirements.

(U) $5,814 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of electromagnetic energy for directed energy weapons, non-lethal weapons, communications, and radar. Evaluate cellular damage and behavioral/cognitive disruption from pulsed radio frequency emitters. Continue health and safety studies on millimeter waves. Improve technology and models for radio frequency exposure prediction, assessment, and hazard warning.

(U) $298 Conclude post-operative evaluation and issue interim recommendations on the study of Photorefractive Keratectomy as a surgical method to reduce aircrew need for glasses or contact lenses.

(U) $545 Develop safety design criteria for portable Active Denial Technology in support of the Air Expeditionary Force/Agile Combat Support initiative, enabling safe exploitation of directed energy weapons. Research and resolve human safety, control, and pointing and tracking issues of directed energy. Verify the non-harmful effects of the active denial technology. Develop safety design criteria for directed energy systems using validated computer model.

(U) $1,700 Design and develop probe kits to rapidly detect and identify biological weapons of mass destruction.

(U) $13,938 Total

(U) FY 2003 ($ in Thousands)

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

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research |
| PROJECT: 7757 | |

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

(U) FY 2003 ($ in Thousands) Continued

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

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

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

(U) $16,336 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602720A, Environmental Quality Technology.

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

(U) PE 0604706F, Life Support Systems.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602202F Human Effectiveness Applied Research | PROJECT: 7757 |

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

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 144,355 | 178,485 | 107,659 | 118,958 | 114,560 | 114,674 | 115,981 | Continuing | TBD |
| 3012 | Advanced Propulsion Technology | 0 | 21,436 | 3,637 | 14,894 | 12,909 | 12,903 | 12,945 | Continuing | TBD |
| 3048 | Fuels and Lubrication | 8,501 | 12,549 | 15,060 | 16,009 | 16,201 | 15,513 | 14,847 | Continuing | TBD |
| 3066 | Turbine Engine Technology | 40,168 | 44,864 | 43,630 | 41,359 | 38,146 | 38,025 | 38,874 | Continuing | TBD |
| 3145 | Aerospace Power Technology | 26,727 | 27,376 | 26,890 | 27,831 | 28,090 | 28,688 | 29,266 | Continuing | TBD |
| 4847 | Rocket Propulsion Technology | 68,959 | 72,260 | 18,442 | 18,865 | 19,214 | 19,545 | 20,049 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, the Hypersonic Technology Program work performed in PE 0602203F, Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B was transferred to Project 3012 in this PE in order to align projects with the Air Force Research Laboratory organization. In FY 2003, only the space unique tasks in Projects 3012 and 4847 will be transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

In FY 2003, this program anticipates receiving $5.7 million from the Cost of War Transfer Account. These funds are not included in the FY 2003 Air Force baseline. Funding will be used for rocket propulsion technologies in support of the Technology for Sustainment of Strategic Systems program.

**(U) A. Mission Description**

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has five projects, each focusing on a technology area critical to the Air Force: 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602203F Aerospace Propulsion |

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

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 2002, Congress added $3.0 million for Pulse Detonation Engines; $3.0 million for magnetic bearing cooling turbine; $1.0 million for Poly (p-phenylene-2,6-benzobisoxazole) (PBO) Membrane Fuel Cells; $1.0 million for lithium ion battery technology for aircraft, spacecraft, and handheld applications; $1.0 million for lithium ion battery technology for solid state lasers; $1.5 million for Engineering Tool Improvement Program for High Cycle Fatigue; $2.3 million for Jet Engine Test Cell upgrade; $7.1 million for the IHPRPT program; and $10.7 million for Air Force Research Laboratory test stand upgrades at Edwards Air Force Base.

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

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

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 123,618 | 149,211 | 136,547 | |
| (U) | Appropriated Value | 124,762 | 179,811 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -1,326 | | |
| | b. Small Business Innovative Research | -2,963 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | 23,700 | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -1,144 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -28,888 | |
| (U) | Current Budget Submit/FY 2003 PBR | 144,355 | 178,485 | 107,659 | TBD |

(U) Significant Program Changes:

FY 2003 decreases are primarily due to space-related actvities being transferred to new space-unique PE 0602500F.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 3012

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3012 Advanced Propulsion Technology | 0 | 21,436 | 3,637 | 14,894 | 12,909 | 12,903 | 12,945 | Continuing | TBD |

Note: In FY 2002, the Hypersonic Technology Program work formerly performed in PE 0602203F, Project 3066; PE 0603202F, Project 668A; and PE 0603216F, Project 681B, has been transferred into this Project in order to align projects with the Air Force Research Laboratory organization. In FY 2003, space unqiue tasks will be transferred to PE 0602500F, Project 5027, in conjunction with the Space Commission recommendation to consolidate all space-unique activities.

**(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 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) $14,450 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 through ground testing. Verify operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation.

(U) $1,376 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 capability and meet Air Force Global Reach/Power needs. Conduct system trade studies to determine military payoff and establish component

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

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) $3,030 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. Perform ground demonstration of flight-type scramjet engine operation and performance over a broad flight speed envelope.

(U) $2,100 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 engine components for incorporation into advanced and combined cycle demonstrator engines.

(U) $480 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) $21,436 Total

(U) FY 2003 ($ in Thousands)

(U) $3,637 This project previously included space unique funding, which has been transferred to PE 0602500F, Project 5027. These funds represent the civilian salaries and in-house support for the work effort transferred and will be transferred at a later date.

(U) $3,637 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 3012 | |

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

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

(U) PE 0603601F, Conventional Weapons Technology.

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

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 3048

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3048 Fuels and Lubrication | 8,501 | 12,549 | 15,060 | 16,009 | 16,201 | 15,513 | 14,847 | Continuing | TBD |

**(U) A. Mission Description**

This 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 2002, Congress added $3.0 million for Pulse Detonation Engines.

(U) FY 2001 ($ in Thousands)

(U) $2,298 Developed high thermal stability hydrocarbon fuels to provide higher heat capacity and operating temperatures and reduced pollutant emissions and signatures for aerospace systems. Evaluated 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 capacity by five-fold. Evaluated low-cost fuel additives in research scale combustors to reduce pollutant emissions (particulates) by 50% in aircraft engines.

(U) $2,839 Developed revolutionary combustion concepts for combined cycle engines and pulse detonation engines. Continued development of novel gas turbine combustor designs including inter-turbine burner. Continued optimization of Trapped Vortex Combustor for inclusion in high performance, low emissions gas turbine engine demonstrators. Conducted preliminary design of pulse detonation engine for military applications. Developed and tested multi-tube, high frequency, demonstrator pulse detonation engine to enable high-performance, low-cost propulsion. Demonstrated an inter-turbine burner concept at representative engine operating conditions. Demonstrated advanced optical diagnostic techniques for health monitoring and control of advanced military combustors.

(U) $2,586 Continued 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. Continued maturation of small prototype diagnostic units for engine health monitoring based on evolving needs of near-term production and demonstrator engines.

(U) $778 Developed, formulated, and evaluated 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion | PROJECT: 3048 |

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

(U) FY 2001 ($ in Thousands) Continued

Fahrenheit and low temperature properties to -70 degrees Fahrenheit. The focus is on enhancing aircraft survivability and operating envelope, and reducing maintenance costs. Developed novel magnetic bearings and vapor phase lubrication concepts for advanced lubrication subsystems. Formulated models to simulate advanced lubrication system behavior.

(U) $8,501 Total

(U) FY 2002 ($ in Thousands)

(U) $1,940 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 a computer model based upon chemical structure-activity relationships for fuel additives design and performance modeling.

(U) $453 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) $665 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) $2,730 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) $275 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 3048 | |

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

(U) FY 2002 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $1,490 | 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) | $2,971 | Develop the technology to build an airbreathing Pulse Detonation Engine (PDE) for use in an unmanned air vehicle. PDEs offer potential for low-cost propulsion systems that can be applied to unmanned vehicles and eventually high-speed combined cycle engines. Fabricate and integrate key components of the PDE including the inlet, intake valve, fuel injector, initiator, controller, and thrust tube. Initiate development of PDE performance predictive models using experimental data. |
| (U) | $12,549 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,400 | 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. Complete development of an initial computer model based upon chemical structure-activity relationships for fuel additives design and performance modeling. |
| (U) | $1,200 | Study low-cost approaches to reduce fuel logistics footprint, including field additization of locally-available fuels to produce a JP-8-quality fuel. Define improvements in additive packages and fuel dispensing methods to reduce logistics footprint, including on-board fuel evaluation and additization. Screen candidate technologies for fuel field diagnostic techniques, including on-line quality assessment. |
| (U) | $1,560 | Investigate hydrocarbon and other high energy density fuel behavior under conditions encountered in combined cycle engines for low-cost access to space. Continue analyses and configuration trade studies to define and evaluate common fuels for future aircraft and military vehicles. Assess additive approaches to improve thermal stability and ignition/combustion properties in reduced scale component testing. |
| (U) | $4,200 | Continue development, testing, and evaluation of revolutionary combustor, and propulsion concepts for gas turbine, pulsed detonation, and combined and advanced cycle engines for missiles, manned and unmanned systems, and access to space. Perform modeling and simulation along with experiments to identify fuel additives and combustor designs to reduce emissions from gas turbine engines. Demonstrate a full-annular ultra-compact combustor at design operating conditions for use as an inter-turbine burner. Investigate non-traditional |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| | PROJECT: 3048 |

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

(U) FY 2003 ($ in Thousands) Continued

thermodynamic cycles for military propulsion systems through simulation/modeling and experimentation. Continue to perform payoff analyses and configuration trade studies to define, focus, and evaluate propulsion technology research for revolutionary combustor and propulsion concepts. Investigate inlet and nozzle configurations for a pulsed detonation engine and investigate incorporating pulsed detonation propulsion technology into gas turbine engines.

(U) $500 Develop and demonstrate optical and electromechanical diagnostic tools and sensors for application to revolutionary combustor and propulsion systems. Investigate pollutant emissions formation pathways through computational and experimental methods. Evaluate methods to reduce gaseous and particulate pollutant emissions from legacy and future gas turbine engines.

(U) $1,100 Develop reliable and economical advanced lubricants. Continue development, test, and qualification activities to provide the most reliable and economical advanced turbine engine lubricants to the Air Force. Develop and test advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Continue to perform payoff analyses and configuration trade studies to define, focus, and evaluate research in lubricants and mechanical systems for combined cycle engines. Perform field support activities for aviation lubrication technologies.

(U) $3,100 Develop advanced bearing concepts for small- and intermediate-sized turbine engine applications. Design, fabricate, and test electromagnetic rotor support and power generation concepts, components, and materials for advanced, oil-less engines, including demonstrators that are part of the Integrated High Performance Turbine Engine Technology program. Continue development and initiate testing of air and foil bearing technology for small- and intermediate-sized turbine engine applications. Initiate development of modeling and simulation capabilities to advance design, shorten development time, and reduce testing requirements for mechanical and electromagnetic rotor support and power generation systems. Commence advanced rotor support and power generation studies for Versatile Affordable Advanced Turbine Engine program requirements.

(U) $1,000 Develop thermal management concepts and analysis tools for long-range strike applications of varying speed classes. Conduct fuel trade studies to identify fuel options and capability shortfalls for long-range strike applications. Develop diagnostic approaches and sensors for control of fuel/thermal management systems across the flight envelope. Continue development of engine fuel system and thermal management components identified in Versatile Affordable Advanced Turbine Engine program.

(U) $15,060 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion | PROJECT: 3048 |

**(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.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 3066

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3066 Turbine Engine Technology | 40,168 | 44,864 | 43,630 | 41,359 | 38,146 | 38,025 | 38,874 | Continuing | TBD |

Note: In FY 2002, the Hypersonic Technology Program work in this project will be transferred within this PE into 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. Note: In FY 2002, Congress added $1.5 million for Engineering Tool Development Program and $2.3 million for Jet Engine Test Cells.

(U) FY 2001 ($ in Thousands)

(U) $26,308 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 rig testing of a state-of-the-art four-stage compressor and delivered to core engine for complete environmental characterization. Completed 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. Developed a reduced order model for intentional mistuning validation and initiate experimental validation. Fabricated 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) $6,762 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. Rig tested exhaust nozzle hardware capable of fluidic injection to delete the requirement for complex, heavy, expensive variable geometry exhaust systems. Fabricated contoured ceramic composite exhaust nozzle hardware. Performed elevated fuel temperature rig testing of the variable displacement vane pump, which eliminates fuel recirculation to tanks, thereby reducing thermal loading and allowing increased thermal capacity to be used elsewhere in the weapon system. Completed design of the non-linear control system, which simplifies control logic development and provides component performance trend data.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 3066 | |

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

(U) FY 2001 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $3,673 | Developed 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. Fabricated low-cost ceramic turbine blades yielding reduced need for cooling air and higher performance. |
| (U) | $1,776 | Developed components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Initiated rig testing of 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. |
| (U) | $1,649 | Designed, developed, and tested propulsion components to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency (DARPA) missile demonstration. 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. |
| (U) | $40,168 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $28,179 | 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) | $6,900 | 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 |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 3066 | |

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

(U) FY 2002 ($ in Thousands) Continued

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) $3,711 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.

(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) $2,278 Upgrade jet engine compressor and turbine aerodynamic test cells to enable assessment of emerging Air Force jet engine technologies supporting fighter and bomber transformational requirements. Increase power capability to 6000 horse power and develop counter-rotating capability for these facilities.

(U) $1,485 Develop modeling and simulation tools to analyze and predict the performance of aerospace engines and their components. Improve analytical tools associated with aerospace engines with the main focus on high performance, long life, advanced cooling techniques, and combustion stability.

(U) $44,864 Total

(U) FY 2003 ($ in Thousands)

(U) $30,380 Develop core engine components (compressors, combustors, and high-pressure turbines) for turbofan/turbojet engines for fighters, attack aircraft, bombers, long-range strike/next generation bombers, and transports. These components enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Perform testing on 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 cost. Conduct testing on an active combustion control high response fuel valve to reduce acoustically coupled fatigue and enhance overall combustion efficiency resulting in fuel burn reduction. Complete subscale rotational intentional mistuning experiment and initiate application of methodology to transonic rig hardware. Modify the spar/shell turbine blade design system using component bench test

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| | PROJECT: 3066 |

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

(U) FY 2003 ($ in Thousands) Continued

results and transition this technology to engine demonstrator testing.

(U) $7,750 Develop turbine engine components (fans, low pressure turbines, engine controls, exhaust nozzles, and integration technology) for turbofan/turbojet engines for fighters, attack aircraft, bombers, long-range strike/next generation bombers, and transports. These components enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost. Conduct testing of a non-linear control system to simplify control logic development and provide the component performance trend data necessary for transitioning this technology to the demonstrator engine program.

(U) $3,700 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. Conduct rig test of an enhanced fan flow control treatment for an all-composite, forward swept shrouded rotor. Design rub tolerant ceramic for an advanced turbine rotor blades.

(U) $1,800 Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. Conduct durability tests of Ceramic Matrix Composite materials under high temperature/high pressure/high moisture conditions to validate composite integrity and life models. Perform rig tests to demonstrate the feasibility of a very high fuel/air ratio combustor with supercritical fuel delivery system.

(U) $43,630 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 3066 | |

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 3145

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3145 Aerospace Power Technology | 26,727 | 27,376 | 26,890 | 27,831 | 28,090 | 28,688 | 29,266 | Continuing | TBD |

**(U) A. Mission Description**

This 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 air and space platforms, and orbiting/maneuvering vehicles. Lightweight power systems suitable for other space applications are also developed. Note: In FY 2002, Congress added $3.0 million for magnetic bearing cooling turbine; $1.0 million for Poly (p-phenylene-2,6-benzobisoxazole) (PBO) Membrane Fuel Cells; $1.0 million for lithium ion battery technology for aircraft, spacecraft, and handheld applications, and $1.0 million for lithium ion battery technology for solid state lasers.

(U) FY 2001 ($ in Thousands)

(U) $5,479 Developed 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. Continued 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) $8,633 Developed thermal management, energy storage, and power conditioning components, and subsystem technologies for air moving target indication radar, high power lasers for space platforms, and orbiting/maneuvering vehicles. Continued 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 air and space platforms. Developed small-scale heat pipes for passive power electronics cooling for improved power density. Evaluated cycle life for long-term space applications of high energy density lithium ion cells and batteries.

(U) $470 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. Continued development of Yttrium Barium Copper Oxide coated conductors.

(U) $956 Designed, fabricated, and evaluated 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| | PROJECT: 3145 |

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

(U) FY 2001 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $3,634 | Continued development of turbomachinery incorporating magnetic bearings to provide augmented cooling and electrical power to Air Force systems. Designed and fabricated ground test turbomachinery equipment for aircraft application. Evaluated feasibility of magnetic bearings to meet directed energy weapon and Expeditionary Air Force ground support power applications. |
| (U) | $2,486 | Developed the Poly(p-phenylene-2, 6-benzobisoxazole) (PBO) membrane for use in Proton Exchange Membrane direct methanol fuel cells. Characterized physical and electrochemical properties of the membranes. |
| (U) | $1,721 | Modified the Variable Displacement Vane Pump (VDVP) design for test on an engine with commercial applications. Fabricated a VDVP design for advanced tactical aircraft applications and evaluated initial endurance and damage tolerance. |
| (U) | $3,348 | Initiated concepts for an integrated vehicle-power-generation-weapon system. Initiated simulation and design of electrical components for magneto-hydrodynamic (MHD) and electro-magneto-hydrodynamic power systems to provide high power sources for hypersonic systems and directed energy weapons. Enables MHD pressure control of hypersonic engine inlet. |
| (U) | $26,727 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $9,663 | 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. Initiate fabrication of Inverter Converter Controller to demonstrate power denisty 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. 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) | $6,236 | 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 air and 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) | $5,534 | Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion | PROJECT: 3145 |

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

(U) FY 2002 ($ in Thousands) Continued

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) $2,970 Develop and demonstrate magnetic bearings for cooling turbine/power generation systems. Magnetic bearings provide increased cooling package reliability and longer life cycles over conventional turbine systems with rolling element bearings or air bearings. This task optimizes the controls for an integrated cooling turbine-generator trim load and advanced magnetic bearing cooling turbine systems.

(U) $991 Develop Poly(p-phenylene-2, 6-benzobisoxazole) (PBO)-based membrane fuel cells. PBO membrane fuel cells offer a lower cost, lighter weight, higher performance, and more energy efficient fuel cell over existing proton exchange membrane fuel cells. Initiate design and fabrication for a prototype PBO-based membrane in a single cell configuration.

(U) $991 Develop large ampere-hour rechargeable lithium-ion cell battery technology for future spacecraft and aircraft. Lithium-ion batteries offer advantages over conventional systems by storing the same amount of energy at one-fourth the weight. Potential applications for rechargeable lithium-ion batteries include satellite energy storage, manned and unmanned aircraft, planetary orbiters, and ground support equipment. Initiate development of large ampere-hour cells that address cycle life technical issues for aircraft and Low Earth Orbit space applications and also address calendar life technical issues paramount for Geosynchronous Earth Orbit applications.

(U) $991 Develop high pulse power rechargeable lithium-ion cell battery technology that maximizes current capacity under high discharge rates required for solid state lasers. Potential high power military applications could include pulse power weapons for spacecraft and aircraft. This effort will focus on proper design and fabrication techniques beginning with relatively small ampere-hour cells.

(U) $27,376 Total

(U) FY 2003 ($ in Thousands)

(U) $9,850 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. Conduct testing of advanced switched reluctance machine controllers. Fabricate and conduct tests on full-scale lithium ion batteries and fuel cells for manned and unmanned vehicles. Continue development of lithium polymer cells.

(U) $5,340 Develop thermal management, energy storage and power conditioning components, and subsystem technologies for aerospace applications. Test and demonstrate an integrated Power Management and Distribution system for space-based distributed power systems that are half the

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 3145 | |

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

(U) FY 2003 ($ in Thousands) Continued

weight and volume of conventional approaches. Fabricate and test full-scale lithium-ion batteries for aerospace spacecraft applications.

(U) $9,700 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. Fabricate and test high density power conditioning for directed energy weapon systems. Continue developing high rate (pulse power) lithium ion batteries. Initiate testing of a thermal management system with Yttrium Barium Copper Oxide coated wire and coils for cryogenic generator applications.

(U) $2,000 Develop high density electrical power system and thermal management technologies for a next generation aerospace long-range strike vehicle. Develop power and thermal requirements for a long-range strike aircraft incorporating advanced weapon systems and initiate compact high power conditioning, energy storage, and thermal management component designs that optimize secondary power system size, weight, and efficiency.

(U) $26,890 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0601102F, Defense Research Sciences.
(U) PE 0602102F, 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**

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion | PROJECT: 3145 |

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

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT: 4847

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4847 Rocket Propulsion Technology | 68,959 | 72,260 | 18,442 | 18,865 | 19,214 | 19,545 | 20,049 | Continuing | TBD |

Note: In FY 2003, space unique tasks in this project will be transferred to PE 0602500F, Project 5026, in conjunction with the Space Commission recommendation to consolidate all space-unique activities.

**(U) A. Mission Description**

This 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. Note: In FY 2002, Congress added $7.1 million for the Integrated High Payoff Rocket Propulsion Technology Program and $10.7 million for upgrading Air Force Research Laboratory Test Stands at Edwards Air Force Base.

(U) FY 2001 ($ in Thousands)

(U) $4,433 Developed high-energy density and non-toxic propellants for increased space launch payload capability. Refined 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. Scaled-up selected propellants for testing and evaluation. Continued to develop, characterize, and model new and advanced propellants for scale-up and testing. Optimized synthetic routes for polymer binders and fuel formulations with specific impulse (Isp) exceeding that available from current systems. Developed high-energy oxidizer formulations for combustion with high-energy fuels to yield greatly enhanced performance. Continued research in the area of low-cost, non-toxic mono-propellants for current and future launch systems. Characterized, studied, and evaluated selected propellants in advanced combustion devices to determine compatibility and performance. Developed and characterized advanced propellants for use in revolutionary launch and spacecraft propulsions systems. Provided technical expertise for the continued use of energetic chemical rocket propellants in existing rocket propulsion systems.

(U) $2,793 Developed advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engines used in heavy lift space vehicles. Continued to characterize, study/evaluate injector performance with application to combustor chamber/injector compatibility to prevent damage to test and operational combustion devices; continued to support commercially developed injectors using unique Air Force test facilities. Developed, analyzed, and modeled advanced combustion devices and injectors that are

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

compatible with new energetic propellants. Developed and evaluated through analysis and modeling advanced/revolutionary propulsion concepts with enhanced performance and reliability.

(U) $5,111 Continued to develop advanced material technology for lightweight components and material property enhancements for use in launch and space systems. Developed advanced ablative components using hybrid polymers for use in current and future launch systems Characterized and developed 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. Developed advanced materials for use with high-energy propellants. Transitioned advanced high temperature materials to the commercial industry and Air Force systems for reduced system weight/cost and increased performance.

(U) $2,092 Continued the development of analytical tools for prediction of propellant life. Continued the transition to industry the tools and techniques used to determine the age life of strategic systems and other solid rocket motors.

(U) $18,735 Continued to develop propulsion component technology for reliable, safe, and low-cost boost and orbit transfer systems. Continued to develop design and processing techniques for high-strength, low-weight engine and motor components (metals and non-metals). Continued development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Initiated development of a low-cost, high discharge pressure turbopump for advanced cryogenic engines. Continued to develop liquid oxidizer for hybrid propulsion technologies for space boosters and air launched missiles. Continued 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. Continued development of high temperature oxygen rich turbine materials for applications to oxidizer rich turbomachinery. Continued application of advanced Aluminum Metal Matrix Composite Materials to rocket turbomachinery housings and rocket structural hardware. Continued characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions. Verified performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continued to demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket space boosters and missiles. Fabricated and tested advanced lightweight rocket engine nozzle for upper stage and space booster applications. Continued characterizing new refractory combustion materials and devices to apply to liquid-propellant rocket engines with dramatic weight reductions. Continued to develop and characterize components applicable to liquid propulsion (cryogenic and storable). Initiated feasibility studies concerning rocket based combined cycle engines.

(U) $6,975 Continued development of missile propulsion technology, aging and surveillance technology, and Post Boost Control Systems (PBCS) for sustainment of current Intercontinental Ballistic Missile fleet. Completed development of compatible case/liner, insulator, and case systems for

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

higher combustion temperature propellants. Completed design and begin fabrication of solid rocket motor test hardware. Initiated a project to develop an advanced lightweight solid rocket motor. Continued development of tools to increase the capability to determine the service life of strategic systems and other solid rocket motors. Completed the development of the advanced PBCS. Continued 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) $5,120 Continued developing solar electric and solar thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites and satellite constellations. Continued Hall thruster development efforts to meet Air Force need for orbit transfers using electric propulsion. Continued development of propulsion systems, including pulsed plasma thrusters, for microsatellites (< 25 kg) needed for advanced Air Force imaging missions. Continued developing solar thrusters and concentrators for future orbital transfer vehicles. Performed preliminary characterization of concentrator surface roughness. Fabricated an advanced solar thermal thruster and integrate with an inflatable concentrator. Began development of an electrically controlled solid propellant.

(U) $12,600 Upgraded and activated rocket engine test stand to enable system level research and test capabilities for new and existing rocket engines. Upgraded test stand for liquid oxygen/kerosene engine research. Prepared test stand to support Integrated High Payoff Rocket Propulsion Technology hydrocarbon boost engine test.

(U) $11,100 Upgraded and activated rocket component test stand 2A at Edwards Air Force Base, California, to support component level research of advanced rocket propulsion systems. Installed high-pressure piping and data acquisition system components.

(U) $68,959 Total

(U) FY 2002 ($ in Thousands)

(U) $5,122 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 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

(U) $2,475 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. 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) $12,600 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) $7,038 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) $7,375 Develop solar electric and thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites and satellite constellations. Continue Hall thruster development efforts to achieve Air Force orbit transfers using electric propulsion. Continue development of microsatellites (< 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

power solar thermal components

(U) $11,985 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) $7,032 Conduct risk reduction efforts on the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program. This includes adding an alternate, high temperature material into the hot gas valve for development and testing of lower cost, higher performance Post Boost Control System propulsion materials, a key portion of the Technology for the Sustainment of Strategic Systems program. Conduct solid and liquid propellant synthesis and scale-up critical for meeting IHPRPT goals to significantly reduce cost-per-pound of payload to orbit for space launch applications. Conduct interim demonstrations of subsystems (propellant, case, nozzle, and insulation) for missile propulsion demonstration programs. Conduct demonstration of new monopropellant solution for spacecraft applications such as the TechSat 21 flight experiment.

(U) $10,597 Complete refurbishment and modernization of a large liquid rocket engine test stand and a component test stand to meet increased demand for liquid rocket test capability at Edwards Air Force Base. Perform modifications necessary to accommodate multiple users and broader capability on Test Stand 1D. Provide increased capability on Test Stand 2A for high pressure fluid storage and more test configurations.

(U) $72,260 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602203F Aerospace Propulsion |
| PROJECT: 4847 | |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $18,442 | This project previously included space unique funding which has been transferred to PE 0602500F, Project 5026. These funds represent the civilian salaries for the work effort transferred and will be transferred at a later date. |
| (U) | $18,442 | 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.
(U) PE 0603401F, Advanced Spacecraft Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 65,412 | 80,847 | 75,799 | 80,380 | 86,316 | 94,626 | 96,330 | Continuing | TBD |
| 2002 | Electronic Component Technology | 21,461 | 20,302 | 13,184 | 11,846 | 12,770 | 16,725 | 16,942 | Continuing | TBD |
| 2003 | EO Sensors & Countermeasures Tech | 11,312 | 14,557 | 14,663 | 15,865 | 15,871 | 16,325 | 16,815 | Continuing | TBD |
| 4916 | Electromagnetic Tech | 0 | 7,298 | 7,264 | 7,420 | 7,507 | 7,685 | 7,888 | Continuing | TBD |
| 5016 | Photonic Component Technology | 0 | 0 | 2,343 | 2,767 | 3,196 | 2,264 | 2,273 | Continuing | TBD |
| 5017 | RF Processing for ISR Sensors | 0 | 0 | 8,143 | 6,773 | 7,988 | 8,037 | 7,595 | Continuing | TBD |
| 6095 | Sensor Fusion Technology | 14,165 | 13,237 | 12,968 | 12,385 | 14,271 | 16,431 | 17,097 | Continuing | TBD |
| 7622 | RF Sensors & Countermeasures Tech | 18,474 | 25,453 | 17,234 | 23,324 | 24,713 | 27,159 | 27,720 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

In FY 2002, work performed under PE 0602702F, Project 4600, moved to this PE, Project 4916. Apparent project ramps are due only to realignment of the projects. This realignment aligned projects with the Air Force Research Laboratory organization. Project realignment did not affect work planned for the overall program element or the budget topline. In FY 2003, space unique tasks in this PE, Projects 2002, 6095, and 7622, will be transferred to PE 0602500F, Projects 5028 and 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |

**(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 surveillance, together with active and passive 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 2002, Congress added $1.2 million for Integration on Flexible Substances, $1.8 million for Adverse Weather Ballistic Imaging and Targeting System, and $1.0 million for Advanced Fourier Transform - Infrared (FT-IR) Gas Analysis.

**(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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 67,024 | 84,149 | 81,697 | |
| (U) | Appropriated Value | 67,644 | 81,149 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -302 | | |
| | b. Small Business Innovative Research | -1,612 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -620 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -5,898 | |
| (U) | Current Budget Submit/FY 2003 PBR | 65,412 | 80,847 | 75,799 | TBD |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |

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

(U) Significant Program Changes:

In FY 2002, work performed under PE 0602702F, Project 4600, moved to this PE, Project 4916. Apparent project ramps are due only to realignment of the projects. This realignment aligned projects with the Air Force Research Laboratory organization. Project realignment did not affect work planned for the overall program element or the budget topline. In FY 2003, space unique tasks in this PE, Projects 2002, 6095, and 7622, will be transferred to PE 0602500F, Projects 5028 and 5029, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 2002

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2002 Electronic Component Technology | 21,461 | 20,302 | 13,184 | 11,846 | 12,770 | 16,725 | 16,942 | Continuing | TBD |

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

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $3,313 Developed compact, affordable, multi-function receiver and phased array components for radar, EW, and other ISR sensors. Demonstrated miniature airborne digital receiver components. Designed and fabricated direct digital waveform transmitters and high-resolution (10-16 bit), ultra-low power (<3.0W) analog-to-digital converters. Demonstrated and refined advanced component evaluation methods. (In FY 2000, portions of this work were performed in Project 6096.)

(U) $4,044 Developed microwave technologies for advanced RF apertures and phased array antennas used in military ISR sensors. Fabricated a high operating temperature, high-efficiency power amplifier to allow dispersed placement of active arrays. Demonstrated S-band (2-4 GHz) silicon carbide transistors for air defense networks. Demonstrated advanced vacuum electronics components. Conducted 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) $10,018 Developed packaging and integration technologies for high performance aerospace RF sensor components. Demonstrated device and multi-chip module surface protective coatings and mixed analog/digital microwave circuits to improve reliability and lower the cost of

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

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

(U) FY 2001 ($ in Thousands) Continued

components operating in harsh military environments. Tested 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) $489 Developed signal control components and techniques to meet radio frequency (RF) loss levels required for future radar, electronic warfare (EW), and intelligence, surveillance, and reconnaissance (ISR) sensors. Designed micro-electro-mechanical phase shifters with a 300% improvement in RF loss performance. Developed miniature filters for high performance channelized radar and EW receivers.

(U) $1,597 Developed RF photonics technologies to demonstrate compact, affordable, wide bandwidth, high data rate aerospace sensors. Fabricated photonic components for high performance digital receivers and signal processors. (Prior to FY 2001, this work was performed in Project 6096.)

(U) $2,000 Developed three-dimensional (3-D) interconnects and packaging technologies for 3-D non-volatile memory.

(U) $21,461 Total

(U) FY 2002 ($ in Thousands)

(U) $3,294 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 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 aerospace platforms.

(U) $3,326 Develop microwave technologies for advanced RF apertures and phased array antennas used in military 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) $4,192 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) $604 Develop signal control components and techniques to meet RF loss levels required for future radar, electronic warfare, and ISR sensors.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

Fabricate and characterize micro-electro-mechanical systems phase shifters for 300% improvement in RF loss performance operating over a 3:1 bandwidth.

(U) $4,205 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) $2,502 Develop innovative transmitter and receiver concepts along with the associated component technology alternatives required for an affordable space-based radio frequency (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) $991 Design and develop Fourier Transform-Infrared spectrometric gas analysis techniques for applications in controlling reactant gases generated during the vapor phase epitaxial growth of semiconductor films on substrates. These techniques will also be used to monitor gas concentrations in nanostructure growths for electronic and optical devices, and in the development of new approaches to detecting chemical and biological agents.

(U) $1,188 Develop and conduct a proof of concept demonstration of the integration of active aperture components into flexible RF-compatible substrates. Integrating these components will enable robust chip placement on flexible phased array subassemblies for radar, electronic warfare, and communications systems.

(U) $20,302 Total

(U) FY 2003 ($ in Thousands)

(U) $3,597 Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System (GPS), radar, electronic warfare (EW), and other intelligence, surveillance, and reconnaissance (ISR) sensors. Test Gallium Arsenide and Indium Phosphide RF components (ADCs, filters, mixers, etc.) inserted into radar and EW digital receiver modules against environment scenarios. Demonstrate a brassboard low-power (< 1.0W), silicon-on-sapphire based analog-to-digital converter and completed ground-level radiation testing in a space-qualified package. Laboratory test a silicon-on-insulator mixed-signal (digital, RF, microwave, etc.) integrated circuit, for reconfigurable signal conversion.

(U) $2,545 Develop microwave technologies for advanced RF apertures and phased array antennas used in military ISR sensors. Develop and demonstrate robust components for L-band and X-band transmitter and receiver channels that operate with limited environmental controls and under severe

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

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

(U) FY 2003 ($ in Thousands) Continued

electromagnetic stress.

(U) $3,247 Develop integration and assembly technologies for high performance aerospace phased array sensors. Demonstrate X-band, flexible RF membrane based sub-assemblies that enable integrating low-cost and low-mass transmitter and receiver channels at the subarray level.

(U) $2,171 Develop signal control and low-power consumption components and techniques to reduce both power loss and power consumption. These components will be required for future radar, EW, and ISR sensors. Characterize and mature micro-electro-mechanical systems wideband phase shifters for extended switch lifetimes. Reduce the power consumption of low-noise amplifiers while maintaining high linearity over wide bandwidths.

(U) $1,624 Refine materials and processes for two-dimensional and three-dimensional device interconnects and component protection from the environment. Verify these inteconnects and components perform on rigid, flexible, and conformal assemblies of high density mixed signal technologies (digital, analog, microwave and millimeter wave devices and components). Test interconnects and components in both packaged (non-hermetic multi-chip modules) and package-less (bare-die-chip on board) forms.

(U) $13,184 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602500F, Multi-disciplinary Space Tech.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603270F, Electronic Combat Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 2003

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | EO Sensors & Countermeasures Tech | 11,312 | 14,557 | 14,663 | 15,865 | 15,871 | 16,325 | 16,815 | Continuing | TBD |

**(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 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 2001 ($ in Thousands)

(U) $3,497 Developed day/night EO sensor component technologies to detect, locate, and identify low contrast ground and aerospace targets from high altitude and space. Developed imaging spectrometer techniques and multispectral focal plane array components. Performed laboratory and field tests on techniques and components. Assessed performance.

(U) $1,042 Developed technology for non-cooperative identification of airborne and ground-based platforms. Designed long-range sensors. Tested coherent image processing/extraction algorithms. Flight demonstrated a multifunction ladar.

(U) $891 Developed military-unique optical transmission components to enable information dominance. Demonstrated useful commercial-off-the-shelf technologies integrated with military-unique components.

(U) $2,356 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. Designed generic modules to improve capabilities of existing systems. Analyzed and demonstrated concepts based on high precision pointing, range gating, and image processing.

(U) $687 Developed countermeasure technologies against IR-guided missiles and EO threats. Designed components and refine techniques to defeat imaging missile seekers. (Prior to FY 2001, this work was conducted in Project 2000.)

(U) $1,521 Developed aerospace missile and laser warning technologies to accurately cue countermeasures. Developed temporal and spectral tracking algorithms, advancing from two-color to multispectral imaging techniques. Tested advanced sensor hardware. (Prior to FY 2001, this work was conducted in Project 2000.)

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 2003 |

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

(U) FY 2001 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $1,318 | Developed optical transmitter technology capable of sensing multiple target characteristics to provide robust non-cooperative target identification. Fabricated a single imaging and non-imaging transmitter. (In FY 2001, this effort transferred from this PE, Project 2000.) |
| (U) | $11,312 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,080 | 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 analyzing and evaluating multifunction ladar flight demonstration data for CID. |
| (U) | $2,799 | Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification. Continue developing 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) | $3,549 | 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. Design and demonstrate targeting 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) | $1,808 | Develop countermeasure technologies for use against infrared- and EO-guided missiles. Continue to design components and refine techniques to defeat imaging missile seekers. Continue exploiting advanced infrared missile technology. |
| (U) | $1,539 | 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) | $1,782 | Investigate the feasibility of designing and fabricating a 3-D Adverse Weather Ballistic Imaging and Targeting System imaging laser radar sensor for the Predator Unmannned Aerial Vehicle. This laser radar would be capable of making one-foot resolution 3-D images of targets and areas of interest through moderate cloud cover. |
| (U) | $14,557 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 2003 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,571 | Develop technology for non-cooperative identification of airborne and ground-based platforms. Conduct air-to-air and air-to-ground demonstrations of long-range combat identification (CID) sensors. Test range-resolved coherent image processing and extraction algorithms, including three-dimensional (3-D) block registration algorithms. Conduct long-range experiments using advanced 3-D sensors for CID applications. Continue passive hyperspectral model development, validation, and performance predictions, and assess signature-based data processing performance based on ground demonstration data. Continue flights, analysis, and evaluation of multifunction ladar for identification of ground targets. |
| (U) | $3,149 | Develop optical transmitter technology capable of sensing multiple target characteristics for robust non-cooperative target identification. Develop pulsed vibration sensing system for long range CID. Begin development of flight-capable, multi-function architectures. Integrate platform compensation techniques into new architectures. Develop breadboard multi-spectral transmitter, and predict performance for different types of targets. |
| (U) | $4,346 | Develop innovative techniques and components to target difficult objects in degraded atmospheric conditions. Continue utility analysis of high altitude active sensors, including platform trades. Perform tower tests of an active multi-spectral imaging system. Demonstrate imaging through weather and obscurants through flight test of active imaging sensors. Design and demonstrate concepts based on high precision pointing, range gating, and image processing. Develop concepts for airborne application of non-mechanical beam steering devices, including mitigating aero-optical effects. Investigate concepts for combined radio frequency and electro-optical apertures. |
| (U) | $1,948 | Develop countermeasure technologies for use against infrared-guided missiles and electro-optical threats. Continue to design components and refine techniques to defeat imaging missile seekers. Continue the exploitation of advanced infrared missile technology. |
| (U) | $649 | Develop aerospace missile and laser warning technologies to accurately cue countermeasures. Laboratory test temporal and spectral tracking algorithms focused on multi-spectral imaging techniques. Initiate the testing of an advanced laser warning receiver for application in a space environment. |
| (U) | $14,663 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 2003 |

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

(U) Related Activities:

(U) PE 0602500F, Multi-disciplinary Space Tech.

(U) PE 0603253F, Advanced Sensor Integration.

(U) PE 0602301E, Intelligence System Program.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 4916

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4916 Electromagnetic Tech | 0 | 7,298 | 7,264 | 7,420 | 7,507 | 7,685 | 7,888 | Continuing | TBD |

In FY 2002, this work transfers to this project 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 2001 ($ in Thousands)

(U) $0 Effort conducted in PE 0602702F, Project 4600.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $1,792 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) $1,941 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) $1,672 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) $1,893 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 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 4916 |

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

(U) FY 2002 ($ in Thousands) Continued

(U) $7,298 Total

(U) FY 2003 ($ in Thousands)

(U) $1,933 Investigate detecting difficult airborne and ground-based targets in clutter from airborne or space-based surveillance platforms. Develop models and experimental techniques for characterizing radio frequency scatter from targets, ground clutter, and foliage.

(U) $1,850 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 forming and limited-scan phased array antennas. Develop high-speed electronics antenna front end applications and micro-electro-mechanical systems technology for delay line switching in phased arrays.

(U) $1,681 Design and develop new electro-optical techniques and components for detecting and identifying concealed targets. Design and fabricate multifunction sensor arrays and the associated materials and device technologies for optical beam steering. Design and develop active components and integration techniques for autonomous three dimensional ladar-guided munitions and other imaging applications. Develop optical processing techniques that compensate for optical aberration in aircraft-generated turbulence.

(U) $1,800 Develop hardware and software for passive multi-dimensional sensing in the thermal infrared spectral wavelength range at high frame rates. Establish viability of tomographic hyperspectral sensing techniques for aerospace applications. Demonstrate the applicability of tomographic hyperspectral sensor concepts to characterizing explosions and missile launches, and to developing techniques for real-time bomb-damage assessment.

(U) $7,264 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602500F, Multi-disciplinary Space Tech.

(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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors | PROJECT: 4916 |

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 5016

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5016 Photonic Component Technology | 0 | 0 | 2,343 | 2,767 | 3,196 | 2,264 | 2,273 | Continuing | TBD |

In FY 2003, photonic component technology work previously performed in this PE, Project 2002, will transfer to this project.

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $1,650 Develop high performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband RF phased array antenna beamforming and control, and for high data rate aerospace sensors and communication systems.
(U) $693 Develop ultrafast, wideband photonic analog-to-digital mixed signal conversion component technology.
(U) $2,343 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 5016 |

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602500F, Multi-disciplinary Space Tech.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603270F, Electronic Combat Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 5017

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5017 RF Processing for ISR Sensors | 0 | 0 | 8,143 | 6,773 | 7,988 | 8,037 | 7,595 | Continuing | TBD |

In FY 2003, efforts in radio frequency processing for intelligence, surveillance, and reconnaissance sensors previously performed in this PE, Project 7622, will transfer to this project.

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $1,572 Investigate techniques for implementing distributed airborne sensor systems to increase sensitivity and improve location accuracy. These techniques include sparse arrays with maneuvering platforms and improved location accuracy using interfermetric methods combined with knowledge-based responsive mode selections.
(U) $2,098 Investigate techniques for multi-intelligence data acquisition from a single platform. Investigate common waveform techniques, knowledge-based scheduling, and advanced target detection for both unconcealed and concealed targets. Determine the electromagnetic compatibility issues associated with simultaneously hosting and operating multiple radars, electronic support measure receivers, integrated communications, and electronic attack components on a single platform. Investigate methods to mitigate unintentional interference sources to multi-intelligence platforms from the ground and in the air, such as commercial broadcast assets, civilian radar assets, and commercial communications systems.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 5017 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $3,940 | Develop multi-mission aerospace microwave processing algorithms to detect and locate advanced cruise missiles, slowly moving ground targets, and stationary targets in severe clutter and jamming environments. Study 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 emission detection. Study advanced waveforms for achieving transmitter adaptivity and simultaneous multi-mode operation to improve interference rejection, self protection, and target identification by exploiting diversities in frequencies, delays, polarizations, modulations, and codings. Develop knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in ground moving target indication sensors. |
| (U) | $533 | Study and analyze technology for detecting and precisely locating concealed targets using standoff aerospace platforms. Initiate investigating emerging adaptive processing techniques for knowledge-aided multi-mission processing and resource management. Initiate the study of adaptive processing techniques for multi-mission conformal arrays. Initiate the study of wideband and polarization adaptive processing techniques for multi-function radar. |
| (U) | $8,143 | Total |

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602500F, Multi-disciplinary Space Tech.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603270F, Electronic Combat Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 6095

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 6095 Sensor Fusion Technology | 14,165 | 13,237 | 12,968 | 12,385 | 14,271 | 16,431 | 17,097 | Continuing | TBD |

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

**(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 2001 ($ in Thousands)

(U) $5,720 Developed, evaluated, and demonstrated single and multi-sensor lethality algorithms to dramatically improve air combat capability. Performed a live-feed to ground station emulation to evaluate real-time information-into-the-cockpit targeting schemes, and to optimize adaptive resource allocation methods. Completed demonstration of real-time, on-board ATR and information fusion using live threat emitter data.

(U) $3,119 Developed, evaluated, and demonstrated single and multi-sensor radar target signature models to support ATR in strike operations. Transitioned the ground target signature database to an operational air-to-ground ATR system. Developed physics-based dynamic complex synthetic aperture radar scene simulation capability using advanced modeling and simulation techniques. Developed innovative target recognition techniques using advanced scattering phenomenology analysis. Transitioned advanced phenomenology-based target recognition techniques to the intelligence community.

(U) $1,257 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. Developed full, collaborative sensor-to-shooter algorithm environment utilizing the most advanced DoD laboratory capabilities from across the country. Evaluated sensor-to-shooter technologies and developed operational concepts.

(U) $134 Developed sensors to provide precise time, position, and velocity measurements to enable multiple-platform, sensor-to-shooter operations in jamming environments. Developed Global Positioning System (GPS) specific jamming mitigation techniques for operation in hostile radio frequency environments. Assessed the advantages for signal tracking of collocating an inertial measurement unit with the phase center of a GPS antenna, and devised techniques to exploit this capability for navigation and strike. Designed and implemented methods to enable GPS receivers to simultaneously handle strong signals from nearby differential reference sources and the weak signals from GPS satellites to

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

improve jam-resistance and positional accuracy.

(U) $3,935 Developed and demonstrated enabling automatic target recognition (ATR) technologies for future intelligence, surveillance, and reconnaissance (ISR) applications. Evaluated 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, continued developing high-impact technologies needed to provide extremely high altitude, long-range targeting and attack capabilities.

(U) $14,165 Total

(U) FY 2002 ($ in Thousands)

(U) $1,954 Develop and evaluate single and multi-sensor ATR lethality algorithms to dramatically improve capability to rapidly find, track, and target time critical mobile targets. 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) $2,547 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, electro-optical 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) $1,788 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) $5,039 Develop and demonstrate enabling ATR technologies for intelligence, surveillance, and reconnaissance applications. Continue evaluating physics-based and adaptive learning techniques.

(U) $1,909 Develop ATR and Sensor Fusion performance assessment technology. Conduct ATR performance evaluation theory research.

(U) $13,237 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 6095 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,976 | Continue integrating, evaluating, and demonstrating single and multi-sensor ATR and sensor fusion algorithms for rapidly finding, tracking, and targeting mobile targets. Continue integrating real-time ATR algorithms, for time-critical targets, on embedded high-performance computing systems. Complete laboratory demonstration of adaptive resource allocation methods. Continue integrating and evaluating algorithms and concepts for detecting and targeting targets under trees. Complete developing single sensor ATR performance assessment technology, and multi-sensor and sensor fusion assessment technology. Continue ATR performance evaluation theory research. Complete the first single sensor automatic target recognition (ATR) performance prediction model. |
| (U) | $3,853 | Develop, evaluate, and demonstrate target signature models to support ATR and sensor fusion algorithm development and testing for reconnaissance and strike mission applications. Develop target signature models for signature exploitation of synthetic aperture radar, electro-optical multispectral systems, and signals intelligence sensors. Demonstrate the ability to generate synthetic air and ground target signatures with sufficient fidelity to support automatic recognition of targets in operationally realistic mission environments. Develop modeling and simulation tools that can estimate warfighter effectiveness enhancements due to inserting ATR and sensor fusion aids into the reconnaissance and strike components of the time-critical targeting kill chain. |
| (U) | $4,508 | Develop and demonstrate enabling ATR, sensor management, and sensor fusion technologies for target detection, tracking, and identification in intelligence, surveillance, and reconnaissance (ISR) and combat identification (CID) applications. Complete the evaluation of adaptive learning techniques for target identification. Initiate laboratory demonstration of adaptive sensor management algorithms for target detection, tracking, and ID. Continue evaluation of physics-based techniques for target detection and identification for ISR and CID applications. |
| (U) | $631 | Develop precision time, position, and velocity sensors capable of operating in jamming environments. These sensors will enable multiple platform sensor to shooter operations. Continue development of Global Positioning System specific jamming mitigation techniques for operation in hostile radio frequency environments with emphasis on synergistically integrating anti-jam technologies. Develop virtual flight test technology for improved assessment of reference sensors. |
| (U) | $12,968 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 6095 |

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

(U) Related Activities:
(U) PE 0602500F, Multi-disciplinary Space Tech.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0603270F, Electronic Combat Technology.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0603762E, Sensor and Guidance Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602204F Aerospace Sensors

PROJECT: 7622

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 7622 RF Sensors & Countermeasures Tech | 18,474 | 25,453 | 17,234 | 23,324 | 24,713 | 27,159 | 27,720 | Continuing | TBD |

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

**(U) A. Mission Description**

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

(U) FY 2001 ($ in Thousands)

(U) $4,988 Developed aerospace microwave sensor technologies for detecting, locating, and engaging airborne and ground targets. Developed 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. Conducted airborne radar data collection. Performed laboratory analysis for application of advanced surveillance techniques. (This effort incorporated work previously performed under PE 0602702F, Project 4506.)

(U) $4,451 Developed 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. Analyzed individual algorithms for improved air and ground moving target indication algorithm performance. Developed adaptive processing techniques that incorporate knowledge-based approaches.

(U) $1,127 Developed technology for detecting and attacking concealed targets. Evaluated 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) $3,008 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 7622 |

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

(U) FY 2001 ($ in Thousands) Continued

techniques, and techniques to degrade modern communication networks. (Prior to FY 2001, this work was conducted in this PE, Project 2000.)

(U) $3,708 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) $1,192 Developed affordable antenna technology for use in operational and future aerospace platform electronic receivers and apertures. Demonstrated, in the laboratory, an integrated ensemble of low-frequency direction-finding antennas. Developed highly precise, wideband, interferometric multimode direction-finding antennas. Demonstrated a micro-electro-mechanical phase shifter controlled array. Demonstrated design tools to predict antenna performance. (Prior to FY 2001, this work was conducted in this PE, Project 2000.)

(U) $18,474 Total

(U) FY 2002 ($ in Thousands)

(U) $2,199 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, and multi-intelligence sensor concept studies and system analyses. Demonstrate sensor performance through in-flight experiments and simulations.

(U) $3,551 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) $1,276 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) $1,735 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

| | | |
|---|---|---|
| (U) | $2,797 | 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) | $3,816 | 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) | $2,790 | 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 radio frequency (RF) architectures and signal processing techniques. Analyze the utility of a space-based sensor architecture. |
| (U) | $1,983 | 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 strategies. |
| (U) | $5,306 | Develop and analyze concepts for a multi-mission unmanned aerial vehicle based sensor suite capable of detecting and tracking advanced aerial targets and both exposed and concealed ground targets. Determine enabling technologies required for full target surveillance capability. |
| (U) | $25,453 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $6,956 | 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. Continue exploitation evaluations against new, advanced RF threats. Develop optimized EW techniques to degrade modern radar, communication, and missile threat systems. Initiate phase calibration development. |
| (U) | $5,357 | Develop technology to enable affordable upgrades to RF signal receivers. Model threat identification algorithms for next generation threat warning receivers. Evaluate state-of-the-art radar and EW digital receiver subsystems with Gallium Arsenide and Indium Phosphide RF components (ADCs, filters, mixers, etc.) for laboratory environment scenario testing. Design advanced very high frequency receiver improvements for detecting targets under trees. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602204F Aerospace Sensors |
| | PROJECT: 7622 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $4,042 | Develop robust, ultra wide bandwidth antenna technology for use in operational and future aerospace platform electronic apertures. Demonstrate prototype wideband, high precision interferometric multimode direction finding antennas. Develop design tools to predict antenna performance installed on host platform models. Demonstrate components and techniques that increase fivefold the signal handling capability of an aperture. |
| (U) | $879 | Develop and evaluate innovative multi-function RF sensing concepts for aerospace applications through modeling and simulation with an emphasis on system engineering. |
| (U) | $17,234 | Total |

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602500F, Multi-disciplinary Space Tech.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603253F, Advanced Avionics Integration.
(U) PE 0602782A, Command, Control, Communications Technology.
(U) PE 0602232N, Navy C3 Technology.
(U) PE 0603792N, Advanced Technology Transition.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 0 | 0 | 53,592 | 70,020 | 73,748 | 68,442 | 73,070 | Continuing | TBD |
| 5023 | Laser & Imaging Space Tech | 0 | 0 | 1,273 | 1,083 | 1,012 | 420 | 398 | Continuing | TBD |
| 5024 | Human Centered Applied Space Tech | 0 | 0 | 496 | 693 | 869 | 0 | 0 | Continuing | TBD |
| 5025 | Space Materials Development | 0 | 0 | 18,608 | 20,449 | 23,888 | 24,144 | 24,676 | Continuing | TBD |
| 5026 | Rocket Propulsion Component Tech | 0 | 0 | 19,612 | 31,048 | 32,543 | 33,206 | 33,708 | Continuing | TBD |
| 5027 | High Speed Airbreathing Prop Tech | 0 | 0 | 4,238 | 4,668 | 4,904 | 5,094 | 5,210 | Continuing | TBD |
| 5028 | Space Sensors, Photonics & RF Proc | 0 | 0 | 1,025 | 1,602 | 2,064 | 1,871 | 4,491 | Continuing | TBD |
| 5029 | Space Sensor & CM Tech | 0 | 0 | 7,038 | 8,737 | 5,650 | 1,687 | 1,186 | Continuing | TBD |
| 5030 | Applied Space Access Vehicle Tech | 0 | 0 | 1,302 | 1,740 | 2,818 | 2,020 | 3,401 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities. In FY 2003, space unique efforts in the following PEs/Projects transferred to this PE in conjunction with the Space Commission recommendation: PE 0602102F, Projects 4347, 4348, 4349, and 5015, to Project 5025; PE 0602201F, Project 2403, to Project 5030; PE 0602202F, Project 7184, to Project 5024; PE 0602203F, Project 4847, to Project 5026; PE 0602203F, Project 3012, to Project 5027; PE 0602204F, Project 2002, to Project 5028; Projects 2002, 6095, and 7622, to Project 5029; PE 0602605F, Project 4866, to Project 5023.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH |

In FY 2003, this program anticipates receiving $43.0 million from the Cost of War Transfer Account. These funds are not included in the FY 2003 Air Force baseline. Funding will be used to advance technologies in support of space-based radar efforts.

**(U) A. Mission Description**

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

**(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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 0 | 0 | 0 | |
| (U) | Appropriated Value | 0 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 53,592 | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Current Budget Submit/FY 2003 PBR | 0 | 0 | 53,592 | TBD |

(U) Significant Program Changes:

This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5023

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5023 Laser & Imaging Space Tech | 0 | 0 | 1,273 | 1,083 | 1,012 | 420 | 398 | Continuing | TBD |

Note: In FY 2003, space unique efforts transferred from PE 0602605F, Project 4866, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project examines the technical feasibility of laser and imaging technologies that are uniquely space-oriented technology including advanced, very long-range optical system concepts for both imaging and beam projection applications. It also supports the modeling and analysis of satellite objects to assess vulnerability to laser radiation and to support the space situational awareness mission. Near-term focus is on the continued assessment of satellite vulnerabilities and their investigation of optical approaches to meet optical quality requirements for ultra-light, large aperture, space-based optical systems.

(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) FY 2003 ($ in Thousands)

(U) $636 Develop and field test advanced optics technologies to support beam projection and imaging applications associated with large aperture lightweight optics. Investigate, test, and characterize larger size advanced optics/liquid crystal optical devices scalable to high power beam projection applications. By decreasing the number of system components and extending the wavelength coverage, this technology has the potential to enable the use of ultra-light, large aperture mirrors in space-based optical systems.

(U) $637 Assess the vulnerability of five new United States, North Atlantic Treaty Organization, or foreign satellites to the effects of high-energy laser weapons. Update previously completed assessments on catalogued satellites. Incorporate improved algorithms and hardware for rapidly characterizing new launches into current data fusion workstations for the space situational awareness mission.

(U) $1,273 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH | PROJECT: 5023 |

**(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 0603444F, Maui Space Surveillance Systems.
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.
(U) PE 0603605F, Advanced Weapons Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5024

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5024 Human Centered Applied Space Tech | 0 | 0 | 496 | 693 | 869 | 0 | 0 | Continuing | TBD |

Note: In FY 2003, space unique efforts transferred from PE 0602202F, Project 7184, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities. Outyear funding profiles will be addressed in future budget activities.

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $496 Develop and evaluate new crew interface concepts for satellite attack reporting, having the optimal mix of human interface technologies that maximize crew situational awareness. Identify new human roles for on-orbit servicing, prepare a satellite control station simulator as an evaluation testbed, and begin to develop a multi-sensory control station interface usable across systems.
(U) $496 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH | PROJECT: 5024 |

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

(U) Related Activities:

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

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5025

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5025 Space Materials Development | 0 | 0 | 18,608 | 20,449 | 23,888 | 24,144 | 24,676 | Continuing | TBD |

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

**(U) A. Mission Description**

This project develops the materials and processing technology base for spacecraft and launch systems to improve affordability, maintainability, and performance of current and future Air Force space systems. Families of affordable lightweight materials are being developed, including metals, polymers, ceramics, metallic composites, and nonmetallic composites, to provide new capabilities for spacecraft, ballistic missile, and propulsion systems to meet the future space requirements. Advanced thermal protection materials are being developed that are affordable, lightweight, dimensionally stable, thermally conductive, and/or ablation and erosion resistant to meet space and ballistic missile requirements. Develops materials technologies for surveillance and terrestrial situational awareness systems and subsystems for space and ballistic missile applications.

(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) FY 2003 ($ in Thousands)
(U) $11,484 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, ceramics, and advanced organic 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, nozzle throats, and spacecraft propulsion. Develop material property databases and initiate demonstration of suitability for application using representative geometry and processing conditions for the intended rocket engine components.
(U) $5,685 Develop affordable, advanced structural and non-structural materials and technologies for Air Force space applications. Demonstrate optically

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH / PROJECT: 5025 |

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

(U) FY 2003 ($ in Thousands) Continued

tailorable thermal control coatings with controlled heat dissipation for spacecraft thermal control. Establish baseline effects of the space environment on polymer and thermal control coatings. Optimize processing methods for the metallic materials which are expected to be used for lightweight, high-strength components in future space vehicles. Test non-autoclave materials and processes for composite cryogenic tank structures for future Air Force space platforms.

(U) $1,439 Develop and demonstrate materials and materials processing technologies to enable improved performance, affordability, and performance of surveillance, tracking, targeting, and situational awareness systems. Refine improved thin film processing techniques to optimize efficiency in solar cells. Validate and transition materials processing techniques and materials that will enable high performance optical control of phased array radar and satellite-to-satellite data links. Demonstrate alternative infrared detector materials for space applications capable of detecting very long wavelengths.

(U) $18,608 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 0603112F, Advanced Materials for Weapon Systems.

(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5026

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5026 Rocket Propulsion Component Tech | 0 | 0 | 19,612 | 31,048 | 32,543 | 33,206 | 33,708 | Continuing | TBD |

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

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $2,082 Develop, characterize, and test advanced 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 and optimize paths for incorporating these materials into propellants with significantly enhanced performance. Continue evaluating the potential of monopropellants 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. Continue to model and analyze

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH / PROJECT: 5026 |

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

(U) FY 2003 ($ in Thousands) Continued

advanced propulsion concepts with enhanced performance and reliability such as laser-propelled lightcraft.

(U) $1,017 Develop advanced liquid engine combustion technology for improved performance while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. Continue to characterize, study, and evaluate injector performance to ensure chamber/injector compatibility and prevent damage to test and operational combustion devices. Continue to develop, analyze, and model advanced combustion devices and injectors compatible with new energetic propellants. Continue to model and analyze advanced propulsion concepts with enhanced performance and reliability such as rocket-based combined cycle engines and pulsed detonation engines.

(U) $2,797 Continue to develop advanced material applications 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. Continue to characterize and develop new high temperature polymer components and carbon-carbon components for use in advanced combustion devices and propulsion systems to meet lower weight, increased strength, and lower cost requirements. Continue to develop advanced motor casings and propellant system components for high-energy propellants.

(U) $5,250 Continue to develop propulsion component technology for reliable, safe, and low-cost boost systems. Complete development and begin testing single stage hydrogen turbopump for advanced cryogenic engines. Continue development of components for hybrid propulsion technologies for space boosters and air-launched missiles. Initiate testing of injector for hydrocarbon or cryogenic fuel applications.

(U) $3,208 Continue development of lightweight combustion chamber and nozzle technology. Continue development of advanced lightweight rocket engine nozzle for upper stage and space booster applications. Initiate design study for high pressure turbopumps for use in advanced upper stage engines.

(U) $2,586 Continue demonstration of missile propulsion technology and Post Boost Control Systems (PBCS) and integrate results of aging models and test database for aging and surveillance technology for sustainment of current Intercontinental Ballistic Missile fleet. Continue demonstration of an advanced lightweight solid rocket motor. Continue demonstration of tools to increase the capability to determine the service life of strategic systems and other solid rocket motors. Continue demonstration of advanced full-scale, flight-like PBCS.

(U) $2,672 Develop solar electric and solar thermal propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites and satellite constellations. Complete Hall thruster development efforts to achieve Air Force orbit transfers using electric propulsion. Continue development of microsatellites (<25 kg) propulsion systems (e.g., plasma thrusters) for advanced imaging missions. Continue developing solar thrusters and concentrators for future orbital transfer vehicles. Continue testing of an electrically controlled solid propellant. Continue development of high power solar thermal components.

(U) $19,612 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602500F MULTI-DISCIPLINARY SPACE TECH | 5026 |

**(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 0602203F, Aerospace Propulsion.
(U) PE 0602303A, Missile Technology.
(U) PE 0602805F, Dual Use Science and Technology.
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5027

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5027 High Speed Airbreathing Prop Tech | 0 | 0 | 4,238 | 4,668 | 4,904 | 5,094 | 5,210 | Continuing | TBD |

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

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $233 Initiate development of flight demonstrator vehicle concepts. Conduct vehicle design trades for integration of hydrocarbon fueled scramjet engine.
(U) $987 Increase scramjet operating range (Mach 3 to >Mach 8) to provide robust options for combined cycle engines. Conduct initial feasibility assessment of variable geometry devices. Investigate variable geometry through collaborative effort with France and Russia.
(U) $301 Conduct assessment of advanced airbreathing engines/Combined Cycle Engines (CCEs) to establish and extend operability limits. Enables development of low internal drag scramjet flowpath for reusable applications. This supports the development of affordable, on-demand access to space vehicles.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602500F MULTI-DISCIPLINARY SPACE TECH | 5027 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $2,717 | Initiate development of critical components for advanced airbreathing engines and CCEs for robust performance over extended Mach range. Initiate development of high performance/low internal drag devices. This provides robust scramjet components applicable to affordable, on-demand access to space vehicles. |
| (U) | $4,238 | 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 0602203F, Aerospace Propulsion.
(U) PE 0602602F, Conventional Munitions.
(U) PE 0602702E, Tactical Technology.
(U) PE 0603111F, Aerospace Structures.
(U) PE 0603216F, Aerospace Propulsion and Power Technology.
(U) PE 0603601F, Conventional Weapons Technology.
(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5028

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5028 Space Sensors, Photonics & RF Proc | 0 | 0 | 1,025 | 1,602 | 2,064 | 1,871 | 4,491 | Continuing | TBD |

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

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $368 | Develop high performance integrated photonic technology link, interconnect, and switching components and subsystems for wideband RF phased array antenna beamforming, and for high data rate space sensors and communications systems. |
| (U) | $191 | Develop efficient, high coefficient chip-scale optical waveguide technology for mixed signal component subsystems. |
| (U) | $370 | Perform independent modeling, test, and evaluation for space-qualified photonic components and integrated devices. |
| (U) | $96 | Initiate the study of adaptive processing techniques for multi-mission conformal arrays for space sensor data. |
| (U) | $1,025 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602500F MULTI-DISCIPLINARY SPACE TECH | 5028 |

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

(U) Related Funding:

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603500F, Multi-Disciplinary Adv Dev Space Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5029

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5029 Space Sensor & CM Tech | 0 | 0 | 7,038 | 8,737 | 5,650 | 1,687 | 1,186 | Continuing | TBD |

Note: In FY 2003, space unique efforts transferred from PE 0602204F, Projects 2002, 6095, and 7622, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $1,663 Develop compact, affordable, multi-function receiver/exciter and phased array components for communications, Global Positioning System, radar, electronic warfare, and other ISR space sensors. Fabricate critical components consisting of gallium arsenide, indium phosphide, silicon, and/or wide bandgap devices for use in multi-mode/multi-function digital receiver prototype modules, and demonstrate a feasible architecture for performing wideband direct digital synthesis from space platforms.
(U) $87 Develop microwave technologies for advanced radio frequency apertures and phased array antennas used in military ISR space sensors. Develop and demonstrate robust components for L-band and X-band transmitter and receiver (T/R) channels that operate with limited environmental controls and under severe electromagnetic stress.
(U) $514 Demonstrate X-band sub-assemblies based on flexible RF membranes that enable low-cost and low-mass T/R channels integrated at the subarray level for space applications.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH / PROJECT: 5029 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $101 | Characterize and mature space-qualified micro-electro-mechanical systems phase shifters for extended switch lifetimes and able to operate over a ten-to-one bandwidth. |
| (U) | $514 | Refine materials and processes for two-dimensional and three-dimensional interconnects for space applications. |
| (U) | $639 | Continue to refine the accuracy of predictions of the scattering phenomenology associated with electromagnetic radiation returned from objects or backgrounds when viewed from space. |
| (U) | $1,730 | Develop space-qualified 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 with emphasis on synergistic integration of anti-jam technologies. Develop virtual flight test technology for improved assessment of reference sensors for space applications. |
| (U) | $1,790 | Develop technology to enable affordable upgrades to space-qualified radio frequency signal receivers. Model threat identification algorithms for next generation threat warning receivers. Evaluate state-of-the-art radar and electronic warfare digital receiver subsystems with Gallium Arsenide and Indium Phosphide radio frequency components (Analog-to-Digital Convertors, filters, mixers, etc.) for laboratory environment scenario testing. |
| (U) | $7,038 | 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 0603500F, Multi-Disciplinary Adv Dev Space Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH | PROJECT: 5029 |

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

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH

PROJECT: 5030

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5030 Applied Space Access Vehicle Tech | 0 | 0 | 1,302 | 1,740 | 2,818 | 2,020 | 3,401 | Continuing | TBD |

Note: In FY 2003, space unique efforts transferred from PE 0602201F, Project 2403, into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

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

(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) FY 2003 ($ in Thousands)
(U) $1,302 Develop advanced structure, flight control, and aerodynamic technologies to enable aircraft-like operations for affordable on-demand military access to space. Define and develop integrated guidance and control laws to expand launch vehicle performance envelope. Develop capability to simulate space access operability in a virtual environment.
(U) $1,302 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602500F MULTI-DISCIPLINARY SPACE TECH | PROJECT: 5030 |

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

(U) Related Funding:

(U) PE 0602201F, Aerospace Flight Dynamics.

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

(U) PE 0602204F, Aerospace Sensors.

(U) PE 0603211F, Aerospace Technology Dev/Demo.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 67,139 | 81,344 | 58,582 | 68,437 | 75,056 | 76,799 | 78,665 | Continuing | TBD |
| 1010 | Space Survivability & Surveillance | 27,164 | 31,063 | 11,938 | 19,396 | 20,912 | 21,309 | 21,943 | Continuing | TBD |
| 4846 | Spacecraft Payload Technologies | 8,057 | 14,777 | 10,631 | 9,900 | 13,973 | 14,321 | 14,709 | Continuing | TBD |
| 5018 | Spacecraft Protection Technology | 0 | 0 | 4,620 | 3,948 | 2,552 | 2,351 | 2,157 | Continuing | TBD |
| 8809 | Spacecraft Vehicle Technologies | 31,918 | 35,504 | 31,393 | 35,193 | 37,619 | 38,818 | 39,856 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

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

**(U) A. Mission Description**

This PE focuses on four 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 operations by investigating advanced component and subsystem capabilities. Third, spacecraft vehicles, focuses on spacecraft platform, payload, and control technologies, and their interactions. The last major area, spacecraft protection, develops technologies for protecting U.S. space assets in potential hostile environments. Note: In FY 2002, Congress added $20.6 million ($1.3 million for Mixed Signal Very Large Scale Integrated (Circuits) for Space Vehicle Communication Subsystems, $8.5 million for the High-frequency Active Auroral Research Program (HAARP) Space Technology, $1.7 million for HAARP Electromagnetic Wave Gradiometer, $2.6 million for HAARP Incoherent Radar, $1.8 million for Satellite Simulation Took Kit, $3.0 million for Composite Cryogenic Fuel Tanks, and $1.7 million for Terabit).

**(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.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 68,850 | 61,086 | 56,479 | |
| (U) | Appropriated Value | 69,487 | 81,686 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -342 | | |
| | b. Small Business Innovative Research | -1,650 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -61 | | | |
| | e. Rescissions | -637 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 2,103 | |
| (U) | Current Budget Submit/FY 2003 PBR | 67,139 | 81,344 | 58,582 | TBD |

(U) Significant Program Changes:

Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 1010

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 1010 Space Survivability & Surveillance | 27,164 | 31,063 | 11,938 | 19,396 | 20,912 | 21,309 | 21,943 | Continuing | TBD |

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

**(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 and technologies to optimize space-based surveillance operations. Finally, it includes technologies that allow the opportunity to mitigate or exploit the aerospace environment for both offensive and defensive operations. Note: In FY 2002, Congress added $12.8 million ($8.5 million for the High-frequency Active Auroral Research Program (HAARP) Space Technology, $2.6 million for HAARP Incoherent Radar, and $1.7 million for HAARP Electromagnetic Wave Gradiometer).

(U) FY 2001 ($ in Thousands)

(U) $2,573 Developed technology to predict space environmental hazards, including solar disturbances and the earth's radiation belts, and the resultant disruptions of operational space systems. This technology leads to improved space system design, lifetime, and operational capabilities and aids in anomaly resolution. Developed technologies that control hazardous space particle populations in extreme environments resulting from natural or adversary actions. Began algorithm development for predicting solar disturbances impacting Air Force systems using all-sky images from new space-based detector system. Developed time-dose probability codes for improved space system design using data from new compact environment anomaly sensors. Began detailed design of active space particle control experiment to demonstrate the feasibility of space-based mitigation technologies.

(U) $9,171 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. Validated all-altitude background clutter prediction code through the use of space-based sensor data. Completed deployment aids and performance prediction models that minimize the operational impacts of atmospheric optical turbulence on laser weapons. Completed an assessment of advanced missile detection technologies that provide for the earliest detection of theater ballistic missiles in boost phase.

(U) $4,159 Developed 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE February 2002 |
|---|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602601F Space Technology | PROJECT<br>1010 |

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

(U) FY 2001 ($ in Thousands) Continued

Completed the fabrication and test of instrumentation for communication/navigation outage forecasting system demonstration. Developed algorithms for correcting ionospheric effects on geolocation accuracy.

(U) $1,587 Developed 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. Designed 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) $6,772 Expanded 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 Alaska facility. Continued 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. Continued the collection of diagnostic data to characterize the space weather environment. Investigated ionospheric Extremely Low Frequency/Very Low Frequency virtual antenna properties. Expanded the high frequency radio transmitter capability from 8-MHz to 10-MHz. Extended roads and installed additional diagnostic pads and instruments that reduce interference problems and enhance radio science capabilities.

(U) $2,902 Developed technologies that improve the survivability of space systems by specifying, forecasting, and mitigating the effects of the ionosphere and space radiation environment. Expanded the coverage of the Scintillation Network Decision Aid, which is a component of a global system for predicting the effects of ionospheric scintillation on communication and navigation systems. Developed advanced, space-borne sensors to detect hazards to spacecraft from space particles and chemical contamination. Developed advanced instrumentation and analysis techniques for real-time monitoring of solar activity and improved prediction of space environmental hazards.

(U) $27,164 Total

(U) FY 2002 ($ in Thousands)

(U) $2,469 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE February 2002 |
|---|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602601F Space Technology | PROJECT<br>1010 |

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

(U) FY 2002 ($ in Thousands) Continued

control experiment. Construct dynamic radiation belt data assimilation and forecast models to predict energetic electron spacecraft hazards.

(U) $8,251 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 collected hyperspectral imaging data, and develop a modeling and simulation capability to predict the performance of surveillance functions under specified scene and atmospheric conditions.

(U) $6,280 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. Assemble the models with data-handling systems to construct the C/NOFS data center. Provide navigation reliability 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) $1,387 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 attack reporting space flight test into system hardware and software. Investigate integrated attack reporting approaches.

(U) $8,418 Continue development of the High Frequency Active Auroral Research Program (HAARP) site transmitting and diagnostic instrument infrastructure. Install a permanent aircraft alert radar, a Very High Frequency ionosphere radio diagnostic, high frequency transmitter enhancements, and diesel power-plant reliability improvements. Provide facility management and environmental oversight. Conduct research programs to assess the viability of exploiting Extremely Low Frequency/Very Low Frequency waves generated in the ionosphere for detecting

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE February 2002 |
|---|---|---|
| BUDGET ACTIVITY<br>02 - Applied Research | PE NUMBER AND TITLE<br>0602601F Space Technology | PROJECT<br>1010 |

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

(U) FY 2002 ($ in Thousands) Continued

and characterizing underground structures and for reducing charged particle populations in the radiation belts, which disrupt satellite systems and operations.

(U) $2,575 Develop a modular design and phased approach for an Incoherent Scatter Radar (ISR) diagnostic capability for the HAARP facility. Prepare the site infrastructure, including a gravel pad, access road, and power and optical fiber distribution networks. Acquire and install Incoherent Scatter Radar transmitting modules for engineering test purposes to validate the overall concept and design.

(U) $1,683 Investigate, enhance, and test electromagnetic radiometry technologies for the detection of underground structures using the High Frequency Active Auroral Research Program facility. Develop a miniature, rugged man-portable hardware system and an experimental airborne system, including improved detection algorithms, frequency agility, and remote data access. Conduct a study for a ground-based, unmanned random array detection system to exploit emerging technology.

(U) $31,063 Total

(U) FY 2003 ($ in Thousands)

(U) $1,364 Develop technologies for monitoring, predicting, and controlling space environmental conditions hazardous to Department of Defense (DoD) operational space systems. Validate algorithms for tracking solar plasma clouds to Earth and predicting onsets of adverse effects on DoD systems. Develop models and algorithms for propagation of solar/geomagnetic activity for spacecraft susceptibility to single event upsets. Complete initial dynamic radiation belt model with real-time data assimilation for spacecraft hazard forecasting.

(U) $4,716 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. Validate background models with new experimental data and apply to surveillance system design trades and performance analyses. From field measurements determine trade space for space system for earliest detection of theater ballistic missiles in boost phase. Upgrade models of atmospheric turbulence sources and improve laser weapon performance prediction model of airborne and space-based systems. Develop advanced techniques to exploit hyperspectral data and validate hyperspectral performance modeling and simulation codes. Develop design requirements for space-based sensor to obtain sub-meter, high spectral resolution measurements of optical/infrared backgrounds for next-generation operational surveillance, target identification, and damage assessment systems.

(U) $5,858 Develop artificial intelligence techniques, forecasting tools, and sensors for improved ionospheric specification and forecasting, including communications/navigation outage forecasting and space-based geolocation demonstrations. Develop data processing software and hardware architecture for collecting and analyzing ground and space data to provide near-real-time nowcasts and forecasts of ionospheric hazards.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology |
| | PROJECT: 1010 |

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

(U) FY 2003 ($ in Thousands) Continued

Validate nowcast and forecast predictions using ground and space-based experimental databases and incorporate results into forecast tool risk reduction. Improve techniques to track the motion of the highly structured plasma in the polar region, to enhance the reliability of ionospheric specification in high latitude theaters. Develop multi-scale algorithms to increase reliability of global ionospheric forecasts.

(U) $11,938 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 0305111F, Weather Systems.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 4846

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4846 | Spacecraft Payload Technologies | 8,057 | 14,777 | 10,631 | 9,900 | 13,973 | 14,321 | 14,709 | Continuing | TBD |

**(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. Note: In FY 2002, Congress added $3.1 million ($1.3 million for Mixed Signal Very Large Scale Integrated (Circuits) for Space Vehicle Communication Subsystems and $1.8 million for Satellite Simulation Tool Kit).

(U) FY 2001 ($ in Thousands)

(U) $2,351 Developed 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. Designed low temperature multi-color and low background infrared detectors and QWIPs, higher temperature infrared detectors, and higher performance radiation-hardened detectors. Continued experimental investigation of two-, three-, and multi-color detectors, and tunable and broadband gratings. Investigated 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) $666 Developed hyperspectral imaging data exploitation methodologies for military remote sensing applications with the Fourier Transform HyperSpectral Imager (FTHSI). The FTHSI payload demonstrated the capability of providing the warfighter data concerning terrain categorization, feature extraction, geological formation mapping, and trafficability within an area observed from space. Completed analysis of the hyperspectral imaging data received from the FTHSI payload. Completed assembly of data images for target identification and image evaluation for commercial and military purposes.

(U) $3,859 Developed technologies for space-based payload components such as low power, high performance, radiation-hardened electronic devices, micro-electro-mechanical system devices, and advanced electronics packaging for next generation high performance space electronics. Goals are decreased feature size, improved scalability, decreased size/weight/power, and radiation-hardness. Continued characterizing microelectronic materials and internal structures and apply results to improve fabrication processes. Designed next-generation low-power,

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

quantum-sized devices such as high-speed, radiation-hardened, low-power alternatives for space applications. Fabricated improved radiation-hardened nonvolatile memories, Fast Fourier Transform processors, optical sensors, and analog devices. Fabricated ultra-high density, low-power micro-electro-mechanical system (MEMS) device for evaluation in space environment. Fabricated smaller, lighter, lower power electronics packaging.

(U) $1,181 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 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. Integrated simulation architecture models using visual programming codes and commercial-off-the-shelf software to enhance fidelity of satellite constellation-level modeling. Interconnected satellite toolkit, spacecraft simulation toolkit, and weather and space simulation software into one framework. Evaluated multi-satellite constellations and distributed satellite cluster models in simulation test bed.

(U) $8,057 Total

(U) FY 2002 ($ in Thousands)

(U) $4,386 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 (two- and three-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) $985 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 FTHSI payload. Develop technology and modeling for understanding the electro-optical/infrared polarimetric phenomenology.

(U) $4,388 Develop technologies for space-based payload components such as low power, high performance, radiation-hardened electronic devices, MEMS devices, and advanced electronics packaging for next generation high performance space electronics. Expand microelectronic material

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology / PROJECT: 4846 |

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

(U) FY 2002 ($ in Thousands) Continued

characterization to silicon-on-insulator 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 micro-electro-mechanical (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) $963 Develop modeling, simulation, and analysis 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) $985 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) $1,783 Develop core infrastructure components for a robust satellite simulation toolkit. The toolkit will enable cost-effective risk reduction for space technology programs via modeling and simulation of all phases from concept design through flight experiment and technology transition. Design and build software components for different user interfaces, connection to external hardware/software environments and simulations, and installation on inexpensive computer platforms. Add models and simulations of such space-based payload systems as radar, hyperspectral, and remote inspection sensors. Develop requirements for and initial designs of high-level models of space capability protection and counterspace technologies to be used for concept studies.

(U) $1,287 Develop radiation-hard analog for mixed signal, Very Large Scale Integrated circuits for secure high-bandwidth intra-satellite and satellite-ground station communications. Radiation test and characterize state-of-the-art commercial mixed signal systems and elements to determine feasibility of adapting commercial technologies for military application. Design new radiation-hard analog elements.

(U) $14,777 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology |
| | PROJECT: 4846 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,808 | 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. Evaluate two- and three-color detector and continue development of multi-color detectors and tunable and broadband gratings. Design and fabricate selected concepts for future longer wavelength infrared detectors and infrared detectors with optimal background-limited performance for stressing, low photon noise, and space backgrounds. Complete design study of next generation long and very long wavelength infrared detector concepts, including quantum wells and strained layer superlattices, as lower cost, higher performance alternatives to mercury cadmium telluride. Evaluate delivered radiation-hardened cryogenic multiplexers for lower background, space infrared detector arrays. |
| (U) | $901 | Develop spectral sensing and data exploitation methodologies for military imaging and remote sensing applications. Continue development of technology and modeling for understanding the electro-optical/infrared polarimetric phenomenology. Evaluate initial polarimetric signature model capability and validate with measured data. Develop capability to integrate polarimetric models into modeling, simulation, and analysis (MS&A) for space-based surveillance applications. |
| (U) | $3,733 | 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. Continue silicon-on-insulator radiation research and enhance the switching speed and durability of the chalcogenide material by ten times for improved devices. Extend the design of the monolithically integrated low power, silicon-based quantum-sized devices to include non-traditional electronic materials. Continue to improve the speed of the radiation-hardened nonvolatile digital memories. Characterize the analog memories and enhance resolution to an eight-bit equivalent. Build space-qualified MEMS reliability test devices and chip-scale packages for ground and flight insertion. Build reconfigurable analog array packaging structures. |
| (U) | $1,189 | Develop 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. Extend simulation architecture to support flight experiment ground-to-space segment simulation, post-experiment distributed signal processing, and post-experiment data validation. The architecture can then be used for objective system-of-systems assessment. |
| (U) | $1,000 | Develop advanced satellite antenna architectures and performance characterization tools for large, lightweight, modular space antennas. Extend antenna architecture and algorithms developed for performance characterization of modular phased array antenna tiles to multi-beam, wide-bandwidth, multi-mode operation to include advanced low-noise amplifiers, integrated wide-bandwidth radiators, and active radio frequency manifold control technologies. Build and test engineering models to simulate performance of multi-beam, wide-bandwidth phased array antenna tiles and integrated antenna models. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology | PROJECT: 4846 |

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

(U) FY 2003 ($ in Thousands) Continued
(U) $10,631 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0603401F, Advanced Spacecraft Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 5018

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5018 Spacecraft Protection Technology | 0 | 0 | 4,620 | 3,948 | 2,552 | 2,351 | 2,157 | Continuing | TBD |

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

**(U) A. Mission Description**

This project develops the technologies for protecting U.S. space assets in potential hostile environments to assure continued space system operation without performance loss in support of warfighter requirements. The project focuses on identifying and assessing spacecraft system vulnerabilities, developing threat warning technologies, and developing technologies to mitigate the effects of both intentional and unintentional threats.

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $1,000 Develop key satellite threat warning technologies and tools for on-board satellite use to detect, geolocate, and characterize intentional and unintentional ground-based radio frequency (RF) and laser signals. Begin development of a high performance multiple threat sensors satellite protection system, improving technical performance of the sensor suite while still minimizing cost, power, and weight. Investigate integration of the miniature radio frequency receiver, laser detector, and ionospheric specification system with advanced reconfigurable processor electronics for the first generation system. Assess feasibility of using a single antenna for performing RF geolocation from a low-earth-orbit satellite. Investigate laser and RF false alarm rejection/mitigation and anomaly resolution and management techniques.

(U) $1,395 Develop miniaturized RF attack receiver. Complete post-test data and system performance analysis of risk reduction space experiment. Continue system integration for year-long space flight demonstration of advanced attack reporting system.

(U) $368 Develop techniques to exploit existing on-board satellite resources as first-line threat detection systems. Investigate use of systems on currently fielded or launch ready satellites for preliminary determination of RF/laser illumination or kinetic impact. Assess the use of telemetry, state-of-health data, and other appropriate data for event determination. Prepare for laboratory proof of concept demonstrations.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology |
| | PROJECT: 5018 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $1,857 | Develop techniques for monitoring and assessing electromagnetic interference and compatibility between ultra-sensitive payload sensors for space systems which support space weather forecasting. Begin payload integration for the Communications/Navigation Outage Forecast System Advanced Concept Technology Demonstration. Design, develop, and test serial communications hardware and software for command and data handling spacecraft sub-system risk reduction for real-time space weather forecasting. Validate data compression techniques with payload sensor data and apply to space flight software for demonstrating space weather forecasting. |
| (U) | $4,620 | Total |

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

Not Applicable.

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

(U) PE 0603401F, Advanced Spacecraft Technology.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602601F Space Technology

PROJECT: 8809

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 8809 Spacecraft Vehicle Technologies | 31,918 | 35,504 | 31,393 | 35,193 | 37,619 | 38,818 | 39,856 | 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 2002, Congress added $4.7 million ($3.0 million for Composite Cryogenic Fuel Tanks and $1.7 million for Terabit).

(U) FY 2001 ($ in Thousands)

(U) $2,990 Continued 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. Advance 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. Continued development of 35 percent efficient solar cells and thin film solar cells. Completed development of power cells using thermal to electric conversion technology and lithium ion and polymer batteries. Improved accuracy of cryocooler modeling tools, and identified mechanisms that limit operational life and degrade cryocooler subsystem performance.

(U) $7,104 Continued 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. 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. Developed and completed vibration suppression algorithms. Continued development of multi-functional structures and complete integration techniques. Integrated and ground tested component subsystems of deployable large aperture optical arrays to identify performance of deployable optics.

(U) $1,552 Continued 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. Conducted MightySat II.1 mission operations and began analyzing platform and stand-alone experiment operations.

(U) $13,695 Continued to develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Fabricated components for

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

microsatellite, and completed detailed design of a three-unit flight constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing.

(U) $1,741 Developed and demonstrated innovative methodology for aluminum aerostructure design. Developed a technical strategy to insert aluminum processing/manufacturing capability into early design and analysis. Identified specific opportunities to employ methodology on Air Force weapon systems. Demonstrated benefits on selected parts/assemblies to minimize cost while maintaining mechanical properties.

(U) $967 Developed low-cost, lightweight, leak-proof, linerless, non-metallic composite cryogenic tanks for reusable and small expendable launch vehicle applications. Designed, fabricated, and tested lightweight composite end-bosses and performed studies to address problems with delamination and micro-cracking.

(U) $3,869 Further developed and evaluated the world's first optically implemented Code Division Multiple Access wide-band network within the context of the Next Generation Internet. Assessed and demonstrated the inherent security capabilities as a means of enhancing information assurance at the transmission level.

(U) $31,918 Total

(U) FY 2002 ($ in Thousands)

(U) $4,386 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. Complete a 32 percent efficient solar cell and a ten percent efficient thin-film solar cell.

(U) $8,877 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) $150 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 final analyses and reports on the MightySat II.1 platform and stand-alone experiment options.

(U) $17,436 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology | PROJECT: 8809 |

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

(U) FY 2002 ($ in Thousands) Continued

communications, distributed processing, and sparse aperture sensing.

(U) $2,972 Develop low-cost, lightweight, leak-proof, linerless, non-metallic composite cryogenic tanks for reusable and small expendable launch vehicle applications. Investigate novel composite material systems and processes, focusing on manufacturability and scaling. Develop liquid oxygen (LOX) compatible material system, addressing both oxidation and ignition phenomena. Design, fabricate, and test full-scale tanks to determine the effectiveness of microcrack mitigation and LOX compatibility techniques on flight-representative articles.

(U) $1,683 Develop and evaluate the world's first optically implemented Code Division Multiple Access wide-band network within the context of the Next Generation Internet. Continue to assess and demonstrate the inherent security capabilities of different coding schema as a means of enhancing information assurance at the transmission level.

(U) $35,504 Total

(U) FY 2003 ($ in Thousands)

(U) $4,688 Develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells and arrays, and innovative power generation concepts. Continue to improve accuracy of cryocooler modeling tools and the identification of mechanisms that limit operational life and degrade cryocooler subsystem performance. Demonstrate a 35 percent efficient solar cell. Demonstrate production capacity for a ten percent efficient thin-film solar cell.

(U) $10,963 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. Flight test payload vibration suppression systems. Continue performance characterization of multifunctional bus structure for small spacecraft.

(U) $15,742 Develop microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Integrate and functionally test three microsatellites which will later form a three-flight unit constellation to demonstrate on-orbit formation flying, inter-satellite communications, distributed processing, and sparse aperture sensing.

(U) $31,393 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602601F Space Technology |
| PROJECT: 8809 | |

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

(U) Related Activities:

(U) PE 0602203F, Aerospace Propulsion.

(U) PE 0602102F, Materials.

(U) PE 0603311F, Ballistic Missile Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602602F Conventional Munitions

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 51,474 | 49,029 | 60,343 | 52,709 | 54,210 | 55,489 | 56,767 | Continuing | TBD |
| 2068 | Advanced Guidance Technology | 0 | 16,667 | 18,048 | 18,156 | 18,716 | 19,155 | 19,795 | Continuing | TBD |
| 2502 | Ordnance Technology | 51,474 | 32,362 | 42,295 | 34,553 | 35,494 | 36,334 | 36,972 | Continuing | TBD |
| | Quantity of RDT&E Articles | 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.

**(U) A. Mission Description**

This program investigates, develops, and establishes the technical feasibility and military utility of advanced guidance and ordnance technologies for conventional air-launched munitions. The program includes two projects: (1) development of advanced guidance technologies including seekers, navigation and control, target detection and identification algorithms, and simulation assessments; and (2) development of conventional ordnance technologies including warheads, fuzes, explosives, munitions integration, and weapon lethality and vulnerability assessments.

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

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

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 52,734 | 49,270 | 49,798 | |
| (U) | Appropriated Value | 53,223 | 49,270 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -241 | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602602F Conventional Munitions |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | b. Small Business Innovative Research | -1,260 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -489 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 10,545 | |
| (U) | Current Budget Submit/FY 2003 PBR | 51,474 | 49,029 | 60,343 | TBD |

(U) Significant Program Changes:

FY 2003 increases are due to increased emphasis in Project 2502 for Advanced Penetrator Technology, Tunnel Defeat Weapons Concepts, and Advanced Energetics.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602602F Conventional Munitions

PROJECT: 2068

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2068 Advanced Guidance Technology | 0 | 16,667 | 18,048 | 18,156 | 18,716 | 19,155 | 19,795 | Continuing | |

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**

This project investigates, develops, and evaluates conventional munitions advanced guidance technologies to establish technical feasibility and military utility. This project includes development of advanced guidance including terminal seekers, navigation and control, signal and processing algorithms, and guidance and control simulations. Project payoffs include: adverse-weather and autonomous precision guidance capability; increased number of kills per sortie; increased aerospace vehicle survivability; improved reliability and affordability; and, improved survivability and effectiveness of conventional weapons.

(U) FY 2001 ($ in Thousands)

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

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $5,733 Investigate and develop advanced guidance component technologies such as laser sources, detectors and detector arrays, receiver electronics, signal pre-processing, target recognition, spatial target characteristics, optics, and beam scanning and shaping technology 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 algorithms and create a database for both measured and synthetic laser radar information. Initiate development and ground test of a scanner-less laser radar 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 laser radar seekers.

(U) $4,782 Investigate and develop advanced navigation and control technologies, for example nonlinear controllers, biomimetic guidance, clutter rejection modules, detection and segmentation modules, and micro-electromechanical gyros 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 applied research of a miniature navigation device, based on micro-electromechanical system technology, which couples the GPS signal with an inertial navigation system to provide

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

ultra-high GPS jamming resistance and accuracy without the need for an anti-jam antenna.

(U) $3,095 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 and validation, statistical analysis of fixed, mobile targets, and 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 including synthetic aperture radar, automatic target recognition, and biomimetic processing. Simulations also include trajectory optimization algorithm and polarization sensing and models to analyze guided munitions and their components that will enable requirement studies, design iteration and evaluation, and experiment risk reduction. These simulations will shorten development time, reduce development 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, laser radar, scene projector instrumentation. The instrumentation will combine optical signals to produce a complex laser radar 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.

(U) $16,667 Total

(U) FY 2003 ($ in Thousands)

(U) $6,774 Investigate and develop advanced guidance component technologies for adverse weather, and autonomous seekers for air-delivered munitions, such as laser sources, detectors and detector arrays, receiver electronics, signal pre-processing, target recognition, spatial target characteristics, optics, and low-cost beam scanning and shaping technologies. These technologies will enable the development of next generation seekers that will increase a weapon's kill probability, reduce pilot workload, and enhance sortie effectiveness. Demonstrate in-house, high-throughput, parallel processing target acquisition algorithms. Evaluate laser radar components to quantify operational range, target detection and

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602602F Conventional Munitions |
| | PROJECT: 2068 |

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

(U) FY 2003 ($ in Thousands) Continued

identification, aim-point selection, and weather penetration effectiveness. Develop a low-cost, synthetic aperture radar seeker to assess future advanced guidance applications.

(U) $4,803 Investigate and develop advanced navigation and control technologies for air-delivered munitions, for instance nonlinear controllers, biomimetic guidance, clutter rejection modules, detection and segmentation modules, and micro-electromechanical gyros. These technologies will allow a more efficient flight path to the target, increase standoff ranges, and enhance strike aircraft effectiveness and survivability. Complete laboratory field testing of a reliable, accurate, miniaturized, and low-cost anti-jam weapon guidance system. This guidance system will be capable of operating in highly dynamic flight environments in the presence of Global Positioning System jamming devices. Develop new design technologies for tactical munitions flight control systems. Develop novel ways to enhance weapon system effectiveness through higher levels of integration of guidance, navigation, control, and estimation algorithms. Investigate the neuro-physiology of insects for applications to guidance. Investigate clutter and mult-discriminate rejection to defeat camouflage, concealment, and deception.

(U) $3,308 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 highly innovative concepts and approaches in guidance and control. Continue investigating biomimetic principles and concepts, including foveal vision and neuromorphic imaging systems, for use in advanced seekers for moving target scenarios. Investigate algorithms to perform flight trajectory shaping that reduce manning effects.

(U) $3,163 Investigate and develop detailed six-degree-of-freedom and hardware-in-the-loop simulations including synthetic aperture radar, automatic target recognition, and biomimetic processing. Technologies also include trajectory optimization algorithm, and polarization sensing and models to analyze guided munitions and their components that will enable requirement studies, design iteration and evaluation, and experiment risk reduction. These simulations will shorten development time, reduce development 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. Investigate the long-term technology and strategy for developing an advanced laser radar scene projector. Develop two-dimensional laser arrays for laser radar scene projectors. Provide detailed performance estimates of guidance-related component technology, using six-degree-of-freedom simulations, for guided weapon systems. Continue to develop modular, system-level, analysis tools to provide comprehensive comparisons among inventory, planned, and conceptual munitions to identify high pay-off technologies and weapon attributes.

(U) $18,048 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602602F Conventional Munitions |
| | PROJECT: 2068 |

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0603601F, Conventional Weapons Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602602F Conventional Munitions

PROJECT: 2502

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2502 Ordnance Technology | 51,474 | 32,362 | 42,295 | 34,553 | 35,494 | 36,334 | 36,972 | Continuing | |

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**

This 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.

(U) FY 2001 ($ in Thousands)

(U) $6,736 Investigated and developed high fidelity analytical tools such as computational mechanics models for predicting weapons effects and assessing target vulnerability. These analysis tools reduced warhead development time and cost, thereby providing more effective munitions to the Air Force. Investigated demilitarization concepts for the 1000-pound unitary, general-purpose bomb. Developed a high-level model, including models of geological structures, involved in predicting penetrator performance against hard targets. Investigated innovative kill mechanisms for defeating weapons of mass destruction. Transitioned selected high fidelity analytical tools to weapon designers, DoD, and industry.

(U) $3,316 Investigated and developed more efficient affordable explosives including inert dense metal additives, tungsten-laden explosives, cast and cure high energy composite explosives, and nano-scale metal fuels that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. These technologies enabled the development of safer, less expensive explosive fills for inventory and future weapons. Completed warhead testing and evaluation of the reformulated MNX-221 explosive to verify improved density and reduced ignition sensitivity. Continued development of a new class of energetic materials based on nano-scale and micro-scale particles, with initial emphasis on improving handling safety. Initiated development of innovative explosive technologies that allowed concentration of the explosive effects on the target, thereby reducing potential collateral damage.

(U) $5,343 Investigated and developed advanced fuze technologies, such as commercially available micro-mechanical systems, shock-hardened components, low energy detonators, light activated and modular firing systems for advanced single point initiation, switches, capacitors, power sources, and safe arming concepts for air-delivered munitions. The advanced fuze technologies enhanced lethality through precise selection of burst-height either at, above, or below the surface to increase weapon safety and tactical performance while simultaneously decreasing

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

procurement costs and system supportability requirements. Investigated micro-electromechanical system technology concepts for safe and arm components and fuze accelerometers. Developed and initiated testing of a low-threshold energy, shock-hardened detector for multi-event, hard target fuze capable of 4000 feet per second impacts.

(U) $5,317 Investigated and developed control and carriage technologies for ordnance packages for advanced air-delivered munitions in order to enhance weapon lethality. Examples of these technologies included high-energy explosives, mass focus fragmentation, and multi-sensor fuzing. These technologies contributed to increasing weapon load-out on strike aircraft and increased sortie effectiveness. Designed, fabricated, and tested submunitions for survivability during high mach number dispensing. Began ground testing of technologies that enabled the development of a fast reaction weapon to engage and destroy time-critical targets. Investigated the communication architectures to determine if they could be utilized to improve munitions planning, performance, and deployment.

(U) $7,118 Investigated and developed advanced warhead kill mechanisms, for instance adaptable warhead, directional control and fragmenting ordnance, application of reactive metals and processing explosive forming, and adjustable-yield ordnance packages. These technologies enhanced air-delivered munition lethality and enabled the development of smaller munitions with effectiveness similar to current inventory weapons, which resulted in a corresponding increase in strike aircraft load-out and sortie effectiveness. Performed 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. Continued testing and characterizing the effectiveness of tantalum warheads against targets that simulate the full spectrum of ground mobile threats. Completed 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. Completed research on explosive compressor generators as novel, non-lethal kill mechanisms.

(U) $5,020 Investigated and developed advanced component technologies, including laser sources, detectors and detector arrays, receiver electronics, signal pre-processing, target recognition, spatial target characteristics, optics, and beam scanning and shaping technology for lower cost, enhanced precision, adverse weather, and autonomous seekers for air-delivered munitions. These technologies enabled the development of next generation seekers that increased a weapon's kill probability, reduced pilot workload, and enhanced sortie effectiveness. Designed and fabricated the subsystems for a gimbal-less, laser radar sensor with total electronic scanning. Developed and validated advanced algorithms that identified mobile targets using their unique external components, such as guns or antenna.

(U) $5,071 Investigated and developed advanced navigation and control technologies for air-delivered munitions, for example nonlinear controllers, biomimetic guidance, clutter rejection modules, detection and segmentation modules, and micro-electromechanical gyros. These technologies allowed an optimal flight path to the target and increased standoff ranges, enhanced strike aircraft effectiveness and survivability. Investigated

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

guidance and control technologies that could provide significantly enhanced capability to locate and engage a moving or partially hidden target. Developed a low-cost, multi-sensor navigation device using micro-electromechanical system technology that could meet tactical grade performance in a low-cost package. Fabricated components and began integration of the component intended for field testing for the multi-sensor navigation device. Combined components of advanced Global Positioning System and began laboratory bench tests for the multi-sensor navigation device.

(U) $2,992 Investigated and developed advanced optical and digital processors and target detection, classification, and identification algorithms for improved seeker performance to allow greater air-delivered weapon autonomy. The advanced seekers would further deny an enemy's ability to hide or camouflage a target while decreasing the pilot's workload. Completed the phenomenology studies required validating the performance enhancements to be realized with a dual-mode, millimeter wave and infrared seeker. Developed the analytical tools required that enhanced the development, test, and analysis of advanced seekers and target detection and identification processors. Investigated optical processing and components technologies that increased sensor field-of-view, tracking rates, and target resolution for the dual-mode seeker.

(U) $2,561 Investigated and developed detailed six-degree-of-freedom and hardware-in-the-loop simulations, including synthetic aperture radar, automatic target recognition, and biomimetic processing. Simulations also included trajectory optimization algorithm and polarization sensing and models to analyze guided munitions or their components to enable requirements studies, design iteration and evaluation, and experiment risk reduction. These advanced simulations reduced development cost and time, and provided more effective munitions. Developed tactical scene generation capability to produce re-useable, government-owned acquisition and targeting software algorithms for guided munition seekers. Completed the analysis of air-to-surface terminal fuzing. Developed in-house personal computer-based simulations for analysis of advanced weapon concepts.

(U) $8,000 Developed microsatellite (10-100 kg) technologies, combined sub-system technologies, and launched 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 was not the correct Program Element for this effort, so these funds were transferred to PE 0603401F, Advanced Spacecraft Technology, for execution).

(U) $51,474 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) $3,318 Investigate and develop more efficient, affordable explosives, including inert dense metal additives, tungsten-laden explosives, cast and cure high energy composite explosives, and nano-scale metal fuels that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. These technologies enable safer, less expensive explosive fills for inventory and future weapons. Continue developing 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. Develop 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 research to investigate cost effective methods to improve current explosives.

(U) $6,258 Investigate and develop advanced fuze technologies for air-delivered munitions, such as commercially available micro-mechanical systems, shock-hardened fuzes, low energy detonators, light-activated and modular firing systems for advanced single point initiation, switches, capacitors, power sources and safe-arming concepts. 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 and field-shock testing of fuze components. Initiate critical component design and fabrication of the next generation burst-height fuze with discrimination against foliage, rain, chaff, electronic countermeasures, and electromagnetic interference. Develop technologies that communicate battle damage assessment through hardened mediums.

(U) $7,394 Investigate and develop control and carriage technologies for ordnance packages for advanced air-delivered munitions in order to enhance weapon lethality. Examples of these technologies include high-energy explosives, mass focus fragmentation, and multi-sensor fuzing. These

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

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. Continue investigating technologies for defeating hard and deeply buried targets.

(U) $9,186 Investigate and develop advanced warhead kill mechanisms, like adaptable warhead, directional control and fragmenting ordnance, and application of reactive metals. The investigation includes characterization of the dynamic response of metals and geologic materials, adjustable yield ordnance packages, and distributed multi-point fire set to enhance air-delivered munition lethality. This enhanced lethality supports the development of smaller munitions with effectiveness similar to current inventory weapons and with a corresponding increase in 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 chemical and biological agent defeat warhead design to determine its ability to deny an adversary access to storage and production facilities 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) $32,362 Total

(U) FY 2003 ($ in Thousands)

(U) $6,507 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. 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. Apply campaign analysis tools to compare inventory, budgeted, and conceptual munitions to identify high pay-off technologies.

(U) $5,206 Investigate and develop more efficient, affordable explosives including inert dense metal additives, tungsten-laden explosives, cast and cure high energy composite explosives, and nano-scale metal fuels that provide both higher blast performance and lower ignition sensitivity for air-delivered munitions. These technologies will enable safer, less expensive explosive fills for inventory and future weapons. Utilize micro-scale and nano-scale fuel and oxidizer particles to create new, advanced, intermolecular energetic materials. Complete efforts to develop

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602602F Conventional Munitions / PROJECT: 2502 |

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

(U) FY 2003 ($ in Thousands) Continued

a new class of materials for use in fragments, shaped charges, and explosively formed projectiles. Continue development of a highly energetic material with twice the power density of conventional explosives, but exhibiting insensitive munition attributes. Develop an explosive capable of surviving Mach eight impacts that still functions as desired when initiated by the fuze. Continue research of dense reactive metal explosives and investigate cost-effective methods to improve current explosives.

(U) $7,103 Investigate and develop advanced fuze technologies for air-delivered munitions, such as commercially available micro-mechanical systems, shock-hardened fuzes, low energy detonators, light activated and modular firing systems for advanced single-point initiation, switches, capacitors, power sources and safe-arming concepts. The advanced fuze technologies will enhance lethality through precise selection of burst-height at, above, or below the surface to increase weapon safety and tactical performance while simultaneously decreasing procurement costs and system supportability requirements. Develop a high resolution, electromagnetic countermeasure-hardened, active imaging fuze that calculates warhead burst direction and detonation time. Determine the benefits of developing a high speed, hard target fuze using sensors such as micro-electromechanical system gyroscopes. Investigate technologies that can communicate battle damage assessment information through hardened mediums.

(U) $10,657 Investigate and develop control and carriage technologies for ordnance packages for advanced air-delivered munitions in order to enhance weapon lethality. Examples of these technologies include high-energy explosives, mass-focus fragmentation, and multi-sensor fuzing. These technologies will increase weapon systems effectiveness by contributing to increased weapon load-out on strike aircraft and enhanced sortie effectiveness. Investigate and compare the subsystem technologies necessary to develop an optimum kill missile against low-observable, air targets. Investigate technologies, such as microbots and nano-encapsulation, to disrupt, deny, destroy, or damage facilities containing chemical and biological weapons. Investigate technologies that can defeat hard and deeply buried targets by simultaneously placing multiple, precise, time-of-arrival guided munitions on target.

(U) $12,822 Investigate and develop advanced warhead kill mechanisms, like adaptable warhead, directional control and fragmenting ordnance, and application of reactive metals. The investigation includes characterization of the dynamic response of metals and geologic materials, adjustable yield ordnance packages, and distributed multi-point fire set to enhance air-delivered munition lethality. This enhanced lethality supports the development of smaller munitions with effectiveness similar to current inventory weapons and with a corresponding increase in strike aircraft load-out and sortie effectiveness. Continue to evaluate initiation-based, adaptable, and multi-mode warheads using enhanced lethality materials and miniaturization technologies for the advanced warhead kill mechanism. Begin evaluation of an ordnance package designed for low collateral damage with high near-field and minimum far-field lethality. Complete assessment of multi-mode warheads using heavy metal liners to enhance lethality. Complete in-house experiments to characterize the interaction of munitions with chemical and biological weapon and

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602602F Conventional Munitions | PROJECT: 2502 |

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

(U) FY 2003 ($ in Thousands) Continued

storage containers. Begin an effort to improve the attributes of penetrating munitions by focusing on improving warhead case survivability, control of depth of burial, trajectory control methodologies while penetrating hardened material, and decreasing case thickness to allow a greater amount of energetic material to be carried to required depth of target.

(U) $42,295 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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 31,110 | 34,616 | 39,936 | 40,251 | 40,748 | 42,266 | 43,078 | Continuing | TBD |
| 4866 | Lasers & Imaging Technology | 15,685 | 19,435 | 23,174 | 24,359 | 24,332 | 25,519 | 25,977 | Continuing | TBD |
| 4867 | Advanced Weapons & Survivability Technology | 15,425 | 15,181 | 16,762 | 15,892 | 16,416 | 16,747 | 17,101 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2003, space unique tasks in Project 4866 will be transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This PE covers research in directed energy technologies, primarily lasers and high power microwaves that are not space unique. In lasers, this includes moderate to high power lasers (solid state and chemical) and associated optical components and techniques. In advanced weapons, this PE examines technologies such as narrowband and wideband high power microwave devices and antennas. Both areas also provide vulnerability/lethality assessments of representative systems. Note: In FY 2002, Congress added $1 million for Tactical/Operations System Simulator.

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

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

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 32,041 | 36,678 | 37,827 | |
| (U) | Appropriated Value | 32,337 | 34,678 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -62 | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | b. Small Business Innovative Research | -774 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -157 | | | |
| | e. Rescissions | -296 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 2,109 | |
| (U) | Current Budget Submit/FY 2003 PBR | 31,110 | 34,616 | 39,936 | TBD |

(U) Significant Program Changes:
Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

PROJECT: 4866

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4866 Lasers & Imaging Technology | 15,685 | 19,435 | 23,174 | 24,359 | 24,332 | 25,519 | 25,977 | Continuing | TBD |

Note: In FY 2003, space unique tasks in Project 4866 will be transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project examines the technical feasibility of moderate to high power lasers and associated optical components required for Air Force missions including long- and short-range weapons, weapon support such as aimpoint selection, and force protection that are not space unique. Technologies applicable for a wide range of vehicles including unmanned combat air vehicles and fighters are being developed. High power solid state and chemical laser devices, optical components, advanced beam control and atmospheric compensation technologies, laser target vulnerability assessment techniques, and advanced optical processes and techniques are developed. Advanced, short-wavelength laser devices for applications such as illuminators and imaging sources for target identification and assessment are developed.

(U) FY 2001 ($ in Thousands)

(U) $2,091 Developed long-range optical technologies for increased resolution, characterization, and data fusion applications. Explored lightweight membrane mirror issues for scaling to very large size (~ 10-meter mirrors). Addressed issues associated with producing a mirror close to required curvature and demonstrated holographic correction capability on scaled optics in laboratory environment.

(U) $724 Developed and field tested novel, advanced optics technologies to support beam projection and imaging applications associated with large aperture lightweight optics. The novel, advanced optics components that provide optical compensation for beam projection and imaging technology were 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 were pursued.

(U) $4,769 Developed high power chemical laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications. Performed engineering validation of advanced chemical oxygen iodine laser nozzle concepts which include iodine atom production techniques and integrated ejector nozzle concepts. Continued to develop/refine a subsonic all gas phase iodine laser demonstrator. Improved radio frequency pumped carbon monoxide supersonic laser for carbon monoxide overtone lasing.

(U) $2,684 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. Developed an electrically pumped mid-infrared solid state laser operating at room temperature. With increased power and pulse duration, this will lead to eliminating the optical pump source and cryogenic cooler for mid-infrared lasers. Investigated novel materials effects associated with ultra-fast lasers for countering focal plane array seekers. Obtained a high fidelity surrogate seeker for

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

laboratory effects testing. Developed a moderate power ultra-fast laser source for investigations of novel atmospheric propagation characteristics.

(U) $5,417 Developed low-cost, scalable, high power solid state laser architectures by integrating 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 such as low-cost, high efficiency, compactness and scalability that will enable applications that require laser mobility. Developed integration technologies for demonstration of power greater than 100 watts.

(U) $15,685 Total

(U) FY 2002 ($ in Thousands)

(U) $1,504 Develop and field test advanced long-range optical technologies to support beam projection and imaging applications. Develop novel, advanced optical 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) $5,073 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. Investigate low basic hydrogen peroxide flow rate and zero-gravity singlet delta oxygen generators for airborne applications. Begin construction of a combustor-driven one kilowatt supersonic all gas-phase iodine laser. Improve the efficiency of the radio frequency-pumped overtone carbon monoxide laser in various spectral bands of interest for infrared countermeasures and remote sensing applications.

(U) $3,561 Develop and demonstrate high-energy laser technologies for airborne tactical applications, including air-to-air and surface-to-air scenarios. Technologies being addressed include lasers for long-range detection of targets in clutter, advanced beam control to control platform vibration, atmospheric jitter, and aero-optic effects. Develop and demonstrate multifunctional laser components capable of detecting, identifying, tracking, and defeating electro-optical targets.

(U) $5,540 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. Begin developing promising

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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 technologies exhibiting attributes such as low-cost, high efficiency (approaching 30%), compactness, and scalability. Develop integration technologies necessary for combining multiple fiber laser modules including coherent, spectral and nonlinear optical beam combining technologies.

(U) $528 Develop advanced laser remote optical sensing technology to support standoff detection of chemical/biological aerosols for signature intelligence on weapons of mass destruction, bomb damage assessment, target characterization, and theater intelligence, surveillance, and reconnaissance. Complete Phase II experiments for frequency agile heterodyne receiver development.

(U) $2,238 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) $991 Develop the Tactical Operations System Simulator to model, evaluate, trade, and optimize directed energy concepts and tactical employment. Develop software/hardware simulation tools to assess performance, demonstrate military utility and benefits to the warfighter, and to identify requirements and technology shortfalls. Integrate tools to provide a government systems engineering, simulation, and operational research capability.

(U) $19,435 Total

(U) FY 2003 ($ in Thousands)

(U) $2,822 This project previously included space unique tasks which have been transferred to PE 0602500F, Multi-disciplinary Space Technology. These funds represent the civilian salaries for the transferred work efforts and they will be transferred at a later date.

(U) $4,995 Develop high power chemical laser technologies for applications such as directed energy weapons, illuminators, and wavelength specific applications. Perform scaled demonstration of optimized high pressure ejector nozzles incorporating iodine atom generation as appropriate for potential long-range technology insertion into airborne laser applications. 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. In concert with generator development, investigate means to cut the chemical laser logistic trail through chemical regeneration or single pass singlet delta oxygen generators. Demonstrate an enhanced overtone carbon monoxide laser in configuration suitable for transition to potential airborne infrared countermeasure applications. Improve the efficiency of the radio frequency-pumped overtone carbon monoxide laser in various spectral bands of interest for infrared countermeasure and remote sensing applications.

(U) $4,981 Develop and demonstrate high-energy laser technologies for airborne tactical applications, including air-to-air and surface-to-air scenarios.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY — PROJECT: 4866 |

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

(U) FY 2003 ($ in Thousands) Continued

Technologies being addressed include lasers for long-range detection of targets in clutter, high-power compact lasers, advanced beam control to control platform vibration, atmospheric jitter, and aero-optical effects. Continue developing laser sources and supporting technology for detecting, identifying, tracking, and defeating electro-optical targets. Demonstrate 30-watt, near-diffraction-limited, 1.5 micron laser.

(U) $7,136 Develop low-cost, scalable, high power solid-state laser architectures by integrating 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. Develop promising fiber laser technologies for a demonstration of attributes such as low-cost, high efficiency, compactness, and scalability. Develop integration technologies necessary for combining multiple fiber laser modules exhibiting powers near one kilowatt.

(U) $1,760 Develop advanced laser remote optical sensing technology to support standoff detection of chemical/biological aerosols for signature intelligence on weapons of mass destruction, bomb damage assessment, target characterization, and theater intelligence, surveillance, and reconnaissance. Initial design and development of flight-qualifiable hardware for differential absorption laser radar applications.

(U) $1,480 Perform vulnerability assessments on potential high energy laser targets to provide critical design data for laser systems to defeat these targets. Update lethality assessment methodology by anchoring modeling tools to empirical data. Conduct vulnerability experiments to update data used for lethality assessments, system effectiveness, and system concept definition. Perform lethality assessments on potential high-energy laser concepts to provide critical data for designing laser systems.

(U) $23,174 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602500F, Multi-Disciplinary Space Technology.

(U) PE 0603444F, Maui Space Surveillance System.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY | PROJECT: 4866 |

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY

PROJECT: 4867

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4867 | Advanced Weapons & Survivability Technology | 15,425 | 15,181 | 16,762 | 15,892 | 16,416 | 16,747 | 17,101 | 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 the potential disruption and degradation of an adversary's electronic infrastructure and military capability are developed. This effect can often be applied covertly with no collateral structural or human damage. These targeted capabilities include local computer and communication systems as well as large and small air defense and command and control systems. This project also provides for vulnerability assessments of representative U.S. strategic and tactical systems to HPM weapons, HPM weapon technology assessment for specific Air Force missions, and HPM weapon lethality assessments against foreign targets.

(U) FY 2001 ($ in Thousands)

(U) $2,846 Investigated and developed technologies for multi-pulsed narrowband and wideband HPM components to support multiple Air Force applications. Continued investigation of better source modeling techniques in order to incorporate HPM technologies into warfighting/war gaming activities. Investigated high efficiency repetitively-pulsed HPM source. Developed frequency agile HPM source. Developed compact repetitively operated sources. Started pulsed atmospheric breakdown experiments. Started explosive generator development experiments to support compact single-shot HPM sources.

(U) $1,801 Assessed effects/lethality of HPM weapon technologies against representative air and ground military systems. Continued to conduct susceptibility tests of representative command and control warfare targets. Investigated effects on targets of HPM sources pulsed at high repetition rates.

(U) $1,932 Investigated and developed wideband HPM technologies that support command and control warfare and other wideband applications. Researched advanced antenna designs driven by mission concepts. Continued applied research to improve wideband HPM sources in order to achieve greater range or smaller packaging. Continued advancement of computer codes' ability to predict the electromagnetic coupling to target equipment and probability of effect inside increasingly complex structures. Expanded HPM effects prediction models for implementation into engagement scenario models. Researched methods to enhance HPM source technology such as power throughput for solid state switches and high repetition rates for high pressure gas switches.

(U) $2,673 Developed narrowband HPM technologies that support suppression of enemy air defenses through the use of reusable airborne platforms and munitions. Continued to expand range of predictability of HPM narrowband effects models for military electronic targets of interest.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

Continued validation of predictability of models. Continued investigation of pulsed power and HPM source capability to support an integrated experiment to show proof-of-principle capability for single shot technologies. Completed design of subscale (laboratory) breadboard HPM system to validate approach and capability for repetitively pulsed technologies for high power microwave (HPM) munitions and airborne electronic attack. Continued development of component technologies – pulsed power, sources, and antennas – for repetitively pulsed airborne and munitions systems.

(U) $3,491 Investigated HPM technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible by the increased power available on future aircraft. Investigated enhanced sources for the most promising concepts identified by the FY 2000 tradeoff study. Continued to develop HPM effects database of commercial-off-the-shelf sources, missile targets, and aircraft platforms.

(U) $1,883 Assessed the vulnerability of seven satellites (U.S., NATO, and foreign) to the effects of directed energy weapons, primarily high energy lasers. Updated previously completed assessments on catalogued satellites. Began developing finite state models to predict satellite performance from observed behavior to support space situational awareness. Compiled assessment data and models into easily accessible folders for satellite characterization.

(U) $799 Investigated the best means for active denial technologies to support agile combat support applications. Continued development of millimeter wave sources for active denial technology and conducted experiments including beam transport and power extraction. Investigated millimeter wave source enhancement technologies using computer simulations.

(U) $15,425 Total

(U) FY 2002 ($ in Thousands)

(U) $6,600 Investigate and develop technologies for narrowband and wideband HPM components to support multiple Air Force applications such as the disruption of electronic systems and subsystems. Continue to improve the electrical efficiency of wideband HPM sources in order to achieve greater range, longer lifetime, or smaller packaging. 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. 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY / PROJECT: 4867 |

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

(U) FY 2002 ($ in Thousands) Continued

(U) $2,869 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. Continue validation of computer codes' ability to predict the wideband electromagnetic coupling to increasingly complex structures. Continue to expand range of predictability of high power microwave (HPM) narrowband effects models to damage or disrupt military electronic targets of interest. Continue validation of predictability of models. Continue developing better HPM source modeling techniques to incorporate HPM technologies into warfighting/war gaming activities.

(U) $3,917 Investigate HPM technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible by the increased power available on future aircraft. Develop enhanced sources for the most promising concepts identified by the tradeoff study to include an HPM repetitively pulsed source on an unmanned aerial platform. Continue to perform effects experiments upon targets of interest to determine effectual lethality of each concept. Continue development of HPM effects database and characterize commercial-off-the-shelf sources and aircraft platforms.

(U) $1,795 Investigate the best means for active denial technologies to support agile combat support applications. Conduct preliminary design study of millimeter wave sources for active denial technology, including airborne active denial. Conduct experiments including power combining, depressed collector, and modulation schemes. Investigate source enhancement technologies using computer simulations.

(U) $15,181 Total

(U) FY 2003 ($ in Thousands)

(U) $7,638 Investigate and develop technologies for narrowband and wideband HPM components to support multiple Air Force applications such as the disruption of electronic systems and subsystems. Continue laboratory testing 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. Conduct a subscale (laboratory) repetitively pulsed gigawatt class experiment.

(U) $2,600 Assess effects/lethality of HPM directed energy weapon technologies against representative air and ground military systems. Continue to conduct susceptibility tests of representative command and control warfare targets. Continue to conduct susceptibility tests of high repetitively pulsed effects on targets. Continue to implement effects data and results into narrowband and wideband HPM experiments and demonstrations. Support refinement of codes to predict probability of effect on target equipment and to guide experiment direction. Continue development of better source modeling techniques to incorporate HPM technologies into warfighting/wargaming activities. Continue validation of computer

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602605F DIRECTED ENERGY TECHNOLOGY / PROJECT: 4867 |

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

(U) FY 2003 ($ in Thousands) Continued

codes' ability to accurately predict the electromagnetic coupling to, and probability of effect on, target equipment within complex structures. Support implementation of predictive models into existing engagement models.

(U) $760 Develop and apply theory of advanced computation to enhance the development of HPM and related technology. Investigate numerical dispersions and enhance plasma models and physics algorithm development for HPM technologies. Perform virtual prototyping for HPM component technologies.

(U) $4,888 Continue to investigate high power microwave (HPM) technologies that support offensive and defensive advanced airborne tactical applications, to include airborne and munitions platforms, made possible by the increased power available on future aircraft. Down select improved sources for the most promising concepts identified by the trade-off study to include an HPM repetitively pulsed source on an air platform. Continue to perform effects experiments upon targets of interest to determine effectual lethality of each concept. Continue development of HPM effects database and continue to characterize commercial-off-the-shelf sources and aircraft platforms.

(U) $876 Continue investigation of best means for active denial technologies to support Agile Combat Support applications. Complete design study of millimeter wave sources for active denial technology and associated support subsystems. Begin virtual prototyping of millimeter wave source. Investigate source enhancement technologies using computer simulations.

(U) $16,762 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602202F, Human Systems Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 84,376 | 66,561 | 70,951 | 80,767 | 82,897 | 84,463 | 86,587 | Continuing | TBD |
| 4519 | Communications Technology | 21,784 | 15,855 | 16,331 | 15,251 | 16,581 | 17,020 | 17,476 | Continuing | TBD |
| 4594 | Information Technology | 31,601 | 23,143 | 24,210 | 24,492 | 24,722 | 25,389 | 26,071 | Continuing | TBD |
| 4600 | Electromagnetic Technology | 10,247 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 4917 | Collaborative Information Tech | 0 | 9,060 | 6,044 | 5,396 | 5,523 | 5,632 | 5,748 | Continuing | TBD |
| 5581 | Command and Control (C2) Technology | 20,744 | 18,503 | 24,366 | 35,628 | 36,071 | 36,422 | 37,292 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, portions of efforts in Projects 4519, 4594, and 5581 move into Project 4917 within this PE. In FY 2002, the effort accomplished in Project 4600 moves into PE 0602204F Project 4916 in order to align projects with the Air Force Research Laboratory organizational structure.

**(U) A. Mission Description**

This program develops the technology base for Air Force Command, Control, and Communications (C3). Advances in C3 are required to increase warfighter readiness by providing the right information, at the right time, anywhere in the world. 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 2002, Congress added $3.9 million for simulation-based acquisition; $1.8 million for Information Hiding, Steganography and Digital Watermarking for Information Protection and Authentication Systems; and $2.3 million for Assured Communications.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 86,448 | 59,672 | 67,480 | |
| (U) | Appropriated Value | 87,249 | 66,659 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -98 | | |
| | b. Small Business Innovative Research | -2,048 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -24 | | | |
| | e. Rescissions | -801 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 3,471 | |
| (U) | Current Budget Submit/FY 2003 PBR | 84,376 | 66,561 | 70,951 | TBD |

(U) Significant Program Changes:

Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

PROJECT: 4519

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4519 Communications Technology | 21,784 | 15,855 | 16,331 | 15,251 | 16,581 | 17,020 | 17,476 | 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 2001 ($ in Thousands)

(U) $7,224 Developed assured and survivable information and networking technologies enabling the capability for worldwide command, control and communication operations for EAF. Developed information systems and networking technologies for globally distributed information systems. Continued to develop technologies to provide managed, seamless global information exchange for the Air Force, in a joint/coalition environment. Developed technologies to improve quality of service, robustness, security, and survivability of mission-critical information.

(U) $7,307 Developed 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. Continued 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) $7,253 Developed Defensive Information Warfare tools and technologies to ensure information protection and security of sensitive and encrypted Air Force communication and information systems. Continued to develop net visualization tools and attack indicators. Continued to develop automated capability for computer forensics analysis. Developed preemptive indicators, damage assessment, and recovery techniques.

(U) $21,784 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602702F Command Control and Communications |
| | PROJECT: 4519 |

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

(U) FY 2002 ($ in Thousands)

(U) $7,561 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. Develop assured communication technology that will focus on techniques for tactical wireless networking, wireless information assurance, and the management of these capabilities within the global information enterprise.

(U) $3,350 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) $4,944 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) $15,855 Total

(U) FY 2003 ($ in Thousands)

(U) $6,015 Develop assured and survivable information and networking technologies enabling worldwide command, control and communication operations for the Global Strike Task Force. Continue to develop technologies to improve quality of service for globally distributed information systems. Complete development of assured networking and information systems technologies to improve survivability to critical infrastructure attacks. Initiate development of securely managed enterprise network technology to develop assured network services across multiple network security domains. Initiate development of programmable networking algorithms that enable the dynamic creation of advanced information delivery services, independent of the underlying physical infrastructure devices.

(U) $4,734 Develop critical assured communications and signal processing technologies to provide adaptive, covert, anti-jam, and assured global battlespace connectivity to aerospace forces and greatly reduce equipment footprint. Continue to develop techniques to improve information assurance capabilities for mobile wireless networks to preclude information attacks aimed at denial of service and quality of service

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602702F Command Control and Communications |
| | PROJECT: 4519 |

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

(U) FY 2003 ($ in Thousands) Continued

degradation. Develop assured communication technologies that will enable a full spectrum of information superiority capabilities in wireless networks in a joint/coalition environment. Investigate high performance wireless device and waveform technologies for improving affordability of critical Air Force command and control networks.

(U) $5,582 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 capabilities for damage assessment and recovery techniques. Continue to develop computer and network forensics tools and data mining tools to assess coordinated information warfare (IW) attacks. Continue to develop detection and eradication techniques for malicious software. Initiate investigations in active response technologies, detection of hidden data, and early assessment of complex IW attacks.

(U) $16,331 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: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

PROJECT: 4594

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4594 Information Technology | 31,601 | 23,143 | 24,210 | 24,492 | 24,722 | 25,389 | 26,071 | 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.

(U) FY 2001 ($ in Thousands)

(U) $4,686 Developed information exploitation technologies for imagery and electronic signals to increase global awareness. Continued 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. Investigated advanced information dissemination techniques for seamless integration into the global information base via the global grid.

(U) $7,390 Developed and evaluated innovative multisensor collaborative fusion technologies in a fully distributed aerospace environment. Developed and evaluated 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) $4,961 Developed global information base technologies to achieve situational awareness at all command levels for the dynamic planning and execution process. Developed and investigated 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. Continued 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) $2,611 Developed embedded, affordable, scalable, teraflop processing technologies for real-time information fusion and exploitation. Developed and evaluated 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) | $5,939 | Developed information technologies that significantly reduce the development cost of complex electronic systems. Completed the development of a requirements modeling representation concisely capturing the engineering requirements for computer-aided simulation, verification, and analysis. Completed 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) | $6,014 | Developed modeling and simulation technologies to support next generation distributed collaborative environments. Evaluated, exploited, and developed techniques to expand the capability while reducing the complexity of existing high-resolution models and simulations for the National Air and Space Warfare Model. Developed simulation techniques to provide accurate, real-time decision support for the next generation distributed collaborative environments. |
| (U) | $31,601 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $5,485 | 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) | $5,585 | 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. |
| (U) | $6,047 | 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, |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

exploit, and develop model abstraction and multi-resolution modeling techniques to reduce the complexity of existing high-resolution models and simulations, supporting the National Air and Space Model.

(U) $1,800 Develop information hiding, steganography and digital watermarking techniques to protect and authenticate data within Air Force and DoD information systems. Develop and evaluate steganography detecting and decoding techniques for data embedding, tamper detection and proofing, image and video content authentication, and secure information dissemination.

(U) $23,143 Total

(U) FY 2003 ($ in Thousands)

(U) $6,848 Develop information exploitation technologies for imagery and electronic signals to increase global awareness. Continue to develop advanced multi-sensor open systems techniques and automated analyst tools for exploiting hyperspectral imagery, on-board video processing, new electronic signals, and speech intelligence products to achieve improved situational awareness.

(U) $6,578 Develop and evaluate innovative multi-sensor collaborative fusion technologies in a fully distributed aerospace environment. Continue to develop techniques to quantitatively evaluate fusion algorithms. Develop multi-source fusion techniques for continuous tracking of militarily significant vehicles in the battlespace. Develop and evaluate fusion technologies for enemy threat prediction based on multi-source fusion.

(U) $5,478 Develop global information base technologies to achieve situational awareness at all command levels for the dynamic planning and execution process. Develop intermediate information extraction techniques to reduce data overload and increase time allocated to analysis and decision-making, enabling the ability to populate knowledge base systems. Continue to develop techniques for a self-organizing, data repository, and content-based extraction. Develop advanced web-based search techniques and information aggregation methods required for rapid situational understanding.

(U) $3,429 Develop affordable, scalable, petaflop processing technologies for real-time information fusion and exploitation. Complete processor in memory content addressable architecture for rapid extraction of information from globally distributed knowledge bases. Evaluate architecture to support real-time requirements for dominant battlespace awareness.

(U) $1,877 Develop modeling and simulation technologies to support next generation planning, execution, and assessment environments. Continue to evaluate, exploit, and develop model abstraction and multi-resolution modeling techniques to reduce the complexity of existing high-resolution models and simulations for next generation distributed collaborative decision support environments, exemplified by the Joint Synthetic Battlespace.

(U) $24,210 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602702F Command Control and Communications | 4594 |

**(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: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

PROJECT: 4600

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4600 Electromagnetic Technology | 10,247 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, Project 4600 efforts transferred to PE 0602204F Project 4916, in order to align projects with the Air Force Research Laboratory organizational structure.

**(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 2001 ($ in Thousands)

(U) $3,313 Designed and developed electromagnetic technologies for advanced surveillance and reconnaissance systems applications. Continued to develop and evaluate algorithms for a digital beam-formed multibeam antenna.

(U) $3,093 Designed and developed antenna concepts for aerospace surveillance and reconnaissance applications. Continued to develop and evaluate advanced concepts for large, lightweight arrays. Continued to develop and evaluate a three-dimensional optically excited antenna array.

(U) $3,841 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. Continued to develop turbulence compensation techniques for precision targeting, target signatures, and phenomenology models, and selected multifunction sensor target characteristics. Continued to design and develop infrared focal plane array technology.

(U) $10,247 Total

(U) FY 2002 ($ in Thousands)

(U) $0 In FY 2002, the effort moves into PE 0602204F, Project 4916.

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 In FY 2002, the effort moves into PE 0602204F, Project 4916.

(U) $0 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602702F Command Control and Communications | 4600 |

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603789F, C3I Advanced Development.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

PROJECT: 4917

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4917 Collaborative Information Tech | 0 | 9,060 | 6,044 | 5,396 | 5,523 | 5,632 | 5,748 | Continuing | TBD |

Note: 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 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) $1,248 Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems command and control, intelligence, surveillance, and reconnaissance 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.)

(U) $2,235 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

sensor-to-shooter scenario stressing the time-critical-target requirement, resulting in denying the enemy the sanctuary of time. (Prior to FY 2002, this effort was accomplished in Projects 5581 and 4594.)

(U) $1,677 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) $3,900 Develop and assess Simulation Based Acquisition (SBA) technologies for application to integrated aerospace systems design and analysis. Conduct experiments with challenge problems to define the boundaries of SBA capabilities. Develop an enhanced collaborative technology architecture that supports the tenants of SBA.

(U) $9,060 Total

(U) FY 2003 ($ in Thousands)

(U) $1,443 Develop critical information transmission technologies to permit the seamless integration of aerospace weapon systems' command and control, intelligence, surveillance, and reconnaissance data/information. Complete the development of assured secure communications technology, leveraging the commercial infrastructure, for positive command and control (C2) of aerospace assets in civilian airspace. Continue the development of secure, wide-band wireless information transfer technology for assured communications between munitions and aircraft.

(U) $2,570 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. Investigate techniques to perform the collaborative planning for the Global Strike Task Force. Continue development of distributed decision making technology for joint battlespace information environment. Continue to develop technology to support a sensor-to-shooter scenario stressing the time-critical-target requirement, which will result in denying the enemy the sanctuary of time.

(U) $2,031 Develop processes, methods, and techniques to provide assured performance, integrity, and security of real-time embedded information systems. Continue to develop dynamically reconfigurable aerospace systems using adaptive computing techniques. Continue to develop concepts, designs, and models for the next generation C2 global information systems, which will allow affordable design and development of highly complex aerospace systems. Develop methods and processes for determining the suitability of Java and Real-Time Java to support open system architectures for real-time, embedded information systems.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602702F Command Control and Communications |
| | PROJECT: 4917 |

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

(U) FY 2003 ($ in Thousands) Continued
(U) $6,044 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: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602702F Command Control and Communications

PROJECT: 5581

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5581 Command and Control (C2) Technology | 20,744 | 18,503 | 24,366 | 35,628 | 36,071 | 36,422 | 37,292 | 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 2001 ($ in Thousands)

(U) $6,158 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 technologies to dynamically assess the battlespace, determine measures to create the desired effects, and provide near-real-time command of forces to execute those measures. Developed technologies to provide alternative courses of action and feasibility assessment in uncertain environments.

(U) $1,963 Investigated and developed technologies for the rapid development and application of next generation knowledge-bases for aerospace C2 systems. Developed tools and techniques needed by an Expeditionary Aerospace Force for building very large comprehensive knowledge bases by rapidly formulating and creating new knowledge, along with capabilities to re-use, augment, and repair existing knowledge-bases. Continued the development of techniques for knowledge-base theory slicing and merging, conflict resolution, and context management. Investigated new techniques to allow users to enter, validate, and manipulate knowledge using natural language, sketching, and templating approaches.

(U) $5,908 Investigated, analyzed, and developed technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by Expeditionary Aerospace Forces. Developed and evaluated advanced display and human-computer interface technologies for current and next generation C2 systems.

(U) $1,979 Developed tools and techniques to promote assured performance and affordability of complex air and space platforms. Continued to develop new techniques for rapidly incorporating new functions into scaleable, open architecture systems. Developed dynamically reconfigurable

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

aerospace systems using field programmable gate arrays. Developed 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) $4,736 Developed the technologies, tools, and techniques required to ensure protection of critical command, control, and communications (C3) infrastructure. Developed the technologies which will allow a robust implementation of an overarching, integrated capability for protection of the global C3 infrastructure. Developed protection techniques with emphasis on integrity of information and availability of networks required for distributed, collaborative command and control (C2) systems.

(U) $20,744 Total

(U) FY 2002 ($ in Thousands)

(U) $5,734 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) $4,835 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. Develop capabilities that learn to extract, correlate, and classify link patterns. Investigate enhanced reasoning techniques and algorithms for more complex inferencing and performance.

(U) $7,934 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 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

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) $18,503 Total

(U) FY 2003 ($ in Thousands)

(U) $7,267 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. Continue to develop tools to visualize the probability of success of qualitatively different courses of action. Continue to develop intelligent agent technologies capable of supporting joint/coalition command and control (C2) systems for various missions. Develop and assess active template technologies for use in dynamic mobile C2 applications. Develop tools to increase situational awareness through intelligent information push and pull in dynamic environments.

(U) $5,485 Investigate and develop technologies for the rapid development and application of next generation knowledge bases for aerospace C2 systems. Continue to develop tools that will automate intelligent extraction, correlation, and classification of link patterns for discovering relevant linkages between entities. Develop enhanced reasoning techniques for complex inferencing and performance of C2 systems.

(U) $7,823 Investigate, analyze, and develop technologies for automatic rapid reconfiguration of distributed intelligent information systems to varying crisis levels faced by Aerospace Expeditionary Forces. Continue to develop dynamic and adaptable interface technology that allows commanders to create a mission-tailored view of the configuration and status of the currently executing Air Operation Center C2 process. Continue to develop advanced interactive displays suitable for deployment with C2 applications and command centers. Continue to develop techniques and applications for information visualization for use in conjunction with multiple, heterogeneous data sets.

(U) $3,791 Investigate and develop technologies to implement flexible, secure and survivable information management and distribution services to enable a Joint Battlespace Infosphere (JBI). Continue to develop techniques for integrating legacy client-server C2 systems into the next generation of agile, web-enabled information management environments. Continue to investigate approaches to enable JBI to service thousands of participating C2 and intelligence, surveillance, and reconnaissance clients exchanging millions of information objects. Investigate and develop technologies that will ensure availability, integrity, and survivability of information within a JBI.

(U) $24,366 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602702F Command Control and Communications | 5581 |

**(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 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.

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

DATE: February 2002

BUDGET ACTIVITY: 02 - Applied Research

PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology

PROJECT: 4770

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4770 | Dual Use Science and Technology (S&T) | 9,717 | 10,316 | 10,626 | 10,820 | 11,031 | 11,242 | 11,455 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**(U) A. Mission Description**

The Dual Use Science and Technology program seeks to leverage industry investments and interests in advanced technologies of mutual advantage to the Air Force and industry. A key objective of this program is for the Air Force to stimulate the development of dual use technologies so as to provide greater access to commercial technologies and to lead to affordable defense systems that maintain battlefield superiority. A critical component of the program is the cost-sharing requirement from both industry and the Air Force. The cooperative funding assures joint commitment to the development effort of successful transitions. Specific projects are determined through annual competitive solicitation(s). Technology areas considered include advanced materials and manufacturing; sensors; advanced propulsion, power, and fuel efficiency; information and communications technologies; and weapon systems sustainment.

(U) FY 2001 ($ in Thousands)

(U) $1,802 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) $1,264 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) $4,578 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,

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| 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

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) $1,399 Developed information and communication 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) $674 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.

(U) $9,717 Total

(U) FY 2002 ($ in Thousands)

(U) $2,606 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) $2,570 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) $2,570 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology |
| PROJECT: 4770 | |

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

(U) FY 2002 ($ in Thousands) Continued

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) $1,270 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 hydraulic, mechanical and pneumatic power subsystems and their costly logistics support; compact high power generation and conditioning; and high rate energy storage.

(U) $10,316 Total

(U) FY 2003 ($ in Thousands)

(U) $2,126 Develop advance materials and manufacturing technologies that will reduce the life-cycle cost while enhancing the capability of both Air Force and commercial air and space vehicles and launch systems. Technology areas of interest include: non-destructive/non-intrusive evaluation techniques; smart and adaptive skins; corrosion resistant coatings; micro and nano-scale electronics; durable, light weight materials for space launch; and agile materials for use in force protection.

(U) $2,125 Develop affordable advanced sensors technologies that have application to commercial and military aerospace platforms. Technology areas of interest include: timely, high quality, precision imaging; sensitive, ambient environment electromagnetic (i.e., infrared) detection; and high speed, precision temporal, spatial, and attitude sensors and controllers.

(U) $2,125 Develop advanced propulsion, power, and fuel efficiency technologies to improve the performance, increase the life, and reduce the cost of military and commercial aerospace operations. Technology areas of interest include: performance and emissions of airbreathing and rocket propulsion systems; advanced gas turbine combustion and blades; electric propulsion alternatives; energy processing, storage, and conversion;

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology |
| PROJECT: 4770 | |

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

(U) FY 2003 ($ in Thousands) Continued

lasers; and smart engine health monitoring techniques.

(U) $2,125 Develop advanced information and communication technologies to enhance the collection, processing, dissemination, security, accuracy, and presentation of information to U.S. and coalition military decision-makers and corresponding commercial industry sectors. Technology areas of interest include: collecting, synthesizing, and encoding of pertinent information; securing the high-speed and reliable fusion, accuracy, security, and transmission of information; and presenting the appropriate information in an efficient, timely, consistent, and easily understood manner.

(U) $2,125 Develop weapon systems sustainment technologies that extend the life and improve the performance, efficiency, reliability, and maintainability of both Air Force and commercial aerospace systems. Technology areas of interest include: avionics; materials fatigue and fracture; corrosion; cost-effective techniques for non-invasive, real-time monitoring of system health/performance; and associated environmental impacts.

(U) $10,626 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 10,051 | 10,417 | 10,652 | |
| (U) | Appropriated Value | 10,144 | 10,417 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -101 | | |
| | b. Small Business Innovative Research | -238 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -96 | | | |
| | e. Rescissions | -93 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -26 | |
| (U) | Current Budget Submit/FY 2003 PBR | 9,717 | 10,316 | 10,626 | TBD |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 02 - Applied Research | PE NUMBER AND TITLE: 0602805F Dual Use Science & Technology |
| | PROJECT: 4770 |

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

(U) Significant Program Changes:
Not Applicable.

D. Execution - 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.
(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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 02 - Applied Research | 0602805F Dual Use Science & Technology | 4770 |

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

(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.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603106F Logistics Systems Technology

PROJECT: 2745

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2745 | Logistics Performance and Support Technology (S&T) | 13,157 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts transferred to PE 0603231F, Project 4923, to align resources with the Air Force Research Laboratory organization.

**(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 2001 ($ in Thousands)

(U) $1,863 Developed and demonstrated technologies to 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. Continued 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) $4,683 Developed and demonstrated intelligent software agents and realistic human behavior models. Developed intelligent software agents that automatically translate and execute air tasking order inputs for synthetic exercises and war games. Developed software agents that enhance the users' ability to monitor and respond to asymmetric events during the planning and scheduling of airlift missions.

(U) $4,549 Developed and demonstrated logistics technologies for improved deployment operations and improved system supportability. 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 to develop an integrated, easily deployable, waste management system to process all types of waste materials produced during deployed

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603106F Logistics Systems Technology / PROJECT: 2745 |

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

(U) FY 2001 ($ in Thousands) Continued

operations.

(U) $2,062 Developed and demonstrated logistics technologies for improved system supportability, deployability, and mobility. These technologies greatly improve the flexibility and deployability of the flightline maintenance equipment, improve the airlift/mobility operations of the Air Expeditionary Force, and ensure that weapon systems are more reliable and maintainable. Completed and transitioned specifications for the next generation of powered support equipment for more agile/lean flightline maintenance. Completed and transitioned specifications and technology for next generation ground refueling systems to support Air Force Special Operations Command.

(U) $13,157 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort moved to PE 0603231F, Project 4923.

(U) $0 Total

(U) FY 2003 ($ 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 cost-effective technologies to improve the design, performance, and support of current and future weapon systems.

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

| | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|
| (U) Previous President's Budget | 13,768 | 0 | 0 | TBD |
| (U) Appropriated Value | 13,895 | 0 | | |
| (U) Adjustments to Appropriated Value | | | | |
| a. Congressional/General Reductions | | | | |
| b. Small Business Innovative Research | -326 | | | |
| c. Omnibus or Other Above Threshold Reprogram | | | | |
| d. Below Threshold Reprogram | -285 | | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603106F Logistics Systems Technology | PROJECT: 2745 |

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

| | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|
| e. Rescissions | -127 | | | |
| (U) Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) Current Budget Submit/FY 2003 PBR | 13,157 | 0 | 0 | TBD |

(U) Significant Program Changes:
In FY 2002, efforts transfer to PE 0603231F, Project 4923, to align resources with the Air Force Research Laboratory organization.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603721N, Environmental Protection.
(U) PE 0604708F, Civil, Fire, Environmental, Shelter.
(U) PE 0604740F, Integrated Command & Control Applications.
(U) PE 0605801A, Programwide Activities.
(U) PE 0708011F, Industrial Preparedness.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) E. Acquisition Strategy**

Not Applicable.

**(U) F. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 41,815 | 45,801 | 21,138 | 41,486 | 42,684 | 41,255 | 42,195 | Continuing | TBD |
| 2100 | Laser Hardened Materials | 10,022 | 23,251 | 12,359 | 30,473 | 30,534 | 28,815 | 30,596 | Continuing | TBD |
| 3153 | Non-Destructive Inspection Development | 10,099 | 6,692 | 3,488 | 3,819 | 4,153 | 4,233 | 4,313 | Continuing | TBD |
| 3946 | Materials Transition | 21,694 | 14,458 | 3,173 | 5,256 | 5,582 | 5,746 | 4,779 | Continuing | TBD |
| 4918 | Deployed Air Base Demonstrations | 0 | 1,400 | 2,118 | 1,938 | 2,415 | 2,461 | 2,507 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, the deployed air base demonstration efforts in PE 0603205F, Project 4398, and PE 0603112F, Project 3946, are transferred into this PE in Project 4918. In FY 2003, only the space unique tasks in Projects 2100 and 3946 will be transferred to PE 0603500F, Project 5032, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This program develops and demonstrates materials technology for transition into Air Force systems. The program has four projects which: (1) develop laser hardened materials technologies for the broadband laser protection of aircrews and sensors; (2) develop non-destructive inspection and evaluation technologies; (3) develop transition data on structural and non-structural materials for aerospace applications; and, (4) develop airbase operations technologies including power generators, deployable shelters, and fire fighting capabilities. Note: In FY 2002, Congress added $1.1 million for Metals Affordability Initiative, $3.4 million for advanced aluminum aerostructures, $2.8 million for ceramic matrix composites for engines, $2.1 million for technology development investment for aging aircraft, $2.1 million for plasma enhanced chemical deposition techniques, $1.0 million for vapor growth carbon fiber (VGCF), and $1.0 million for handheld holographic radar gun which explains the perceived decrease in FY 2003.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 43,575 | 32,748 | 25,734 | |
| (U) | Appropriated Value | 43,978 | 46,248 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -447 | | |
| | b. Small Business Innovative Research | -1,032 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -728 | | | |
| | e. Rescissions | -403 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -4,596 | |
| (U) | Current Budget Submit/FY 2003 PBR | 41,815 | 45,801 | 21,138 | TBD |

Significant Program Changes:

(U) Significant Program Changes:

In FY 2003, only the space unique tasks in Projects 2100 and 3946 will be transferred to PE 0603500F, Project 5032, in conjunction with the Space Commission recommendation to consolidate all space unique activities. Additionally, in FY 2002, this program received Congressional Adds which explains the perceived decrease in FY 2003.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems

PROJECT: 2100

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2100 Laser Hardened Materials | 10,022 | 23,251 | 12,359 | 30,473 | 30,534 | 28,815 | 30,596 | Continuing | TBD |

Note: In FY 2003, space unique tasks in Project 2100 will be transferred to PE 0603500F, Project 5032, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(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 directed energy threats. Concepts are demonstrated to provide hardening options for transition to Air Force systems. The goal is to ensure mission capability before, during, and after threat exposure. Current protection schemes are activated by intensity or wavelength and are only capable of countering a specific portion of the laser threat. Recent laser technology development has increased laser wavelength agility. To harden systems against all potential lasers the development of a combination of approaches is required.

(U) FY 2001 ($ in Thousands)

(U) $1,448 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. Fabricated and characterized hybrid optical limiters for the protection of staring focal plane arrays. Fabricated rugate fixed-wavelength filters and optical switches for mid-wave infrared (MWIR) space systems. Developed hardening solutions for critical space sensor designs and environments based on successful approaches employed in tactical sensors.

(U) $5,077 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. Developed fixed filters and invisible laser eye protection visor for panoramic night vision goggles (PNVG). Evaluated tunable filter PNVG protection technology. Validated wrap-around tristimulus spectacles (eye-glasses). Developed prescription capable flexible filter for eye protection. Transitioned prescription-capable, eye-centered rugates on lenses with dyed plastic substrates.

(U) $3,497 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. Fabricated high performance rugate filters for hardened low light level television systems. Initiated development of specific hardening techniques for specific munitions. Developed specific hardening techniques for MWIR and long-wave infrared staring forward looking infrared systems.

(U) $10,022 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 2002 ($ in Thousands)

(U) $5,636 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 optical limiters for the protection of mid-wave infrared staring focal plane arrays. Test and update hardened coating process for rugate fixed-wavelength filters and optical switches for mid-wave infared space systems. Fabricate hardening solutions for critical space sensor desings and environments based on successful approaches employed in tactical sensors.

(U) $9,046 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 panaromic night vision night goggle (PNVG) program. Begin development of tunable liquid crystal filter technology for the PNVG program.

(U) $8,569 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) $23,251 Total

(U) FY 2003 ($ in Thousands)

(U) $6,148 Develop and demonstrate advanced materials technologies that enhance laser protection for Air Force aircrews to ensure safety and to enable aircrews to perform required missions in a laser threat environment. Transition flexible filter technology in the form of spectacles for human factors evaluation and design refinement. Transition first generation tristimulus filter technology for daytime missions to the Life Support Systems Program Office. Fabricate refined tristimulus filter eyewear based on results from human factors study. Transition fixed wavelength filter technology to the PNVG program for flight tests. Continue the development of tunable filter technology for PNVGs. Identify and evaluate hardening technologies for use in protecting eyes from agile laser threats.

(U) $6,211 Develop and demonstrate advanced materials technologies that enhance laser hardening for sensors, avionics, and components to increase survivability and mission effectiveness of areospace systems. Demonstrate complete hardening for a fielded TV sensor system. Develop hardening solutions for Charge Coupled Device imaging systems. Initiate hardening development for multispectral and hyperspectral sensor

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 2003 ($ in Thousands) Continued

systems.

(U) $12,359 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) PE 0603500F, Multi-disciplinary Adv Dev Space 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) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems

PROJECT: 3153

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 3153 | Non-Destructive Inspection Development | 10,099 | 6,692 | 3,488 | 3,819 | 4,153 | 4,233 | 4,313 | 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 2002, Congress added $2.1 million for technology development investment for aging aircraft and $1.0 million for handheld holographic radar gun which explains the perceived decrease in FY 2003.

(U) FY 2001 ($ in Thousands)

(U) $6,912 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. Transitioned 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. Transitioned 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) $1,731 Developed and demonstrated 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) $558 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. Evaluated NDE benchmarks and develop an automated inspection capability to inspect engine rotary components for planned life extension of engine rotors. Developed a method 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: February 2002 |
|---|---|
| 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 2001 ($ in Thousands) Continued

(U) $898 Developed and demonstrated 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. Established 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) $10,099 Total

(U) FY 2002 ($ in Thousands)

(U) $3,270 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.

(U) $1,434 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) $1,988 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) $6,692 Total

(U) FY 2003 ($ in Thousands)

(U) $1,141 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 of joints in aging aircraft. Develop and demonstrate 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: February 2002 |
|---|---|
| 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 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $1,409 | 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. Continue transition of NDE benchmarks. Test an automated inspection capability to inspect engine rotary components for planned life extension of engine rotors. Downselect optimal NDE approaches to extend the life of fracture-critical gas turbine engine components and establish protocols for component inspections. Develop residual stress gradient measurement technology to increase measurement on shot peened surfaces. |
| (U) | $938 | Develop and demonstrate advanced inspection technologies supporting low-observable systems to enhance affordability and ensure full performance and survivability. Transition to the field an advanced multispectral low-observable nondestructive evaluation tool for assessing radio frequency signature (zone vs. whole aircraft) that is real-time, small, lightweight, portable, user friendly, and covers multiple frequency bands. |
| (U) | $3,488 | 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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems

PROJECT: 3946

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3946 Materials Transition | 21,694 | 14,458 | 3,173 | 5,256 | 5,582 | 5,746 | 4,779 | Continuing | TBD |

Note: In FY 2002, the deployed air base demonstration efforts in Project 3946, are transferred within this PE into Project 4918. In FY 2003, space unique tasks in Project 3946 will be transferred to PE 0603500F, Project 5032, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

Develops and demonstrates advanced material and processing technologies for fielded and planned Air Force weapon, airframe, and engine applications. Advanced materials and processes that have matured beyond applied research are characterized, critical data are collected, and critical evaluations in the proposed operating environment are performed. This design and scale-up data enhances overall affordability of promising material and processing technologies, providing needed initial incentive for their industrial development. Note: In FY 2002, Congress added $1.1 million for Metals Affordability Initiative, $3.4 million for advanced aluminum aerostructures, $2.8 million for ceramic matrix composites for engines, $2.1 million for plasma enhanced chemical deposition techniques, and $1.0 million for vapor growth carbon fiber which explains the perceived decrease in FY 2003.

(U) FY 2001 ($ in Thousands)

(U) $12,896 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. Fabricated advanced aircraft brake materials with improved braking capacity, increased life, and better environmental stability. Fabricated large integrated composite structures for aircraft with reduced part count and assembly costs. Validated advanced non-linear optical materials for aircraft infrared countermeasures against far-infrared laser sources.

(U) $4,003 Developed and demonstrated 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) $1,751 Developed and demonstrated 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. Validated an accelerated environmental effects test to determine in-service performance degradation of aircraft coating systems. Fabricated a large aperture Aluminum Oxynitride window material with high optical quality, durability, and strength. Transitioned the utilization of quantitative residual stress measurements in the fatigue life management of turbine engine disks.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

(U) $442 Provided affordability education and training through the application of integrated product and process development 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. Initiated education and training of organic IPPD and cost modeling experts in each Air Force S&T Technical Directorate.

(U) $2,602 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 the AEF operations: deployed base systems and physical force protection. Developed scaled air-inflatable frames for large shelters. Demonstrated advanced cycle technologies for mobile heat pumps that reduce weight and volume by 30%. Fabricated a small-footprint fuel cell reformer capable of converting logistics fuels into hydrogen for fuel cell power generation. Fabricated structural retrofits and develop deployable blast protection reinforcement systems for buildings to reduce blast debris hazards.

(U) $21,694 Total

(U) FY 2002 ($ in Thousands)

(U) $8,566 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) $4,335 Develop and demonstrate advanced materials and processing technologies to enhance the sustainability of Air Force aerospace 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 window material with high optical quality, durability, and strength. Evaluate the effectiveness of corrosion abatement treatments and transition the results.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 2002 ($ in Thousands) Continued

(U) $14,458 Total

(U) FY 2003 ($ in Thousands)

(U) $2,360 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. Continue to fabricate and characterize integrated composite structure assemblies for aircraft with reduced part count and assembly costs. Complete the demonstration of advanced non-linear optical materials for aircraft infrared countermeasure against far-infrared laser sources and transition results. Conduct characterization of materials and processes for enhancing the reliability and maintainability of low-observable systems.

(U) $813 Develop and demonstrate advanced materials and processing technologies to enhance the sustainability of Air Force aerospace systems by lowering operations and maintenance costs and ensuring full operability and safety of systems and personnel. Initiate efforts to develop and characterize corrosion resistant coatings and corrosion prevention compounds for aging aircraft structures applications.

(U) $3,173 Total

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0603211F, Aerospace Structures

(U) PE 0603202F, Aerospace Propulsion Subsystem Integration

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603500F, Multi-disciplinary Adv Dev Space 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**

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems |
| | PROJECT: 3946 |

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

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603112F Advanced Materials for Weapon Systems

PROJECT: 4918

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4918 Deployed Air Base Demonstrations | 0 | 1,400 | 2,118 | 1,938 | 2,415 | 2,461 | 2,507 | Continuing | TBD |

Note: In FY 2002, the deployed air base demonstration efforts in PE 0603205F, Project 4398, and PE 0603112F, Project 3946, are transferred into this PE in Project 4918.

**(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 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) $550 Demonstrate and transition advanced rapid deployment airbase technologies that reduce airlift, setup times, manpower requirements, and sustainment costs in support of 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 laser operations.

(U) $742 Demonstrate and transition efficient and cost-effective technologies to provide physical protection technologies to 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

(U) $1,400 Total

(U) FY 2003 ($ in Thousands)

(U) $1,147 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. Continue development of shelters, power, and rapid airfield assessment technologies that improve air mobile systems performance and reduce airlift requirements in support of AEF operations. Develop advanced aircraft fire fighting technologies such as fire fighting agents and equipment. Transition highly effective, deployable crash/rescue system based on three-dimensional foam technology to support AEF operations.

(U) $125 Demonstrate and transition affordable, rapid deployment technologies that ensure military readiness, maintain aerospace missions, support advanced weapon systems, and enable peacetime training operations. Continue development of advanced waste reactor technologies to support emerging weapons. Demonstrate rapidly deployable full-scale mixed-base hydrogen peroxide production plant that reduces the airborne laser logistics burdens by thirty percent.

(U) $846 Demonstrate and transition efficient and cost-effective technologies to provide physical protection technologies to AEF deployed warfighters and infrastructure. Develop deployable protective and reactive blast suppression technologies to protect deployed warfighters. Continue development of autonomous vehicles to support Air Force operational requirements for unexploded ordnance clearance and active range operations.

(U) $2,118 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**

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603112F Advanced Materials for Weapon Systems | 4918 |

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

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603202F Aerospace Propulsion Subsystems Integration

PROJECT: 668A

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 668A | Aircraft Propulsion Subsystem Integration | 33,267 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts transferred to PE 0603216F, 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.

(U) FY 2001 ($ in Thousands)

(U) $5,103 Designed, fabricated, and demonstrated durability and integration technologies for turbofan/turbojet engines for improved supportability and affordability of current and future Air Force aircraft. Completed 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) $21,246 Designed, fabricated, and tested advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Fabricated a full-demonstrator engine test fixed inlet guide vanes and moderate aspect ratio rotor, Integrally Bladed Rotor repair, fan rim damper, HCF mistuning technologies, vaneless counterrotating high/low pressure turbine, probabilistic

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603202F Aerospace Propulsion Subsystems Integration | 668A |

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

(U) FY 2001 ($ in Thousands) Continued

rotor system design, gamma titanium aluminide low pressure turbine coverplate, sprayform cast hardware, and Ceramic Matrix Composite technologies. Continued advanced engine designs for High Cycle Fatigue robust front frame, two-stage forward swept fan, tiled low pressure turbine (LPT) blade, uncooled Ceramic Matrix Composite (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) $4,512 Designed, fabricated, and tested advanced component technologies for improved performance, durability, and affordability of engines for missile and uninhabited air vehicle applications. Continued design of organic matrix composite fan, high stage loading splittered fan, uncooled ceramic high/low pressure turbine, and slinger combustor.

(U) $1,926 Designed and initiated fabrication of integrated propulsion designs to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency missile demonstration.

(U) $480 Designed a low volume, high temperature and pressure combustor. Evaluated performance in cruise missile or uninhabited air vehicle applications.

(U) $33,267 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Efforts moved to PE 0603216F, Project 4921.

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 No activity.

(U) $0 Total

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603202F Aerospace Propulsion Subsystems Integration |
| | PROJECT: 668A |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 34,619 | 0 | 0 | |
| (U) | Appropriated Value | 34,940 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -820 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -532 | | | |
| | e. Rescissions | -321 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 33,267 | 0 | 0 | TBD |

(U) Significant Program Changes:
Note: In FY 2002, the efforts performed under this program transferred to PE 0603216F, Project 4921.

**(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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 44,774 | 60,914 | 50,589 | 42,072 | 37,115 | 38,011 | 38,045 | Continuing | TBD |
| 5019 | Advanced RF Technology for ISR Sensors | 0 | 0 | 4,725 | 6,047 | 4,250 | 5,925 | 5,531 | Continuing | TBD |
| 665A | Advanced Aerospace Sensors Technology | 17,156 | 17,334 | 11,241 | 10,157 | 10,976 | 9,922 | 11,063 | Continuing | TBD |
| 69DF | Target Attack and Recognition Technology | 27,618 | 43,580 | 34,623 | 25,868 | 21,889 | 22,164 | 21,451 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

In FY 2002, work performed under PE 0603253F, Projects 2735 and 666A, moves to this PE, Project 665A. Apparent project ramp in Project 665A is due only to realignment of the projects. In FY 2003, efforts in advanced radio frequency (RF) technologies for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this PE, Project 665A, transfers to this project. Also in FY 2003, space unique tasks in this PE, Project 665A, will be transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

Divided into three broad project areas, this program develops technologies to enable the continued superiority of sensors from aerospace platforms. The first project develops and demonstrates advanced technologies for RF sensors for aerospace ISR systems. The second project develops and demonstrates advanced technologies for electro-optical (EO) sensors, radar sensors and electronic counter-countermeasures (ECCM), and components and algorithms. The third project develops and demonstrates RF and EO sensors for detecting, locating, and targeting airborne, fixed, and time-critical mobile ground targets obscured by natural or man-made means. Together, the projects in this program develop the means to find, fix, target, track, and engage air and ground targets anytime, anywhere, and in any weather. Note: In FY 2002, Congress added $1.0 million for Advanced Physical Vapor Transport and $7.4 million for the Radar Target Modeling Thrust.

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new sensor and electronic combat system developments that have military utility and address warfighter needs.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 46,381 | 55,809 | 43,098 | |
| (U) | Appropriated Value | 46,811 | 61,509 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -595 | | |
| | b. Small Business Innovative Research | -1,100 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -507 | | | |
| | e. Rescissions | -430 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 7,491 | |
| (U) | Current Budget Submit/FY 2003 PBR | 44,774 | 60,914 | 50,589 | TBD |

(U) Significant Program Changes:

In FY 2002, work performed under PE 0603253F, Projects 2735 and 666A, moves to this PE, Project 665A. Apparent project ramp in Project 665A is due only to realignment of the projects. In FY 2003, space unique tasks in this PE, Project 665A, will be transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

PROJECT: 5019

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5019 Advanced RF Technology for ISR Sensors | 0 | 0 | 4,725 | 6,047 | 4,250 | 5,925 | 5,531 | Continuing | TBD |

In FY 2003, efforts in advanced radio frequency technologies for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this PE, Project 665A, transfers to this project.

**(U) A. Mission Description**

This project develops and demonstrates radio frequency (RF) aerospace surveillance sensors and signal processing for ISR sensors capable of operating in adverse clutter and jamming environments. This project provides the warfighter with sensors capable of detecting and tracking both airborne (conventional and low radar cross section) and ground-based high value, time-critical targets. Work includes developing aerospace environmentally qualified (vibration, shock, temperature, and radiation hardened) sensor capabilities (including integrated electro-optical mixed signal), as well as advanced component and subsystem technologies.

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $882 Configure data collection opportunities using existing assets for validation of techniques generated for advanced air moving target indication, ground moving target indication (GMTI), and foliage penetrating ground target indication. Initiate effort to design a flexible testbed using a manned test aircraft to demonstrate multi-intelligence surveillance.

(U) $1,503 Conduct in-house development of a multi-intelligence sensor design, utilizing technologies developed in aperture development, signal processing, and radar design. Develop techniques for discriminating ground from air targets under conditions of common pulse repetition frequencies, waveforms, and receiver systems.

(U) $1,457 Develop advanced radar signal processing techniques to mitigate clutter and jamming interference, and improve detection and tracking of difficult targets in hostile environments. Develop knowledge-aided radar signal processing techniques for improved detection and false alarm control performance in GMTI sensors. Implement multi-dimensional adaptive processing techniques and knowledge-aided radar signal

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors | PROJECT: 5019 |

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

(U) FY 2003 ($ in Thousands) Continued

processing techniques on selected advanced computing architectures, and demonstrate these techniques for multi-mission aerospace radar applications.

(U) $883 Develop and demonstrate photonic digital and analog mixed signal multi-gigahertz component architectures. Develop and integrate chip-scale photonic and hybrid mixed signal components for radio frequency signal generation, phased array antenna beam formation, and beam control. Develop and demonstrate high-resolution wide bandwidth photonic wavelength division multiplexing and signal processing technology. Provide performance modeling, verification, and analysis of photonic and hybrid mixed signal devices for military unique applications.

(U) $4,725 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 0603270F, Electronic Combat Technology.
(U) PE 0603500F, Multi-disciplinary Adv Space Tech.
(U) PE 0604270F, Electronic Warfare (EW) Development.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

PROJECT: 665A

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 665A Advanced Aerospace Sensors Technology | 17,156 | 17,334 | 11,241 | 10,157 | 10,976 | 9,922 | 11,063 | Continuing | TBD |

In FY 2003, space unique tasks in this project will be transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommedation to consolidate all space unique activities. Also in FY 2003, efforts in advanced radio frequency technologies for intelligence, surveillance, and reconnaissance (ISR) sensors previously performed in this project will transfer to this PE, Project 5019.

**(U) A. Mission Description**

This project develops and demonstrates aerospace sensor technologies for manned and unmanned platforms, including electro-optical (EO) sensors, targeting and attack radar sensors, and electronic counter-countermeasures (ECCM) for radars. It provides aerospace platforms with the capability to precisely detect, track, and target both airborne (conventional and low radar cross section) and ground-based, high-value, time-critical targets. Project activities include developing multi-function radar and electronic combat technology. Desired warfighting capabilities include the ability to detect concealed targets in difficult background conditions.

(U) FY 2001 ($ in Thousands)

(U) $641 Developed integrated EO sensor technology to search, detect, locate, and identify air and ground targets at ranges longer than currently achievable, whether the targets are camouflaged, low-observable, or employing other means of deception. Optimized sensor design and performed utility assessments for an affordable integrated targeting capability.

(U) $10,500 Developed EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace ISR applications. Completed critical signature data collection experiments to determine performance parameters for day/night hyperspectral sensors. Fabricated a hyperspectral imaging sensor for high altitude reconnaissance aircraft.

(U) $868 Developed advanced radar signal processing techniques to mitigate clutter and jamming interference and improve detection and tracking of difficult targets. Demonstrated ability to detect slow moving airborne and ground targets from an airborne platform.

(U) $3,148 Developed and demonstrated 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. Performed flight test demonstrations of foliage penetration RF sensor and real-time image formation algorithms.

(U) $20 Developed technology to lower life cycle costs of radar systems. Developed low-cost, lightweight antennas using micro-electro-mechanical phase shifters for aerospace surveillance and strike radar applications.

(U) $765 Developed advanced EO sensor technology for non-cooperative target identification. Flight tested eye-safe sensor. Performed necessary modifications prior to sensor transition.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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) Continued

| | | |
|---|---|---|
| (U) | $133 | Developed advanced multi-function sensor component technologies for radar, electronic warfare, navigation, and communications applications. Demonstrated and evaluated affordable, high performance radio frequency (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) | $743 | Developed advanced RF photonic signal control and distribution technologies for phased array apertures. Demonstrated and evaluated photonic beamforming. Designed and fabricated true-time-delay photonic technology for phased array antennas used in intelligence, surveillance, and reconnaissance (ISR) applications. (In FY 2000, this effort was conducted under PE 0603726F, Project 2863.) |
| (U) | $338 | Developed and demonstrated advanced modular, shareable digital RF sensor technologies for aerospace sensor suites used in intelligence, surveillance, and reconnaissance (ISR) applications. Fabricated and tested dual-use, modular digital RF receiver components for multi-mode radar operations. |
| (U) | $17,156 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,710 | 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) | $3,718 | Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace ISR applications. Continue fabricating a demonstration sensor for high altitude reconnaissance aircraft, perform initial system utility demonstrations, and develop signature-based data processing techniques. |
| (U) | $1,032 | Develop advanced radar signal processing techniques to mitigate clutter and jamming interference and improve detection and tracking of difficult targets. Design processing architecture for evaluating multi-dimensional adaptive processing techniques. Demonstrate these techniques for multi-mission aerospace radar applications. |
| (U) | $3,231 | Develop, test, evaluate, and demonstrate the RF sensor techniques required to detect, track, and target high-value, time-critical targets that are concealed through staelth or deceptive techniques. Demonstrate technologies to increase detection range for low-observable targets. Initiate concept design study for a 'mini' unmanned aerospace vehicle RF sensor to detect, track, and target high-value, time-critical targets that are difficult to detect through either stealth or concealment. |
| (U) | $908 | Develop advanced EO sensor technology for non-cooperative target identification. Complete design and begin development of a multi-function laser for air and ground target identification. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603203F Advanced Aerospace Sensors |
| | PROJECT<br>665A |

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

(U) FY 2002 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $1,099 | 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. Complete testing a multi-chip module version of a monobit receiver for electronic warfare applications. Develop advanced radio frequency (RF) photonic signal control and distribution technologies for phased array apertures. |
| (U) | $1,985 | Develop and demonstrate advanced modular, sharable, digital RF sensor technologies for aerospace sensor suites performing intelligence, surveillance, and reconnaissance (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) | $1,660 | 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) | $991 | Develop deposition techniques for high growth rate, high quality silicon carbide semiconductor substrates to enable advanced physical vapor transport techniques. |
| (U) | $17,334 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,239 | 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. Complete fabricating and testing a ground demonstration sensor and aircraft integration design. Assess real-time data processing performance. |
| (U) | $3,333 | Develop EO sensor technologies to detect and locate camouflaged and concealed targets for aerospace ISR applications. Complete fabricating and testing a demonstration sensor for high altitude reconnaissance aircraft. Perform flight characterization. Assess signature-based data processing performance. |
| (U) | $1,398 | Develop advanced EO sensor technology for non-cooperative target identification. Complete design and begin development of a multi-function laser for air and ground target identification. |
| (U) | $1,210 | Develop technologies to maximize GPS jam resistance, positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Develop advanced GPS M-Code technologies. Develop reference technologies to adaptively operate GPS in buildings, underground, and in air and space to provide precise time, position, and velocity for multiple platforms. Develop virtual flight test |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors | PROJECT: 665A |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| | | technology for improved assessment of GPS anti-jam technologies. |
| (U) | $1,828 | Develop, test, evaluate, and demonstrate the RF sensor techniques required to detect, track, and target high-value, time-critical targets that are difficult to detect through either stealth or concealment. Evaluate 'mini' unmanned aerospace vehicle concept of operation and RF sensor performance improvements in the detection, tracking, and targeting of high-value, time-critical targets. |
| (U) | $233 | Provide concept definition and system analysis of a fire control radar system for airborne applications. |
| (U) | $11,241 | 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 0603205F, Flight Vehicle Technology.
(U) PE 0603707F, Weather Systems Advanced Development.
(U) PE 0603500F, Multi-disciplinary Adv Space Tech.
(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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors

PROJECT: 69DF

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 69DF Target Attack and Recognition Technology | 27,618 | 43,580 | 34,623 | 25,868 | 21,889 | 22,164 | 21,451 | Continuing | TBD |

In FY 2003, efforts in advanced radio frequency technologies for intelligence, surveillance, and reconnaissance previously performed in this project will transfer to this PE, Project 5019.

**(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 2001 ($ in Thousands)

(U) $2,347 Developed advanced situational awareness technologies for rapid detection, location, and prosecution of time-critical targets. Demonstrated algorithms for multisensor fusion of on- and off-board data and images.

(U) $1,346 Developed and demonstrated technologies for real-time information in- and out-of-the-cockpit for improved situational awareness. Completed route replanning simulations. Continued developing real-time retargeting algorithms for special operation forces applications.

(U) $1,823 Developed and evaluated radar automatic target recognition (ATR) algorithms for tracking and identifying moving and stationary ground targets. Conducted risk reduction activities to improve affordability and the smooth transition of technology via planned sensor upgrades to strike and reconnaissance platforms.

(U) $835 Developed target recognition concepts using hyperspectral imaging data and other candidate sensor inputs to determine requirements for ATR

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors | PROJECT: 69DF |

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

(U) FY 2001 ($ in Thousands) Continued

and target/background phenomenology efforts. Evaluated algorithms using hyperspectral imaging data.

(U) $3,108 Continued testing and integrating Defense Advanced Research Projects Agency (DARPA) multi-sensor Automatic Target Recognition (ATR) fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, and reconnaissance missions.

(U) $4,159 Developed advanced tactical targeting technology in conjunction with DARPA for suppression of enemy air defenses. Optimized targeting algorithms and techniques. Modified 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 Developed Integrated Demonstrations and Applications Laboratory technology. Performed integration of infrared (IR) and radio frequency (RF) sensors to simulate battlefield-condition sensor operation at dramatically reduced cost.

(U) $10,500 Developed a National Radar Signature Production and Research Capability (RCAS). Developed computer modeling and simulation of aircraft radar signature libraries necessary to discriminate friend, foe, and neutral targets.

(U) $27,618 Total

(U) FY 2002 ($ in Thousands)

(U) $1,193 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 determine 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 during most of their deployment cycles.

(U) $3,230 Develop common, open system technologies for integrating real-time information in- and out-of-the-cockpit 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) $2,718 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. These algorithms will significantly impact the capability to find, fix, track, target, engage, and assess time-critical targets in all phases of deployments, including active and passive communication and emission states; during hide in foliage; and either moving or stationary.

(U) $873 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. Conduct performance analyses on candidate algorithms using

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603203F Advanced Aerospace Sensors |
| | PROJECT<br>69DF |

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

(U) FY 2002 ($ in Thousands) Continued

hyperspectral imaging data.

(U) $2,796 Continue testing and integrating DARPA multi-sensor ATR fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, and reconnaissance, strike, and weapon systems. Demonstrate impact to image analysts and Air Operation Center decision makers of automated multi-sensor Automatic Target Recognition (ATR) and fusion capability on sensor-to-shooter timeline reductions for time-critical targeting.

(U) $25,441 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. Develop and demonstrate air-to-ground radar imaging technology and reliable combat identification technology to enable capability to detect and target difficult, concealed, and non-cooperative targets.

(U) $7,329 Continue developing a National Radar Signature Production and Research Capability. Develop, validate, and begin integrating data libraries discriminating friend, foe, and neutral targets into aircraft radar signature computer modeling and simulation tools.

(U) $43,580 Total

(U) FY 2003 ($ in Thousands)

(U) $2,006 Develop modeling and simulation to show enhanced global awareness and precision engagement capability for warfighters, as enabled by automated targeting technologies for rapid detection, location, and prosecution of time-critical targets. Employ the modeling, simulation, and analysis testbed to analyze and demonstrate ATR and information fusion algorithms for time-critical targeting, emphasizing the difficult targeting missions where weather, terrain, foliage, camouflage, and deception techniques obscure or conceal the targets of interest. Develop and employ air and ground target signature generation models to support automated target signature exploitation in automatic target recognizer and multi-sensor fusion algorithms. Generate synthetic target signatures for automated signature exploitation of radio frequency and electro-optical sensor data.

(U) $1,818 Continue common open system technology integration for real-time information in- and out-of-the-cockpit to improve aircrew combat and joint battlespace situational awareness, target nomination, and target engagement capabilities. Demonstrate initial capability to fuse all-source threat, imagery, target, and survivor location data using an airborne platform digitally linked to airborne combat search and rescue assets.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603203F Advanced Aerospace Sensors |
| | PROJECT: 69DF |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $5,160 | Continue developing and testing an ATR system for tracking and identifying moving and stationary ground targets for use in strike and reconnaissance platforms. Integrate advanced stationary target identification techniques and algorithms with synthetic aperture radar processing. Advance the state-of-the-art for moving target identification techniques and algorithms by providing technology maturation and risk reduction. Continue analysis of requirements and affordable risk reduction for transition via planned sensor upgrades to strike and reconnaissance platforms. |
| (U) | $3,766 | Test and integrate Air Force and Defense Advanced Research Projects Agency (DARPA) multi-sensor automatic target recognition (ATR) fusion algorithms into the Air Force ATR evaluation test facility for application to Air Force intelligence, surveillance, reconnaissance, strike, and weapon systems. Characterize single and multisensor contributions from radar and electro-optic (including hyperspectral imaging) sensors with automated exploitation. Continue demonstrating to image analysts and Air Operation Centers decision makers of automated multi-sensor ATR and fusion capability on timeline reductions for time-critical targeting. |
| (U) | $12,973 | Develop technology to detect, identify, and engage targets under trees (TUT). Characterize performance of foliage penetration radar sensors and algorithms for robust target detection and tracking with low probability of false alarms. Develop TUT-specific tools Intelligence Preparation of the Battlefield for improved tracking, detection, sensor management, and target identification and location. Develop tools for multi-intelligence georegistration. Perform end-to-end modeling for the TUT family of systems, providing measures of effectiveness that encompass the entire kill chain cycle. Perform virtual simulations to identify system integration issues, human decision functions, and system processes. Develop integration plans with warfighter-selected operational systems. Test system functionality, including fusion and georegistration; and concepts of employment. |
| (U) | $8,900 | Continue developing and demonstrating a moderate confidence automatic target recognition and advanced cueing (ATR/C) capability for stationary and moving targets under the Air-to-Ground Radar Imaging effort. Continue developing a follow-on, high confidence combat identification capability under the Reliable Combat Identification for Surface Targeting effort. Characterize advanced stationary and moving target radar data to determine its utility for ATR/C and combat identification. Develop tools to support sensor system, sensor management, and system performance analyses. Characterize the performance of identification techniques for multiple moving targets. Perform advanced multi-sensor data collection on stationary and moving targets. Determine which combination of sensors, modes, and fusion processing techniques would provide combat identification of the highest confidence. |
| (U) | $34,623 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603203F Advanced Aerospace Sensors | 69DF |

**(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 0603500F, Multi-disciplinary Adv Space Tech.
(U) PE 0603762E, Sensor and Guidance Technology.
(U) PE 0603270F, Electronic Combat Technology.
(U) Theater Missile Defense System Program Office.
(U) Low Altitude Night Targeting and Infrared Navigation (LANTIRN) System Program Office.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 10,685 | 4,556 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 2978 | Flight Vehicle Technologies | 3,092 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 4398 | Air Base Technology | 7,593 | 4,556 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, Project 2978, efforts transferred to PE 0603211F, Project 4920 and Project 4398, efforts transferred to PE 0603112F, Project 4918.

**(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 2002, Congress added $1.8 million for AFRL [Air Force Research Laboratory] Tyndall for weapon systems logistics, deployed base systems technology, and force protection, and $2.8 million for E-SMART Chemical and Biological Sensors.

**(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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 10,944 | 0 | 0 | |
| (U) | Appropriated Value | 11,045 | 4,600 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -44 | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | b. Small Business Innovative Research | -259 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -101 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 10,685 | 4,556 | 0 | TBD |

(U) Significant Program Changes:

In FY 2002, Project 2978, efforts transferred to PE 0603211F, Project 4920 and Project 4398, efforts transferred to PE 0603112F, Project 4918.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology

PROJECT: 2978

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2978 Flight Vehicle Technologies | 3,092 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, Project 2978, efforts transferred to PE 0603211F, Project 4920.

**(U) A. Mission Description**

This program develops and demonstrates advanced manned and unmanned aerospace flight controls, and vehicle-pilot interface technologies for improved aerospace vehicle performance, decreased vulnerability, and reduced logistics support.

(U) FY 2001 ($ in Thousands)

(U) $201 Continued development of aerospace vehicle air-to-air collision avoidance technologies to increase tactics flexibility and increase aerospace vehicle survivability. Continued 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. Initiated integration of the auto air collision avoidance algorithms into vehicle management systems architecture and validate in a laboratory environment.

(U) $533 Demonstrated 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. Conducted physical system ground demonstration of optical control technologies.

(U) $958 Developed 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 Initiated Congressionally directed efforts to address development issues associated with fiber optics control technologies.

(U) $3,092 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Efforts transferred to PE 0603211F, Project 4920.

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology | PROJECT: 2978 |

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

Not Applicable.

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

(U) Related Activities:

(U) PE 0602201F, Aerospace Vehicle Technology

(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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603205F Flight Vehicle Technology

PROJECT: 4398

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4398 Air Base Technology | 7,593 | 4,556 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, Project 4398 efforts transferred to PE 0603112F, Project 4918.

**(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 2002, Congress added $1.8 million for AFRL[Air Force Research Laboratory] Tyndall to conduct efforts in weapon systems logistics, deployed base systems technology, and force protection, and $2.8 million for E-SMART Chemical and Biological Sensors.

(U) FY 2001 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $134 | Developed aircraft and air base fire fighting and power generation technologies to improve fire fighting rescue. Tested safe fire fighting agents. Continued development of protective fire fighting clothing and fire risk assessment technologies. Evaluated new fire fighting training concepts. |
| (U) | $125 | Developed technologies, utilities, and shelters that improve air base operations. Completed the acoustic cycle heat pump technology demonstration that reduces airlift requirements in support of Aerospace Expeditionary Force operations rapid deployment. |
| (U) | $134 | Constructed an air transportable shelter advanced development model for field testing to support Aerospace Expeditionary Force operations rapid deployment. |
| (U) | $3,000 | Continued 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 | Initiated 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) | $7,593 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE |
|---|---|
| | February 2002 |

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603205F Flight Vehicle Technology | 4398 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $1,783 | Continue Congressional directed effort related to providing increased explosion mitigation, increased ability to conduct rapid airfield assessment, improved lightweight airfield matting, and more efficient deployable utility systems. |
| (U) | $2,773 | Continue Congressional directed E-SMART effort that develops and integrates chemical and biological senor and monitoring technologies into the E-SMART system. |
| (U) | $4,556 | Total |

(U) FY 2003 ($ 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 0602201F, Aerospace Vehicle Technologies
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 17,675 | 22,945 | 22,315 | 25,455 | 28,445 | 28,992 | 29,541 | Continuing | TBD |
| 486U | Advanced Aerospace Structures | 17,675 | 6,538 | 4,937 | 5,478 | 6,003 | 6,033 | 6,156 | Continuing | TBD |
| 4920 | Flight Vehicle Tech Integration | 0 | 16,407 | 17,378 | 19,977 | 22,442 | 22,959 | 23,385 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: Beginning in FY 2002, 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.

**(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 2002, Congress added $1.0 million for three-dimensional woven preform composites, $1.4 million for Access-to-Space Joint Systems Program Office, $4.9 million for Aeronautical Systems Center, and $1.5 million for affordable combat avionics initiative.

**(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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 18,291 | 26,269 | 22,469 | |
| (U) | Appropriated Value | 18,461 | 23,169 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -224 | | |
| | b. Small Business Innovative Research | -433 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -183 | | | |
| | e. Rescissions | -170 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -154 | |
| (U) | Current Budget Submit/FY 2003 PBR | 17,675 | 22,945 | 22,315 | TBD |

(U) Significant Program Changes:
Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo

PROJECT: 486U

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 486U | Advanced Aerospace Structures | 17,675 | 6,538 | 4,937 | 5,478 | 6,003 | 6,033 | 6,156 | 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 2002, Congress added $1.0 million for three-dimensional woven preform composites.

(U) FY 2001 ($ in Thousands)

(U) $4,382 Continued 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. Developed advanced methods for predicting structural strength and life remaining due to effects of fatigue, corrosion, and damage. Developed and validate low-cost advanced methods to restore original structural integrity, reduce repair cost, reduce inspection cost, and increase aircraft availability.

(U) $1,003 Developed 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 eliminating fatigue in weapons bay areas. Evaluated 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 Developed advanced structural concepts and design methods for future aerospace vehicles for enhanced affordability and higher performance. Demonstrated, 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 Demonstrated 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. Continued to develop design concepts and structural criteria to implement lower cost manufacturing processes and materials in future airframes. Verified the structural integrity of affordable bonded unitized composite structure.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo |
| | PROJECT: 486U |

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

(U) FY 2001 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $4,321 | Reduced susceptibility and increase survivability of existing and planned aircraft through demonstration of lightweight and low-cost electromagnetic infrared signature suppression capability. Applied new structural design specifications that allow smaller and damage tolerant inlet and exhaust engine ducts. Designed a full-scale structurally integrated airframe and turbine engine inlet and begin ground component testing. |
| (U) | $4,000 | Continued developing the processing and domestic production capability of constituent material for high strength polymeric foam for aerospace vehicles. |
| (U) | $1,500 | Initiated Congressionally directed efforts to accelerate development of three-dimensional woven preform composite technology to produce low weight, non-corroding structural components. |
| (U) | $17,675 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,305 | 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 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) | $991 | Continue Congressionally directed efforts to accelerate development of three-dimensional woven preform composite technology to produce low weight, non-corroding structural components. |
| (U) | $6,538 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603211F Aerospace Technology Dev/Demo | 486U |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,165 | Continue improvements in sustainment technologies for 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 composite repair of thick and complex structures. Continue development of new analytical methods and techniques to expand bonded composite repair capability to thick and complex geometry structures enabling repair in lieu of replacement of primary load carrying structural components. |
| (U) | $2,772 | Develop innovative new non-traditional sustainment technologies that will extend aircraft life, increase aircraft availability, and reduce operation and support costs. Continue development of unitized composite structures to replace mechanically fastened built up components that are highly susceptible to damage from dynamic in-service usage resulting in elimination of maintenance actions due to loose fasteners and fastener hole damage. |
| (U) | $4,937 | Total |

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Vehicle Technologies
(U) PE 0603333F, Unmanned Air Vehicle Dev/Demo
(U) PE 0604731F, Unmanned Combat Air Vehicle
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo

PROJECT: 4920

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4920 | Flight Vehicle Tech Integration | 0 | 16,407 | 17,378 | 19,977 | 22,442 | 22,959 | 23,385 | Continuing | TBD |

Note: Beginning in FY 2002, 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 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) $4,110 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 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 load bearing structure for antenna performance improvement. Mature concepts with advanced aerodynamic technologies that enable structurally integrated highly survivable and maintainable inlet and exhaust systems.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo |
| | PROJECT: 4920 |

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

(U) FY 2002 ($ in Thousands) Continued

| | | |
|---|---|---|
| (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) | $1,387 | Initiate Congressional directed efforts to establish an Access-to-Space Joint System Program Office. |
| (U) | $4,853 | Initiate Congressional directed efforts with Aeronautical Systems Center. |
| (U) | $1,485 | Initiate Congressional directed efforts for affordable combat avionics initiatives. |
| (U) | $16,407 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $5,320 | Develop and demonstrate key control automation techniques and algorithms to enable the safe and interoperable application of unmanned aerial vehicle systems. Continue development and demonstrate hardware and algorithms for automated air collision avoidance. Flight demonstrate intelligent-agent based algorithms and modular software system architecture for cooperative control of unmanned aerospace vehicles systems. |
| (U) | $4,193 | Develop an integrated control technology suite to provide significantly increased reliability and mission effectiveness for air vehicle systems. Complete baseline systems architecture combining compact, low-cost hardware with adaptive, fault tolerant inner-loop control and autonomous, trajectory-generating outer-loop control. Develop, test, and verify component technologies for systems integration. |
| (U) | $362 | Demonstrate and validate advanced control mechanization technologies to provide highly reliable operations for manned and unmanned systems at significantly reduced size, weight, and cost. Complete advanced development and demonstration of direct optical control and interfacing of vehicle management and more-electric subsystems. |
| (U) | $1,886 | Develop multi-functional integrated structures to reduce acquisition costs, support costs, weight, and volume while increasing the performance of air vehicles. Continue development of concepts with embedded high frequency multi-element antenna arrays in load bearing structures to enable increased antenna performance and new capabilities at reduced cost, weight, and volume. Develop highly efficient and durable multifunction structures with embedded electrical conductors and data cabling, health monitoring networks, fuel handling and sensing, and thermal management to minimize vehicle weight, volume, and acquisition and support costs. |
| (U) | $1,997 | Develop integral airframe technologies to enable increased propulsion system performance. Complete demonstration of inlet duct concepts |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603211F Aerospace Technology Dev/Demo | 4920 |

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

(U) FY 2003 ($ in Thousands) Continued

with advanced aerodynamic technologies that enable structural integration, enhanced performance, survivability, and increased propulsion system performance. Develop conformal inlet concepts with advanced aerodynamic technologies that enable higher efficiency propulsion systems.

(U) $2,106 Develop advanced structural concepts and design methods to significantly enhance the affordability and increase the performance of current and future aerospace vehicles. Continue development of new analysis methods, design concepts, and design criteria to enable low-cost unitized composite structures. Continue development of demonstration articles for test verification of analyses methods, design concepts, and design criteria.

(U) $1,514 Develop affordable advanced aero-structural concepts and design methods to enable new performance capabilities for future aerospace vehicles. Continue flight test demonstration of the increased high speed control authority of an active aeroelastic wing. Develop concepts applying continuous moldline technologies to reduce aerodynamic drag and electromagnetic signature for reconfigurable structures to enable maximum warfighting capability an d versatility in a single platform. Develop highly efficient wing concepts integrating active aeroelastic design concepts, adaptive structures, and aerodynamic flow control technologies to enable new capabilities for long-range air vehicles and long endurance vehicles.

(U) $17,378 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 0603333F, Unmanned Air Vehicle Dev/Demo.

(U) PE 0604731F, Unmanned Combat Air Vehicle.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603211F Aerospace Technology Dev/Demo |
| | PROJECT: 4920 |

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

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 41,722 | 121,548 | 85,650 | 72,863 | 66,163 | 69,350 | 71,480 | Continuing | TBD |
| 2480 | Aerospace Fuels and Atmospheric Propulsion | 3,417 | 12,380 | 7,675 | 8,201 | 8,248 | 9,292 | 10,329 | Continuing | TBD |
| 3035 | Aerospace Power Technology | 2,688 | 4,602 | 6,240 | 4,312 | 4,390 | 4,475 | 4,560 | Continuing | TBD |
| 4921 | Aircraft Propulsion Subsystems Int | 0 | 37,479 | 35,783 | 28,914 | 25,217 | 26,671 | 27,116 | Continuing | TBD |
| 4922 | Space & Missile Rocket Propulsion | 0 | 30,607 | 1,464 | 1,507 | 1,553 | 1,617 | 1,664 | Continuing | TBD |
| 681B | Advanced Turbine Engine Gas Generator | 35,617 | 36,480 | 34,488 | 29,929 | 26,755 | 27,295 | 27,811 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, all turbine engine technology efforts performed in PE 0603202F, Project 668A, are transferred to PE 0603216F, Project 4921. Also in FY 2002, all rocket propulsion technology efforts performed in PE 0603302F, Projects 4373 and 6340, are transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory organization. In FY 2003, space unique tasks in Project 4922 will be transferred to PE 0603500F, Project 5033, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

In FY 2003, this program anticipates receiving $4.4 million from the Cost of War Transfer Account. These funds are not included in the FY 2003 Air Force baseline. Funding will be used for rocket propulsion technologies in support of the Technology for Sustainment of Strategic Systems program.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology |

**(U) A. Mission Description**

This 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 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 2002, Congress added $2.0 million for the Joint Expendable Turbine Engine Concept demonstrator; $4.4 million for the IHPRPT program; and $2.0 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 43,413 | 114,335 | 96,161 | |
| (U) | Appropriated Value | 43,814 | 122,735 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -1,187 | | |
| | b. Small Business Innovative Research | -1,029 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -662 | | | |
| | e. Rescissions | -401 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -10,511 | |
| (U) | Current Budget Submit/FY 2003 PBR | 41,722 | 121,548 | 85,650 | TBD |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |

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

(U) Significant Program Changes:
FY 2003 decreases are primarily due to transfer of space unique activities to PE 0603500F, Project 5033.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT: 2480

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2480 | Aerospace Fuels and Atmospheric Propulsion | 3,417 | 12,380 | 7,675 | 8,201 | 8,248 | 9,292 | 10,329 | Continuing | TBD |

**(U) A. Mission Description**

This 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 2001 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $810 | Continued 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. Demonstrated, 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. |
| (U) | $770 | Demonstrated effectiveness of thermally stable JP-8+100 for reduced maintenance in a variety of aircraft. Fabricated a sub-scale integrated fuel/air heat exchanger-combustor in a cooling air heat exchanger configuration, using fuel/air heat exchanger technology designed and fabricated in FY 2000. |
| (U) | $385 | Demonstrated low-cost fuel-additive approaches to control particulate emissions from gas turbine engines. Demonstrated concepts for improving ignition and combustion in advanced engines. |
| (U) | $1,452 | Initiated investigation of 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) | $3,417 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |
| | PROJECT<br>2480 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,950 | 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) | $3,450 | 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. |
| (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) | $797 | Develop low-cost fuel additives for Air Force applications. Evaluate and demonstrate optimum low-cost fuel additive to reduce particulate |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |
| | PROJECT<br>2480 |

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

(U) FY 2002 ($ in Thousands) Continued

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) $800 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) $730 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) $12,380 Total

(U) FY 2003 ($ in Thousands)

(U) $700 Demonstrate thermally stable fuels to enhance cooling capacity (performance) and reduce fuel system maintenance. Continue to study, test, and demonstrate advanced high heat sink fuels that can increase fuel delivery system durability at high temperatures and reduce maintenance due to fuel degradation in a sub-scale integrated fuel/air heat exchanger. Demonstrate long-term JP-8+225 performance in a fuel system simulator.

(U) $400 Continue determination of fuel cooling requirements for advanced aircraft sensors and directed energy weapons to meet the needs of evolving manned and unmanned aerospace systems. Develop requirements for low temperature additives to prevent fuel from freezing to allow advanced manned and unmanned systems to sustain high altitude loiter for extended periods. Refine design and build Unmanned Aerial Vehicle fuel system/tank simulator to study high and low temperature fuel behavior.

(U) $800 Develop low-cost fuel additives for Air Force applications. Continue performing demonstration testing with low-cost fuel additives to reduce particulate emissions from gas turbine engines by 50 percent and to improve ignition characteristics and combustion in current and advanced propulsion concepts including combined cycle engines. Demonstrate effectiveness of particulate mitigation additives in a full-scale engine test.

(U) $400 Develop fuel system technology. Continue design and development of 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. Continue investigation of fuel concepts to maximize performance of advanced or combined cycle engines and

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 2003 ($ in Thousands) Continued

minimize logistic costs. Complete characterization of hydrocarbon fuel candidates for combined cycle engines.

(U) $875 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 packages to improve fuels and advanced field diagnostic techniques such as smart nozzles to assess fuel quality, additive injection requirements, and aid in mission planning by monitoring mission limiting fuel properties. Demonstrate field-capable concept for fuel identification and characterization.

(U) $4,500 Continue development of high fidelity analytical tools to evaluate combined cycle engine options, such as gas turbine and ramjet/scramjet combinations, for next generation aerospace vehicles and their weapons for long-range strike. Continue evaluation of advanced (ramjet/scramjet) and combined cycle engine options for next generation aerospace vehicles and their weapons for long-range strike. Develop key engine technologies to maximize the use of vehicle speed in force miniaturization and platform survivability for a capability beyond low-observables. Continue to conduct analyses and experiments to optimize component technologies for transition between gas turbine engine and ramjet/scramjet engine cycles, and to optimize cruise speed of ramjet/scramjet engines. Continue to conduct pre-design study to evaluate force-multiplier and bomber survivability as a function of flight Mach number achievable for next generation aerospace vehicles and their weapons.

(U) $7,675 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 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 | |
|---|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT<br>2480 |

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT: 3035

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 3035 | Aerospace Power Technology | 2,688 | 4,602 | 6,240 | 4,312 | 4,390 | 4,475 | 4,560 | Continuing | TBD |

**(U) A. Mission Description**

This 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 2001 ($ in Thousands)

(U) $752 Designed, fabricated, and tested an electrical distribution system which ensures fault tolerant architecture, improving aircraft reliability and survivability. Performed testing of the demonstrator aircraft on-board Integrated Power Unit (IPU). The demonstrator integrated the 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 approaches.

(U) $0 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.

(U) $1,936 Developed 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, decrease maintenance, and two times increase in power density, which is enabling for advanced fighter aircraft and Uninhabited Combat Aerial Vehicles. Performed trade studies and requirements definitions for advanced motor drives applicable to fuel pumps and flight control actuators.

(U) $2,688 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |
| | PROJECT<br>3035 |

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

(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) | $236 | 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 sufficient to fabricate coated conductors for cryogenic generators. |
| (U) | $777 | 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) | $1,589 | 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) | $4,602 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $933 | Develop power generation and conditioning; high rate batteries; and energy storage component and subsystem technologies for integration of high power subsystems with directed energy weapons. Develop high power low duty cycle generator for pulsed directed energy weapons. Continue to fabricate lengths of Yttrium Barium Copper Oxide sufficient to fabricate coated conductors for cryogenic generators. |
| (U) | $1,155 | Develop power generation, conditioning, and distribution component; 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. Develop power generator system that is closely coupled with propulsion system. |
| (U) | $2,152 | Develop power generation, conditioning and distribution; energy storage; and thermal management component and subsystem technologies that are synergistic with air, space, and weapons platforms. Demonstrate advanced power conditioning technologies with motor drives and lithium ion batteries that provide reductions in both volume and weight. |
| (U) | $2,000 | Continue to develop and demonstrate high-density secondary power system and advanced weapons power technology for a next generation aerospace vehicle for long-range strike. Conduct trade studies, detailed design, and critical technology development to optimize secondary |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| 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 2003 ($ in Thousands) Continued

power system size, weight, and efficiency. Continue evaluation of electric power technology options for advanced weapon systems.

(U) $6,240 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.
(U) PE 0603605F, Advanced Weapons Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT: 4921

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4921 Aircraft Propulsion Subsystems Int | 0 | 37,479 | 35,783 | 28,914 | 25,217 | 26,671 | 27,116 | Continuing | TBD |

Note: In FY 2002, all turbine engine technology efforts performed in PE 0603202F, Project 668A, are transferred into this project.

**(U) A. Mission Description**

This 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. Aerospace Propulsion Subsystems Integration (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. Note: In FY 2002, Congress added $2 million for Joint Expendable Turbine Engine Concept demonstrator engine.

(U) FY 2001 ($ in Thousands)

(U) $0 Previously accomplished in PE 0603202F, Project 668A.

(U) $0 Total

(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 program including forward swept fan blade damage tolerance, advanced instrumentation, model validation, and improved test protocol.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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) Continued

(U) $20,100 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 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) $6,120 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) $1,981 Develop turbine engines that reduce fuel consumption, increase thrust/airflow ratio, and reduce production costs for supersonic expendable and limited life unmanned vehicle turbine engines. This is the goal of the Joint Expendable Turbine Engine Concept demonstrator, an important demonstrator in the Integrated High Performance Turbine Engine Technology program. Perform design, fabrication, assembly, and test of materials and high pressure ratio technologies. These technologies include single crystal Lamilloy blades and advanced thermal barrier coated cast cool vanes.

(U) $37,479 Total

(U) FY 2003 ($ in Thousands)

(U) $6,177 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 structural durability testing of fixed inlet guide vanes and Moderate Aspect Ratio rotor, IBR repair, fan rim damper, HCF mistuning and damping technologies, vaneless counter-rotating high/low pressure turbine, probabilistic rotor system design, gamma titanium aluminide LPT coverplate, sprayform cast hardware, and CMC

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |
| | PROJECT<br>4921 |

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

(U) FY 2003 ($ in Thousands) Continued

technologies.

(U) $20,800 Design, fabricate, and test advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Complete advanced engine designs and initiate fabrication of HCF robust front frame, affordable OMC fan frame, two-stage forward swept fan, tiled Low Pressure Turbine (LPT) blade, uncooled Ceramic Matrix Composite (CMC) LPT blade, Metal Matrix Composite shaft and model-based flexible control with diagnostics. Initiate advanced engine designs for tandem fan with Organic Matrix Composite (OMC) tip shroud, carbon counter-rotating intershaft seal, and active augmenter screech control. Each of these component technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines.

(U) $5,306 Design, fabricate, and test advanced component technologies for limited life engines. These technologies improve performance, durability, and affordability of engines for missile and unmanned air vehicle applications. Complete fabrication and conduct testing on an OMC fan, uncooled ceramic high pressure turbine, slinger combustor. Complete fabrication of low volume combustor. Complete engine structural durability testing of high stage loading splittered fan and uncooled ceramic low pressure turbine.

(U) $3,500 Develop high speed turbine engine technology for next generation aerospace vehicles for long-range strike. Complete study to evaluate gas turbine technologies for long-range strike vehicles (e.g., gas turbine and ramjet/scramjet combined/combination cycle engines). Continue integrated design and initiate long lead hardware for turbine engine controls, exhaust nozzles, high temperature material components, and mechanical systems for capability beyond low-observables.

(U) $35,783 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603216F Aerospace Propulsion and Power Technology | 4921 |

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

(U) PE 0603003A, Aviation Advanced Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT: 4922

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4922 | Space & Missile Rocket Propulsion | 0 | 30,607 | 1,464 | 1,507 | 1,553 | 1,617 | 1,664 | Continuing | TBD |

Note: In FY 2002, all rocket propulsion technology efforts performed in PE 0603302F, Projects 4373 and 6340, are transferred into this project, in order to align projects with the Air Force Research Laboratory organization. In FY 2003, only the space unique technology efforts in this project will be transferred to PE 0603500F, Project 5033, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This 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 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. Note: In FY 2002, Congress added $4.4 million for the IHPRPT program.

(U) FY 2001 ($ in Thousands)

(U) $0 Previously accomplished in PE 0603202F, Projects 4373 and 6340.

(U) $0 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |
| | PROJECT<br>4922 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $10,675 | 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) | $3,775 | 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 transfer. |
| (U) | $4,000 | 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) | $2,800 | 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) | $4,357 | Continue to develop turbomachinery components for integration into an advanced liquid propellant test bed demonstration. Complete fabrication and assembly of the combustion chamber and injector for a 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. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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) Continued
(U) $30,607 Total

(U) FY 2003 ($ in Thousands)
(U) $1,464 This project previously included space unique funding which has been transferred to PE 0603500F, Project 5033. These funds represent the civilian salaries for the work effort transferred and will be transferred at a later date.
(U) $1,464 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603401F, Advanced Spacecraft Technology.
(U) PE 0603853F, Evolved Expendable Launch Vehicle Program.
(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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT: 681B

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 681B | Advanced Turbine Engine Gas Generator | 35,617 | 36,480 | 34,488 | 29,929 | 26,755 | 27,295 | 27,811 | Continuing | TBD |

**(U) A. Mission Description**

This 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. Note: In FY 2002, Congress added $2 million for vectored thrust ducted propellers.

(U) FY 2001 ($ in Thousands)

(U) $27,035 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. Completed 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. Designed and fabricated 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) $1,953 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. Conducted 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) $4,181 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. Fabricated hardware for core engine testing of forward swept splittered compressor rotor, high temperature rise

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology |
| | PROJECT: 681B |

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

(U) FY 2001 ($ in Thousands) Continued

combustor, counter rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings.

(U) $2,115 Designed, developed, and initiated testing on structures and propulsion designs to demonstrate performance and durability of advanced hypersonic propulsion concepts in support of Defense Advanced Research Projects Agency missile demonstration. Performed fabrication and testing of flight type scramjet combustor and inlet.

(U) $333 Evaluated novel vectored thrust propellers for turboprop/turboshaft engine concepts for application to helicopters for combat rescue.

(U) $35,617 Total

(U) FY 2002 ($ in Thousands)

(U) $29,080 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) $2,270 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) $1,981 Develop turboprop/turboshaft engine technologies that are applicable to military helicopter applications such as combat search and rescue.

(U) $36,480 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603216F Aerospace Propulsion and Power Technology | 681B |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $28,826 | 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 design and continue hardware fabrication of a core engine test article with a load decoupler fan frame, a trapped vortex combustor, ceramic matrix composite combustor liner, ceramic bearing, advanced turbine blisk and advanced turbine vane materials. Complete design and continue fabrication of hardware for core engine testing of a high pressure ratio four stage compressor with integrated lightweight combustor with ceramic matrix composite panels, microcircuit cooling, revolutionary hot section material, and an endothermic fuel/air heat exchanger. Each of these technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines. |
| (U) | $2,024 | 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. Continue design and initiate fabrication of long lead hardware for turbine engine advanced hardware for core engine evaluation in the national durability programs. |
| (U) | $3,638 | 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 uninhabited air vehicles. Complete 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) | $34,488 | 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| 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.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603227F Personnel Training and Simulation Technology

PROJECT: 2743

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2743 | Advanced Training/Force Management | 6,171 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts transfer to PE 0603231F, Project 4924, to align resources with the Air Force Research Laboratory organization.

**(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.

(U) FY 2001 ($ in Thousands)

(U) $713 Developed and demonstrated 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. Completed first training transfer studies of the impact of DMT on Air Force air-to-air combat flying performance, and demonstrated impact of DMT on washback rates and quality of performance during Flight Lead Upgrade training. Completed identification and representation of mission essential competencies for aerospace and information operators and force protectors. Developed and field tested a common satellite architecture for control training in aerospace operations center, and integrated team performance measurement methods to assess the readiness and mission impact of DMT for combat support teams.

(U) $1,294 Developed advanced distributed learning information systems technologies that increase mission rehearsal capability for the warfighter by

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603227F Personnel Training and Simulation Technology |
| | PROJECT<br>2743 |

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

(U) FY 2001 ($ in Thousands) Continued

creating the ability to import real-time intelligence data into the Distributed Mission Training (DMT) environment. Technologies provide the warfighter with enhanced training tools to make accurate and timely decisions in a real-time environment. Infused real-time intelligence data under the mandated High Level Architecture (HLA) structure and continued evaluation of a multi-level security system for geographically disbursed man-in-the-loop simulators operating under different security classification levels. Demonstrated and evaluated pilot training results using real-time intelligence information.

(U) $1,761 Demonstrated advances in simulator visual system technologies through the development of high fidelity image generation, display, and database systems. Advanced visual systems 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. Continued development of PC-based high resolution real-time image generator and development tools. Advanced development of an ultra-high resolution laser projector for DMT simulators. Continued development and integration of a less expensive, optical infinity display material for the simulator.

(U) $998 Advanced 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. Developed threat models and environment representations that can be updated with real-time intelligence data. Developed physics-based radar threat, and other sensor models and their interaction with the environment. Developed an HLA compliant simulation architecture optimized for real-time, distributed, scalable training activities. Developed and tested imagery manipulation tools for automatic database generation including automatic materials encoding of source imagery versus current hand coding.

(U) $1,405 Developed and demonstrated technologies for high fidelity Night Vision Goggle (NVG) simulation to support and increase mission training, preview, and rehearsal capabilities. This reduces the cost of initial NVG qualification, allows for effective advanced night operation mission pretraining prior to aircraft, and increases combat training realism by adding simulated weather, seasonal, and environmental changes. Evaluated measures of training effectiveness, mission performance, and transfer of training from simulator to the aircraft. Conducted field evaluation of NVG training techniques to include distance estimation for aircraft, formation and aerial refueling, and combat maneuvering.

(U) $6,171 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| 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 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $0 | Effort moved to PE 0603231F, Project 4924. |
| (U) | $0 | Total |

(U) FY 2003 ($ 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 new system developments that have military utility and address warfighter needs.

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 6,432 | 0 | 0 | TBD |
| (U) | Appropriated Value | 6,491 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -152 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -109 | | | |
| | e. Rescissions | -59 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 6,171 | 0 | 0 | TBD |

(U) Significant Program Changes:

In FY 2002, efforts transfer to PE 0603231F, Project 4924, to align resources with the Air Force Research Laboratory organization.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603227F Personnel Training and Simulation Technology | 2743 |

**(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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 17,088 | 34,023 | 29,690 | 35,193 | 34,490 | 33,559 | 34,196 | Continuing | TBD |
| 2830 | Decision Support and Cognitive Systems | 5,500 | 7,435 | 6,238 | 7,695 | 7,008 | 6,434 | 6,387 | Continuing | TBD |
| 3257 | Helmet-Mounted Sensory Technologies | 11,588 | 9,534 | 5,938 | 6,124 | 5,398 | 5,497 | 5,595 | Continuing | TBD |
| 4923 | Logistics Readiness and Sustainment | 0 | 10,324 | 7,341 | 11,806 | 10,750 | 11,192 | 11,565 | Continuing | TBD |
| 4924 | Distributed Mission Training Technology | 0 | 6,730 | 7,532 | 6,664 | 7,369 | 7,387 | 7,392 | Continuing | TBD |
| 5020 | Directed Energy Protective Systems | 0 | 0 | 2,641 | 2,904 | 3,965 | 3,049 | 3,257 | Continuing | TBD |
| | Quantity of RDT&E Articles | 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. In FY 2003, the Directed Energy Protective Systems program at Brooks AFB will move from Project 3257 to Project 5020 to align resources with the Air Force Research Laboratory organization.

**(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 Decision Support and Cognitive Systems project develops and demonstrates crew system interface technologies and information operations technologies that promote effective decision-making, control, and execution in operational environments. The Helmet-Mounted Sensory Technologies project, develops, and demonstrates advanced operator interface technologies for multi-functional helmet-mounted displays and night vision devices, and laser eye protection. The Logistics Readiness and Sustainment project develops and demonstrates technologies that will protect the force, enhance logistics, and improve the design, deployability, performance, and support of current and future weapon

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology |

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

systems. The Distributed Mission Training Technology project develops and demonstrates advanced training, simulation, and mission rehearsal technologies. The Directed Energy Protective Technologies project develops and demonstrates advanced technologies for laser eye protection and for assuring safety of personnel involved with test, deployment, and operation of high-energy laser weapons. Note: In FY 2002, Congress added $1.0 million for Combat Automation Requirements Testbed and $1.0 million for Head-Mounted 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.

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 17,319 | 32,356 | 34,775 | TBD |
| (U) | Appropriated Value | 17,479 | 34,356 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -333 | | |
| | b. Small Business Innovative Research | -410 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | 179 | | | |
| | e. Rescissions | -160 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -5,085 | |
| (U) | Current Budget Submit/FY 2003 PBR | 17,088 | 34,023 | 29,690 | TBD |

(U) Significant Program Changes:

Decrease in FY 2003 is to fund other priority Science and Technology programs.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

PROJECT: 2830

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2830 | Decision Support and Cognitive Systems | 5,500 | 7,435 | 6,238 | 7,695 | 7,008 | 6,434 | 6,387 | Continuing | TBD |

**(U) A. Mission Description**

This project provides technology to improve human combat performance, combat support performance, and aerospace safety through better information delivery and crew station integration, which are achievable through effective decision support and cognitive systems engineering. Crew stations represent the fundamental interface between the warfighter and equipment across the gamut of aerospace operations. To cope with the recognized data overload in command centers and weapon platforms, this project develops technologies to quantify requirements, develop information interfaces, and evaluate crew performance in selected operational environments. This project includes bioacoustic technologies to complement decision support and visual information technologies as part of an integrated solution to negate information overload in the Air Expeditionary Force environment, while improving sound cueing, voice communications, and hearing protection for weapon systems operators, command centers, and security forces. Note: In FY 2002, Congress added $1.0 million for Combat Automation Requirements Testbed.

(U) FY 2001 ($ in Thousands)

(U) $1,844 Developed and demonstrated 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 supported clear accountability in design. Completed development of simulation software and demonstrated integration with human operator models using the High-Level Architecture. Completed a functional specification for using the modeling technology in a simulation-based testbed that supported establishing objective, performance-based crew system requirements.

(U) $2,950 Developed and demonstrated subsystems to protect the aircrew member during combat and emergency operations in current and future aircraft. Demonstrated life support technologies to address specific deficiencies observed in recent combat operations. Decreased 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) $706 Developed and demonstrated advanced, user-tailored information management and portrayal technologies that enhance battlespace situational awareness for global-level and MAJCOM-level information operations centers to reduce decision-making bottlenecks. Continued to develop user-tailored visualizations promoting battlespace situational awareness. Demonstrated the capability for effective, time-critical information exchange operations between MAJCOM Network Operations and Security Centers.

(U) $5,500 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603231F Crew Systems and Personnel Protection Technology | 2830 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $1,247 | 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. Demonstrate feasibility of modeling teamwork, intra-team communications, and air center operations in support of effectiveness trades used during acquisition. |
| (U) | $3,466 | 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 and Helmet-Mounted Devices (HMDs) that will provide a decrease in head and neck injuries for crewmembers wearing HMDs during high-speed emergency ejections. Conduct windblast testing to verify head, neck, and eye protection are provided to 600 Knots Equivalent Air Speed. |
| (U) | $990 | Develop and demonstrate user-tailored information management and portrayal technologies that enhance battlespace situational awareness for global-level and MAJCOM-level information operations 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 understanding of adversarial decision-making. Demonstrate the effectiveness of combat assessment tools in joint or Air Force specific exercises. |
| (U) | $742 | 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) | $990 | 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) | $7,435 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603231F Crew Systems and Personnel Protection Technology |
| | PROJECT<br>2830 |

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

(U) FY 2003 ($ in Thousands)

(U) $651 Develop and demonstrate human modeling technologies and simulation tools to justify crew performance requirements, reduce the cost and time for system developers to isolate and analyze critical operator tactics in simulated operational exercises, and support analysis of alternatives. Continue to extend human modeling and simulation technologies to make effective trade offs between crew system concepts and mission effectiveness. Begin to analyze and develop integrated crew system concepts to reduce manning within air operations centers, showing contribution of human modeling to substantiate time-critical targeting effectiveness and affordability.

(U) $2,761 Develop and demonstrate user-tailored information management and portrayal technologies that enhance battlespace situational awareness for global- and MAJCOM-level information warfare and aerospace operations centers to reduce decision-making bottlenecks. Transition and integrate initial version of combat assessment tools into joint and/or Air Force weapon systems. Develop effects-based adversarial decision-making process and model to characterize different types of adversary systems and assess alternative ways they may be favorably influenced by allied force actions. Develop speech recognition front-end and advanced visualization for operations centers' information management tool. Improve flow of time-critical targeting information into strike aircraft to enhance pilot situational awareness, exploiting capabilities inherent with helmet-mounted display technology.

(U) $910 Develop advanced high performance bioacoustic hearing protection systems to achieve 40-45 dB noise attenuation for personnel working in and around fighter aircraft, with a long-term goal of 50 dB protection. Demonstrate communication capability in 150 dB noise fields. Integrate deep insert earplug technology with active noise reduction to achieve 45 dB field attenuation. Demonstrate improved attenuation and user acceptability in laboratory and field environments.

(U) $1,000 Develop and demonstrate advanced technologies to enhance security force situational awareness and threat response time using acoustic sensors. Demonstrate to deployed security forces an information management concept that can improve situational awareness by using intelligent algorithms, three-dimensional (3-D) audio, and audio symbology to code the detected threats and assist in threat intervention. Demonstrate at a military exercise the operational payoff from using 3-D audio radios and helmets in a mobile patrol squadron. Begin to develop an automated threat assessment system using neural networks and a sound library to evaluate the severity and importance of detected noise.

(U) $916 Develop and demonstrate human-centered science and technology for the Air Force Information Operations (IO) community addressing Information in Warfare and Information Warfare needs. This research will provide the information operations warrior with tailored decision support systems, guidelines for effective selection of information warriors, IO simulators and training systems, improved operational shift schedules to increase personnel efficiency and effectiveness, enhanced decision-making tools, and automated tools to reduce operator task load.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| 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 2003 ($ in Thousands) Continued

Tools will be developed to influence human senses to enable perception management and deception, model and simulate human behavior, develop adversary cultural and decision models, and improve interaction and monitoring capability by determining effectiveness of automated tools in support of intelligence and information warfare units.

(U) $6,238 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 0604706F, Life Support Systems.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

PROJECT: 3257

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3257 Helmet-Mounted Sensory Technologies | 11,588 | 9,534 | 5,938 | 6,124 | 5,398 | 5,497 | 5,595 | Continuing | TBD |

Note: In FY 2003, the Directed Energy Protective Systems program at Brooks AFB will move from Project 3257 to Project 5020 to align resources with the Air Force Research Laboratory organization.

**(U) A. Mission Description**

This project develops and demonstrates advanced technologies for ejection-safe multi-functional helmet-mounted displays (HMD), and night vision devices. 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. Note: In FY 2002, Congress added $1.0 million for Head-Mounted Technology.

(U) FY 2001 ($ in Thousands)

(U) $7,758 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. Developed and demonstrated the utility of color symbology on HMT/D. Integrated and demonstrated a miniature flat display to replace cathode ray tubes in HMT/Ds. Integrated a HMT/D into the air-to-ground strike mission. Continued 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) $2,565 Developed and demonstrated technologies for improved aircrew NVG 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 provide aircrew members a wider field-of-view, improved low-light level resolution, and reduced halo. Integrated and evaluated laser eye protection (LEP) technologies with panoramic night vision goggles (PNVG). Integrated imagery insertion on PNVG for flight test.

(U) $1,265 Developed and demonstrated technologies that counter the laser threat, and permit the deployment and use of high-energy laser weapons. Continued to evaluate the biological effects of laser weapons and high-energy laser systems. Initiated aircrew evaluation of dye and dielectric stack technologies for infrared and visible laser eye protection. Conducted optical and performance evaluations, and began aircrew evaluations of airborne laser, and vision corrective LEP spectacles. Delivered Laser Range Safety Tool to missile test ranges to support flight testing of Airborne Laser and other high-energy laser systems.

(U) $11,588 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603231F Crew Systems and Personnel Protection Technology | 3257 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,586 | 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. 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. Develop and demonstrate high-brightness, high resolution, miniature flat panel display and assess utility as a replacement for cathode ray tube on future daytime HMT/Ds. |
| (U) | $2,104 | 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 (LEP) technologies. Continue flight evaluation of IPNVG and demonstrate imagery insertion in flight. |
| (U) | $2,844 | 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 aircrew evaluation of dye/dielectric stack combination LEP. Complete performance evaluation of vision-corrective prescription capability and airborne LEP of dielectric stack-based technologies, 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) | $9,534 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,947 | Develop and demonstrate advanced HMT/D and subsystem technologies to improve mission effectiveness and pilot situational awareness during day and night missions in all-weather conditions. These technologies help pilots to detect, identify, target, and launch weapons faster and more accurately. Investigate and develop advanced symbology sets for tactical HMT/Ds to improve targeting, increase situational awareness, and reduce spatial disorientation. Integrate ultra-sonic transducers with inertial head tracker to improve tracker accuracy. Investigate utility of advanced daytime HMT/D incorporating miniature color display for future simulations and flight evaluations. |
| (U) | $1,534 | 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. Incorporate and evaluate laser hardening technologies for image intensifier tube. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603231F Crew Systems and Personnel Protection Technology | 3257 |

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

(U) FY 2003 ($ in Thousands) Continued

Integrate IPNVG with a HMT/D.

(U) $1,457 Develop and demonstrate subsystems to protect the aircrew member wearing Helmet Mounted Devices (HMDs) during emergency ejection in current and future high-performance fighter aircraft. Advanced head/neck protection systems will provide a decrease in head and neck injuries for crewmembers wearing HMDs during high-speed emergency ejections. Conduct tests to verify head, neck, and eye protection are provided to 600 Knots Equivalent Air Speed (KEAS) threshold, 700 KEAS objective.

(U) $5,938 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 Program.
(U) PE 0604706F, Life Support Systems.
(U) PE 0604201F, Integrated Avionics Planning and Development.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

PROJECT: 4923

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4923 Logistics Readiness and Sustainment | 0 | 10,324 | 7,341 | 11,806 | 10,750 | 11,192 | 11,565 | Continuing | TBD |

Note: Prior to FY 2002, efforts in this project were reported 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 available electronically throughout weapon systems 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 worldwide logistics management.

(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) $1,820 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 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) $4,298 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 player's ability to monitor events and execute missions, and better represent logistics functions in synthetic exercises. Develop software agents that anticipate problems and offer decision options to command center personnel during mobility operations.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

| | | |
|---|---|---|
| (U) | $4,206 | 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) | $10,324 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,645 | Develop and demonstrate intelligent software agents and realistic human behavior models. These computer agents and models will add realism and fidelity to large-scale synthetic environments and war games, and improve the user interaction with logistics information systems. Develop intelligent software agents that mimic the functionality of command/control echelons and opposing forces and that better represent logistics functions in synthetic exercises. |
| (U) | $3,054 | Develop and demonstrate logistics technologies for improved deployment operations and improved system supportability. These technologies will maximize the efficiency and effectiveness of Air Force deployments and mobility operations in support of agile combat support initiatives and the emerging Air Expeditionary Force concepts. 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, and process tracking. Initial software tool set will be tested and transitioned to users. |
| (U) | $1,642 | Develop and demonstrate advanced user interface technologies to enhance the utility of Air Mobility Command's command and control systems. These interfaces will combine artificial intelligence software with automated, work-centered collaborative planning and decision support technologies. Command and control operators will have immediate access to integrated, decision quality information from multiple sources, thereby enabling faster, more accurate decision making and problem resolution during mobility operations. |
| (U) | $7,341 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603231F Crew Systems and Personnel Protection Technology | 4923 |

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

(U) Related Activities:
(U) PE 0602201F, Aerospace Flight Dynamics.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603721N, Environmental Protection.
(U) PE 0604708F, Civil, Fire, Environmental, Shelter.
(U) PE 0604740F, Integrated Command & Control Applications.
(U) PE 0605801A, Programwide Activities.
(U) PE 0708011F, Industrial Preparedness.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

PROJECT: 4924

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4924 | Distributed Mission Training Technology | 0 | 6,730 | 7,532 | 6,664 | 7,369 | 7,387 | 7,392 | Continuing | TBD |

Note: Prior to FY 2002, efforts in this project were reported 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 aerospace operations. This project develops and demonstrates advanced training and simulation technologies that will improve warfighter readiness by enhancing mission training and mission rehearsal capabilities. Development and effective use of this global battlespace requires advances in training systems, interconnection, information, visual, and representation technologies. The resulting mission training and rehearsal capabilities will enhance the mission essential competencies of the combat and combat support individuals and teams that comprise the aerospace force.

(U) FY 2001 ($ in Thousands)

(U) $0 FY 2001 activity reported in PE 0603227F, Project 2743.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $1,811 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, and 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 security forces. 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.

(U) $1,983 Develop and demonstrate the application of information and communications technologies for realistic mission training and mission rehearsal

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603231F Crew Systems and Personnel Protection Technology |
| | PROJECT<br>4924 |

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

(U) FY 2002 ($ in Thousands) Continued

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 (DMT) environment.

(U) $1,584 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 DMT simulators.

(U) $1,352 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) $6,730 Total

(U) FY 2003 ($ in Thousands)

(U) $2,418 Advance warfighter training capabilities by developing and demonstrating representational technologies and simulation techniques for integrated training and rehearsal, which includes training for aerospace operations, command and control, force protection, and air base defense warfighters. Develop and validate training technologies and methods to enable deployed personnel to maintain mission essential skills. Implement and evaluate the next generation threat system in DMT testbed, while integrating with multi-hyperspectral and weather databases. Develop functional requirements for hyperspectral databases to support realistic sensor simulation.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $1,845 | 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. Demonstrate the capability to establish a High Level Architecture federation that provides aircrew and command and control training to geographically separate audiences. Demonstrate a High Level Architecture federation operating at multiple security levels. |
| (U) | $1,807 | Demonstrate advances in simulator visual system technologies through the development of high fidelity image generator display, components, and databases. Advanced visual systems will provide operators enhanced cuing in simulated high-definition immersive environments and greater visual detail to identify other aircraft, ground vehicles, roads, and bridges at realistic tactical ranges, thus increasing mission rehearsal capability for the warfighter. Develop and demonstrate less expensive, optical infinity display components for the simulator. Develop and demonstrate a proof-of-concept ultra-high resolution, color laser projector. Integrate and evaluate high bandwidth PC-based image generator with high-resolution laser projector. |
| (U) | $1,462 | Develop and demonstrate technologies for night vision device training and high fidelity Night Vision Goggle (NVG) simulation. This development will reduce the cost of initial NVG qualification and increase combat training realism. Complete generic NVG simulation and generic Forward Looking Infra-Red simulation using same tools used for NVG functionality, allowing for high-fidelity, completely correlated visible and sensor simulation imagery. Develop proof-of-concept for dual mode, covert and overt, external aircraft lighting for F-15C. Complete digital conversion of introductory and instructor courseware. Evaluate simulator-based training scenarios for initial qualification, spatial orientation, and advanced combat night operations. |
| (U) | $7,532 | 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 0604227F, Distributed Mission Training.

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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology | PROJECT: 4924 |

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603231F Crew Systems and Personnel Protection Technology

PROJECT: 5020

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5020 Directed Energy Protective Systems | 0 | 0 | 2,641 | 2,904 | 3,965 | 3,049 | 3,257 | Continuing | TBD |

Note: In FY 2003, the Directed Energy Protective Systems program at Brooks AFB will move from Project 3257 to Project 5020 to align resources with the Air Force Research Laboratory organization.

**(U) A. Mission Description**

This project develops and demonstrates advanced technologies for laser eye protection (LEP) and for assuring safety of personnel involved with test, deployment, and operation of high-energy laser weapons. The project develops technologies to provide protection against laser threats and hazards, without compromising performance, vigilance, and mission effectiveness. It also develops tools and guidelines for testing and deploying high-energy laser systems and technologies to enhance personnel safety and effectiveness in aerospace operations.

(U) FY 2001 ($ in Thousands)

(U) $0 FY 2001 activity reported in PE 0603231F, Project 3257.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 FY 2002 activity reported in PE 0603231F, Project 3257.

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $590 Develop and demonstrate LEP technologies in the form of spectacles and visors for aircrew and ground personnel to provide protection from lasers while minimizing negative impacts on vision. Evaluate protective performance, visual acuity impacts, life support equipment compatibility, and aircrew acceptability of next-generation, fixed-line tristimulus protection against multiple visible wavelengths.

(U) $1,330 Develop and demonstrate agile LEP technologies for aircrew and ground personnel. Technologies will result in a single device that can be used by all aircrew for protection against any/all laser hazards or threats. Continue development and integration of LEP with Integrated Panoramic Night Vision Goggles. Continue design, development, and evaluation of a Laser Familiarization Program for warfighters toward integration with Distributed Mission Training system. Continue supporting development and evaluation of a Laser Detector and Warning system toward integration into aircraft cockpits and with agile LEP.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603231F Crew Systems and Personnel Protection Technology | 5020 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $721 | Develop and demonstrate technologies that permit safe testing, deployment, and use of high-energy laser weapons. Integrate probabilistic Risk Assessment technology into laser range hazard assessment tools for use by test ranges with high-energy laser weapon systems, including airborne laser flight tests. Continue to evaluate the biological effects of high-energy laser systems. Conduct damage threshold studies on short pulse (sub-microsecond) high-energy laser pulses. Continue to evaluate the biological effects of non-lethal laser weapons. |
| (U) | $2,641 | Total |

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

Not Applicable.

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

(U) PE 0602102F, Materials.
(U) PE 0602202F, Human Effectiveness Applied Research.
(U) PE 0603112F, Advanced Materials for Weapon Systems.
(U) PE 0603319F, Airborne Laser Program.
(U) PE 0604706F, Life Support Systems.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603245F Flight Vehicle Technology Integration

PROJECT: 2568

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2568 | Flight Vehicle Technology Integration | 17,225 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts transferred to PE 0603211F, Project 4920.

**(U) A. Mission Description**

This program integrates and demonstrates advanced flight vehicle technologies that will improve the performance and supportability of existing and future manned and unmanned aerospace vehicles. System level integration brings together the aerospace vehicle technologies along with avionics, propulsion, and weapon systems to flight demonstrate them in a near-realistic operational environment. Integration and flight test demonstrations reduce the risk and time required to transition technologies into operational aircraft. This program provides proven aerospace vehicle technologies for all-weather, day or night operations, and technologies for improved affordability.

(U) FY 2001 ($ in Thousands)

(U) $10,578 Developed and demonstrated technologies to support the joint Air Force/Defense Advanced Research Projects Agency unmanned combat air vehicle goals. Demonstrated lightweight/low-cost composite structures, multifunction apertures, compact low-observable inlets and exhaust, and advanced materials technologies for affordable low-observables. Demonstrated advanced weapons suspension and release technologies, and the integration of human system interface technologies for advanced manned and unmanned operations.

(U) $925 Developed and demonstrated advanced flight control techniques for affordable and reliable autonomous control. Integrated, developed, and tested advanced vehicle management technology with advanced system prognostics and autonomous control software to achieve reliability and affordability goals. Completed integrated flight control technology specification for unmanned air vehicles.

(U) $1,907 Initiated Congressionally directed effort to address advanced technology development of explosionissues associated with integration of explosion resistant fuel tank lining materials.

(U) $3,815 Initiated 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) $17,225 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603245F Flight Vehicle Technology Integration | 2568 |

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

(U) FY 2002 ($ in Thousands)

(U) $0 Efforts transferred to PE 0603211F, Aerospace Structures, Project 4920, Flight Vehicle Tech Integration.

(U) $0 Total

(U) FY 2003 ($ 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 17,960 | 0 | 0 | |
| (U) | Appropriated Value | 18,126 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -426 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -309 | | | |
| | e. Rescissions | -166 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 17,225 | 0 | 0 | TBD |

(U) Significant Program Changes:

In FY 2002, efforts transferred to PE 0603211F, Project 4920.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603245F Flight Vehicle Technology Integration | PROJECT: 2568 |

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

(U) Related Activities:

(U) PE 0602201F, Aerospace Vehicle Technology

(U) PE 0603106F, Logistics Systems Technology.

(U) PE 0603211F, Aerospace Technology Dev/Demo

(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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 5,061 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 2735 | Avionics Integration Technology | 1,885 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 666A | Sensor Fusion & Integration Tech | 3,176 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In FY 2002, the remaining efforts in Projects 2735 and 666A were transferred to PE 0603203F, Project 665A.

**(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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 5,301 | 0 | 0 | |
| (U) | Appropriated Value | 5,350 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | b. Small Business Innovative Research | -126 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -114 | | | |
| | e. Rescissions | -49 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 5,061 | 0 | 0 | TBD |

(U) Significant Program Changes:

In FY 2002, the remaining efforts in Projects 2735 and 666A were transferred to PE 0603203F, Project 665A.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration

PROJECT: 2735

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2735 Avionics Integration Technology | 1,885 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

In FY 2002, the remaining efforts in this project were transferred 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 2001 ($ in Thousands)

(U) $1,885 Developed and demonstrated advanced modular, sharable digital RF sensor technologies for aerospace sensor suites performing ISR applications. Fabricated and tested dual-use, modular, digital RF receiver components for multimode radar operation. (In FY 2002, this work was transferred to PE 0603203F, Project 665A.)

(U) $1,885 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort transferred to PE 0603203F, Project 665A.

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603253F Advanced Sensor Integration | 2735 |

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

(U) Related Activities:

(U) PE 0603204F, Aerospace Sensors.

(U) PE 0603203F, Advanced Aerospace Sensors.

(U) PE 0603270F, Electronic Combat Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration

PROJECT: 666A

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 666A | Sensor Fusion & Integration Tech | 3,176 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

In FY 2002, the remaining efforts in this project were transferred 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 2001 ($ in Thousands)

(U) $3,176 Developed technologies to maximize GPS jam resistance, positional accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Refined GPS receiver processing technology and direct signal acquisition techniques. Continued evaluation of GPS modernization candidate military signals for exploitable vulnerabilities. (In FY 2002, this effort was transferred to PE 0603203F, Project 665A.)

(U) $3,176 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort transfers to PE 0603203F, Project 665A.

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603253F Advanced Sensor Integration | PROJECT: 666A |

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602782A, Command, Control, Communications Technology.
(U) PE 0602232N, Navy C3 Technology.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603270F, Electronic Combat Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603270F Electronic Combat Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 26,391 | 32,405 | 23,350 | 27,773 | 27,047 | 26,302 | 27,165 | Continuing | TBD |
| 2432 | Defensive System Fusion Technology | 9,362 | 8,307 | 8,110 | 8,251 | 7,815 | 6,058 | 5,529 | Continuing | TBD |
| 431G | RF Warning & Countermeasures Tech | 7,672 | 8,402 | 6,009 | 6,906 | 6,618 | 7,814 | 8,990 | Continuing | TBD |
| 691X | EO/IR Warning & Countermeasures Tech | 9,357 | 15,696 | 9,231 | 12,616 | 12,614 | 12,430 | 12,646 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In FY 2003, space unique tasks in this PE, Projects 431G and 691X, will be transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(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, infrared, and laser threats to aerospace platforms. Note: In FY 2002, Congress added $1.0 million for the Integrated Demonstrations and Applications Laboratory's Coherent Command, Control, Communications, Navigation, and Identification Signal Simulations, and $3.5 million for Closed-Loop Infrared Countermeasures.

**(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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603270F Electronic Combat Technology

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 26,636 | 28,221 | 29,559 | |
| (U) | Appropriated Value | 26,882 | 32,721 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -316 | | |
| | b. Small Business Innovative Research | -631 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | 386 | | | |
| | e. Rescissions | -246 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -6,209 | |
| (U) | Current Budget Submit/FY 2003 PBR | 26,391 | 32,405 | 23,350 | TBD |

(U) Significant Program Changes:

In FY 2003, space unique tasks in this PE, Projects 431G and 691X, will be transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603270F Electronic Combat Technology

PROJECT: 2432

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 2432 Defensive System Fusion Technology | 9,362 | 8,307 | 8,110 | 8,251 | 7,815 | 6,058 | 5,529 | Continuing | |

**(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.

(U) FY 2001 ($ in Thousands)

(U) $2,193 Developed 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 effort, performed design of optimized sensor fusion algorithms and processor hardware for joint coalition platforms.

(U) $3,847 Developed and investigated offensive counter information warfare technologies to disrupt and/or deny adversarial C2 nodes and networks. Continued threat exploitation. Conducted ground/field testing of brassboard against modern digital C2 network links. Designed experimental hardware and software to counter adversarial communication and navigation systems.

(U) $2,767 Conducted evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness. Conducted laboratory evaluations of receiver technology for advanced fighter applications. Integrated 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) $555 Developed affordable threat alert technologies for combat aircraft to increase survivability against advanced, integrated radio frequency air defense systems. Conducted trade study analyses for techniques to defeat future threat radar guided missile systems.

(U) $9,362 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603270F Electronic Combat Technology |
| | PROJECT<br>2432 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $2,282 | 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) | $302 | Develop and implement advanced hardware-in-the-loop threat simulators in the Integrated Demonstrations and Applications Laboratory (IDAL) to conduct evaluations and risk reduction demonstrations of defensive sensors and fusion of multiple information sources for situational awareness. Develop and conduct IDAL risk reduction evaluations and demonstrations that evolve advanced sensor processing technologies for real-time threat situational awareness. |
| (U) | $4,732 | Develop affordable radar and radio frequency (RF) emitter warning concepts and techniques. Develop affordable threat alert and jamming technique generator technologies for combat aircraft to increase survivability against advanced, integrated RF, electro-optical, and infrared air defense systems. Perform trade study analyses for techniques to defeat future threat radar guided missile systems. Complete requirements study and transition analysis, begin hardware and software development, and hold preliminary design reviews for an advanced digital threat warning and response capability. (In FY 2001, portions of this effort were performed in PE 0603203F, Project 69DF.) |
| (U) | $991 | Continue integrating Coherent Command, Control, Communications, Navigation, and Identification (C3NI) signal simulation capabilities into the IDAL. Upgrade the IDAL's C3NI equipment to the standards required for a joint survivability demonstration. |
| (U) | $8,307 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,296 | Develop and investigate offensive counter information warfare technologies to disrupt and deny hostile command and control nodes and networks. Complete hardware/software system integration and conduct extensive ground tests to evaluate electronic attack and Electronic Support Measures techniques to counter adversarial communication and navigation systems. Continue the detailed planning for the flight tests. Investigate and analyze various computer networks for selection of the most viable threat. Design effective countermeasures techniques against the selected high-speed, wideband data link targets. |
| (U) | $2,458 | Integrate advanced sensor receiver and processing technologies, and conduct IDAL risk reduction evaluations and demonstrations that focus these technologies on mission applications. Conduct IDAL risk reduction evaluations and demonstrations to evolve advanced sensor threat |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603270F Electronic Combat Technology / PROJECT: 2432 |

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

(U) FY 2003 ($ in Thousands) Continued

identification and location algorithms for real-time threat situation awareness.

(U) $2,356 Develop affordable radar and radio frequency (RF) emitter warning concepts and techniques. Develop affordable threat alert and jamming techniques generator technologies 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 threat radar guided missile systems. Continue hardware and software development through subsystem tests and early system integration for an advanced digital threat warning and response capability.

(U) $8,110 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 0603500F, Multi-disciplinary Adv Space Tech.

(U) PE 0604270F, Electronic Warfare (EW) Development.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603270F Electronic Combat Technology

PROJECT: 431G

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 431G RF Warning & Countermeasures Tech | 7,672 | 8,402 | 6,009 | 6,906 | 6,618 | 7,814 | 8,990 | Continuing | |

In FY 2003, space unique tasks in this project will transfer to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(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 2001 ($ in Thousands)

(U) $1,406 Developed affordable radar and RF emitter warning concepts and techniques. Evaluated a wideband digital receiver for affordable electronic support measures and radar warning receiver suites.

(U) $3,313 Developed wideband, multimode, multifunction apertures for electronic warfare applications (i.e., threat detection, threat avoidance, suppression of enemy air defenses, surveillance, and reconnaissance). Integrated and chamber tested a multimode antenna to demonstrate a tenfold improvement in gain while providing a wide field of view and a low radar cross section.

(U) $2,953 Developed aerospace platform self-protection and support jamming technologies to counter advanced RF threats associated with current and future air defense weapon systems. Conducted laboratory evaluations of EC techniques to increase aerospace system survivability. Completed demonstration of a steerable high-power array. Designed and developed a flight-worthy brassboard for monopulse angle jamming integrated electronic countermeasures. Built and demonstrated an advanced electronic protection breadboard.

(U) $7,672 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603270F Electronic Combat Technology |
| | PROJECT: 431G |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $1,305 | Develop Advanced Tactical Targeting Technology in conjunction with DARPA for Suppression of Enemy Air Defenses (SEAD). Integrate and flight test brassboard units that triangulate threat emitter positions and provide targeting for precision guided munitions. |
| (U) | $779 | Develop wideband, multimode, multifunction apertures for electronic warfare applications (i.e., threat detection, threat avoidance, SEAD, 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) | $6,318 | Study and initiate developing aerospace platform self-protection and support jamming technologies to counter advanced radio frequency threats associated with current and future aerospace weapon systems. Conduct field 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) | $8,402 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $1,934 | Develop wideband, multimode, multifunction apertures for electronic warfare applications (i.e., threat detection, threat avoidance, suppression of enemy air defenses, surveillance, and reconnaissance). Demonstrate proof-of-concept for cost and weight reduction for adaptive, wideband conformal phased arrays that are integrated into potential unmanned aerospace platforms. These subarrays will have multiple polarization elements and perform over and extremely wide frequency range with an instantaneous bandwidth of between 4:1 to 10:1. |
| (U) | $4,075 | Complete study and continue developing and demonstrating aerospace platform self-protection and support jamming technologies and techniques to counter advanced RF threats associated with current and future aerospace weapon systems. Initiate developing next generation monopulse countermeasure systems. Continue developing and evaluating innovative RF countermeasure techniques for aerospace platforms against future RF threat systems. Continue developing and performing laboratory and field tests of advanced electronic protection techniques and technology to protect our aerospace radar systems. |
| (U) | $6,009 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603270F Electronic Combat Technology | 431G |

**(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 0603500F, Multi-disciplinary Adv Space Tech.

(U) PE 0604270N, EW Development.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603270F Electronic Combat Technology

PROJECT: 691X

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 691X EO/IR Warning & Countermeasures Tech | 9,357 | 15,696 | 9,231 | 12,616 | 12,614 | 12,430 | 12,646 | Continuing | |

In FY 2003, space unique tasks in this project will be transferred to PE 0603500F, Project 5034, in conjunction with the Space Commission recommendation to consolidate all space unique tasks.

**(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 2001 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $3,859 | Developed on-board, closed-loop, laser infrared countermeasures (IRCM) for large aircraft to defeat current and future IR missiles in multiple scenarios. Fabricated a flight-worthy closed-loop IRCM suite for demonstration on large aircraft. |
| (U) | $1,193 | Conducted in-house analyses of current and future IR threat missiles. Completed digital models of IR threat missiles. Simulated expendable countermeasure techniques for conventional and imaging IR missiles. Designed combined effects expendables for tactical aircraft to defeat imaging IR missiles. |
| (U) | $980 | Developed 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. Conducedt laboratory evaluation of ability of laser warning sensor technology to locate/identify laser hazards and cue appropriate response. |
| (U) | $1,907 | Developed EO and IR missile warning technologies to alert aircrews and aircraft self-protection systems to the approach of advanced, low-signature threats. Evaluated multispectral imaging technology for missile warning and/or distributed aperture sensors. |
| (U) | $1,418 | Developed countermeasure technology to defeat passive EO/IR aircraft tracking sensors and ordnance guidance. Investigated gimballess beam steering technologies to reduce weight and drag of countermeasure subsystems. |
| (U) | $9,357 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603270F Electronic Combat Technology |
| PROJECT: 691X | |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $9,164 | 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) | $1,151 | 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) | $1,618 | 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 developing laser warning sensor technology for space situational awareness. Complete design of radiometer module and initiate designing geolocation and spectrometer modules. 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) | $1,829 | 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. Initiate developing multi-color warning technologies that improve threat detection and reduce declaration times in heavy clutter environments. |
| (U) | $1,934 | Develop countermeasure technology to defeat passive EO/IR aircraft tracking sensors and ordnance guidance. Continue evaluating 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) | $15,696 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $320 | Develop on-board, closed-loop, laser IRCM for large aircraft to defeat current and future IR-guided missiles in multiple scenarios. Complete flight tests of closed-loop IRCM technology on large aircraft. |
| (U) | $1,604 | Conduct in-house analyses of the vulnerabilities of current infrared missile systems and future imaging infrared sensors. Fabricate expendable decoy technology suitable for peacekeeping operations that can be safely deployed at low altitudes over urban areas. Acquire and assess capabilities and vulnerabilities of imaging infrared sensors used for target acquisition. |
| (U) | $2,949 | 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. Initiate design of airborne laser warning sensor which can cue agile filter protection for aircrew or sensor protection. |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603270F Electronic Combat Technology | 691X |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $4,358 | Develop countermeasure technology to defeat passive EO/IR aircraft tracking sensors and ordnance guidance. Initiate advanced technology demonstration program to detect and counter passive electro-optical and infrared tracking sensors. Complete preliminary design for a method to counter sensors beyond kinematic launch capability. |
| (U) | $9,231 | 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 0603500F, Multi-disciplinary Adv Dev Space Tech.
(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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 26,703 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 4373 | Launch and Orbit Transfer Propulsion Technology | 22,864 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 6340 | Satellite Control and Maneuvering Propulsion Technology | 3,839 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory (AFRL) organization.

**(U) A. Mission Description**

This program develops and demonstrates advanced rocket propulsion and space launch technologies. It provides the technological steps 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 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.

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 27,776 | 0 | 0 | |
| (U) | Appropriated Value | 28,033 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -658 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -415 | | | |
| | e. Rescissions | -257 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 26,703 | 0 | 0 | TBD |

(U) Significant Program Changes:

In FY 2002, remaining efforts in this PE will transfer to PE 0603216F, Project 4922.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion

PROJECT: 4373

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4373 | Launch and Orbit Transfer Propulsion Technology | 22,864 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, efforts transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory (AFRL) 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 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 2001 ($ in Thousands)

(U) $8,663 Developed propulsion technology for existing and future launch vehicles. Continued to develop turbomachinery components for integration into advanced liquid test bed demonstrator. Continued fabrication and assembly of combustion chamber and injector. Continued fabrication of oxygen turbopump for integration into an advanced liquid booster engine. Continued testing of oxygen and hydrogen turbopump assemblies and preburner components for integration into an advanced liquid booster engine. Installed oxygen turbopump assembly into test facility and prepared for hot fire testing of pump assembly. Completed fabrication of oxygen and hydrogen preburner components for integration into an advanced liquid booster engine. Initiated the design of advanced hydrocarbon test bed engine.

(U) $8,735 Developed propulsion technologies for existing and future upper stage and orbit transfer vehicles. Completed thrust chamber testing and achieved performance above predicted levels. Initiated turbopump testing and demonstrated progress in hardware operation Continued to demonstrate solar thermal propulsion technologies, such as strut development and pointing and tracking, for orbit transfer and maneuvering propulsion technology. Continued program to develop electric propulsion systems for orbit transfer by developing high-power Hall thrusters capable of low earth orbit-geosynchronous orbit transfer. Initiated the design of the advanced smallsat propulsion demonstration to develop microsat formation flying for Air Force imaging missions.

(U) $1,750 Developed technologies for the sustainment of strategic systems. Continued the Strategic Sustainment Demonstration program which integrates advanced propellant, case, and nozzle technologies and demonstrates all cost and performance goals.

(U) $3,716 Developed technologies for Pulse Detonation Engines (PDE) to enable next generation propulsion options for affordable access to space and unmanned missions. Defined PDE performance requirements. Designed PDE engine and key subsystems including inlet, intake valve, fuel

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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. Fabricated components and evaluated fuel injection, initiation, and cooling systems.

(U) $22,864 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort moved to PE 0603216F, Project 4922.

(U) $0 Total

(U) FY 2003 ($ 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 0602203F, Aerospace Propulsion.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603853F, Evolved Expendable Launch Vehicle Program.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603302F Space and Missile Rocket Propulsion

PROJECT: 6340

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 6340 | Satellite Control and Maneuvering Propulsion Technology | 3,839 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, efforts transferred to PE 0603216F, Project 4922, in order to align projects with the Air Force Research Laboratory (AFRL) 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 2001 ($ in Thousands)

(U) $419 Developed propulsion systems for satellite formation flying. Initiated development of mathematical models to address different propulsion technologies that could be used for small satellite formation flying. Using these models, the optimum propulsion system for use in small satellites was downselected.

(U) $325 Developed propulsion for satellite stationkeeping and repositioning. Initiated brass board level testing of a pulsed plasma thruster system. Hot fire tested the thruster in conjunction with the power processing unit.

(U) $3,095 Developed propulsion systems for use in satellite propulsion. Initiated development of propulsion system for fleet of Air Force small satellites (<100 kg) required for key Air Force Space Command concepts. Initiated design of flight hardware and began technology transition of selected propulsion concepts from the laboratory to the commercial sector. Initiated the fabrication of flight hardware for TechSat 21 spacecraft.

(U) $3,839 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Effort moved to PE 0603216F, Project 4922.

(U) $0 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| 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 2003 ($ 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 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.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603311F Ballistic Missile Technology

PROJECT: 4091

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4091 | Missile Electronics | 22,249 | 1,188 | 0 | 0 | 0 | 0 | 0 | 0 | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In FY 2003, this program anticipates receiving $4.9 million from the Cost of War Transfer Account. These funds are not included in the FY 2003 Air Force baseline. Funding will be used for ballistic missile technologies in support of the Technology for Sustainment of Strategic Systems program.

**(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, for Ballistic Missile Technology in FYs 2000 and 2001, and for Global Positioning System (GPS) Range Safety in 2002.

(U) FY 2001 ($ in Thousands)

(U) $16,066 Developed 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 tested 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. Initiated certification of the GPS-INS range safety system at missile launch sites.

(U) $1,439 Developed and demonstrated 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. Transitioned current advanced GPS anti-jamming receiver, enhanced antenna architecture, and novel window material technologies to concept exploration. Designed and demonstrated critical components/technologies essential to new reentry architectures.

(U) $4,744 Developed and demonstrated 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. Selected affordable, existing advanced-technologies directly tied to user requirements. Conducted 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. Demonstrated revolutionary materials testing, service life prediction/component age out, and

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| 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) Continued

recovery techniques.

(U) $22,249 Total

(U) FY 2002 ($ in Thousands)

(U) $990 Develop technologies for the integration of advanced Global Position System-Inertial Navigation System (GPS-INS) technologies into space and missile range instrumentation and missile guidance systems to meet more stringent range safety requirements. Develop and demonstrate robust technologies for the command and control system providing non-interfering, continuous, two-way missile communication under all flight conditions.

(U) $124 Extend the acceptance and certification of qualified GPS-INS range safety technologies to meet launch-range requirements in more locations and encompassing more severe launch conditions.

(U) $74 Continue plasma technology development efforts to mitigate GPS communication loss through the reentry blackout phase of flight.

(U) $1,188 Total

(U) FY 2003 ($ 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|
| (U) Previous President's Budget | 22,789 | 0 | 0 | |
| (U) Appropriated Value | 23,000 | 1,200 | | |
| (U) Adjustments to Appropriated Value | | | | |
| a. Congressional/General Reductions | | -12 | | |
| b. Small Business Innovative Research | -540 | | | |
| c. Omnibus or Other Above Threshold Reprogram | | | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603311F Ballistic Missile Technology | PROJECT: 4091 |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -211 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | 0 | | |
| (U) | Current Budget Submit/FY 2003 PBR | 22,249 | 1,188 | 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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603333F Unmanned Air Vehicle Dev/Demo

PROJECT: 5067

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 5067 | Unmanned Combat Air Vehicle Tech Demo | 0 | 20,952 | 18,000 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: Beginning in FY 2002, ongoing Air Force technical efforts related to the Joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program have been consolidated into this PE per Congressional direction. Only the UCAV portions of the following PEs and Projects have been transferred into this PE: PE 0602202F, Project 7184; PE 0603203F, Project 665A; PE 0603211F, Project 4920; PE 0603601F, Project 670A; and PE 0603789F, Project 4072.

**(U) A. Mission Description**

This program will develop, demonstrate, and transition advanced unarmed, unmanned aerial vehicle (UAV) and armed UCAV technologies. Flight testing to demonstrate integration of critical technologies, such as autonomous operations, inter-vehicle communications, and multi-vehicle flight operations, will improve the performance and supportability of UAVs and UCAVs.

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $11,754 Develop and integrate critical technologies that provide for autonomous operations, inter-vehicle communications, multi-vehicle flight operations. Prepare to conduct an end-to-end demonstration of the mission utility of the UCAV.

(U) $1,850 Complete the development of advanced fusion technology to evaluate the capability of UCAVs to operate in a Command, Control, Communication, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated Command, Control, and Communications (C3) network. Demonstrate, through flight test, the concept of single distributed control by performing a hand off between a friendly area of operations controller and the area of responsibility controller (i.e., 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 an affordable UCAV unit recurring flyaway goal in a C4ISR data-rich environment as part of an integrated C3 network. Demonstrate multi-vehicle flight operations: escort formations; collision avoidance; auto

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603333F Unmanned Air Vehicle Dev/Demo |
| | PROJECT<br>5067 |

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

(U) FY 2002 ($ in Thousands) Continued

routing; and dynamic re-tasking among others. Demonstrate multiple re-planned weapons drops.

| | | |
|---|---|---|
| (U) | $2,668 | Continue to develop and demonstrate both electro-optical and radio frequency technologies for both advanced technologies and complete sensor capabilities on the unmanned combat air vehicle (UCAV). |
| (U) | $1,400 | Continue human systems technology support by demonstrating remote operator control/interface, that can extend the capability to effectively and affordably perform the 21st century missions of defense suppression and tactical attack. |
| (U) | $1,334 | Continue to integrate miniature munition concepts with UCAV and support integration and planning of a UCAV flight test. |
| (U) | $20,952 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $11,461 | Complete development and integration of critical technologies that provide for autonomous operations, inter-vehicle communications, and multi-vehicle flight operation. Complete an end-to-end demonstration of the mission utility of the UCAV. |
| (U) | $2,699 | Complete the development and demonstration of technologies to support an affordable UCAV unit recurring flyaway goal in a Command, Control, Communications, Computer, Intelligence, Survellance, and Reconnaissance (C4ISR) data-rich environment as part of an integrated Command, Control, and Communication network. Demonstrate multi-vehicle flight operations: escort formations; collision avoidance; auto routing; and dynamic re-tasking among others. Demonstrate multiple re-planned weapons drops. |
| (U) | $1,897 | Complete development and demonstration of both electro-optical and radio frequency technologies for both advanced technologies on the UCAV. |
| (U) | $995 | Complete human systems technology support by demonstrating remote operator control/interface, that can extend the capability to effectively and affordably perform the 21st century missions of defense suppression and tactical attack. |
| (U) | $948 | Complete integration of miniature munition concepts with UCAV and complete UCAV flight test with miniature munition concepts. |
| (U) | $18,000 | Total |

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for new unarmed, unmanned aerial vehicles and armed, UCAVs that have C4ISR or combat utility and address warfighter needs.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603333F Unmanned Air Vehicle Dev/Demo |
| | PROJECT: 5067 |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | | 0 | 0 | |
| (U) | Appropriated Value | | 20,952 | | |
| (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 | | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 18,000 | |
| (U) | Current Budget Submit/FY 2003 PBR | | 20,952 | 18,000 | TBD |

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to Congress directing the consolidation of Air Force Science and Technology funding for the Joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle program into a single Program Element.

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

(U) PE 0602202F, Human Effectiveness.
(U) PE 0602201F, Aerospace Vehicle Technologies.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603211F, Aerospace Technology Dev/Demo.
(U) PE 0603601F, Conventional Weapons.
(U) PE 0603789F, C3I Advanced Development.
(U) PE 0604731F, Unmanned Combat Air Vehicle.
(U) PE 0602702E, Tactical Technology.
(U) PE 0603285E, Advanced Aerospace Systems.
(U) PE 0603762E, Sensor and Guidance Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603333F Unmanned Air Vehicle Dev/Demo |
| PROJECT: 5067 | |

**(U) E. Acquisition Strategy**

Not Applicable.

**(U) F. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 61,171 | 60,932 | 42,315 | 53,323 | 54,364 | 61,987 | 63,206 | Continuing | TBD |
| 2181 | Spacecraft Payloads | 15,357 | 17,061 | 14,066 | 15,276 | 16,398 | 16,719 | 17,040 | Continuing | TBD |
| 3834 | Integrated Space Technology Demonstrations | 32,831 | 24,268 | 12,268 | 20,931 | 18,967 | 25,853 | 26,344 | Continuing | TBD |
| 4400 | Space Systems Protection | 5,302 | 6,050 | 2,798 | 3,075 | 3,545 | 3,617 | 3,685 | Continuing | TBD |
| 4938 | Space Developmental Planning | 0 | 4,980 | 0 | 0 | 0 | 0 | 0 | 0 | TBD |
| 5021 | Space Systems Survivability | 0 | 0 | 4,030 | 4,256 | 4,874 | 5,008 | 5,142 | Continuing | TBD |
| 682J | Spacecraft Vehicles | 7,681 | 8,573 | 9,153 | 9,785 | 10,580 | 10,790 | 10,995 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, efforts were transferred from PE 0603410F, Space Systems Environmental Interactions Technology, into Project 4400 in this PE, in order to align projects within the Air Force Research Laboratory organization. In FY 2003, selected efforts in Project 4400, were transferred within this PE into Project 5021, in order to focus on improving survivability of space systems in natural environments.

**(U) A. Mission Description**

This program develops, integrates, and demonstrates space technologies in the areas of spacecraft payloads, spacecraft protection, spacecraft and launch vehicles, and space systems survivability. The integrated space technologies are demonstrated by component or system level tests on the ground or in flight. Note: Congress added $7.0 million in FY 2002 ($6.0 million for Scorpius Low-Cost Launcher and $1.0 million for Next Generation Hybrid Orbital Maneuver Vehicle).

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology |

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 63,019 | 54,528 | 50,373 | |
| (U) | Appropriated Value | 63,602 | 61,528 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -596 | | |
| | b. Small Business Innovative Research | -1,498 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -350 | | | |
| | e. Rescissions | -583 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -8,058 | |
| (U) | Current Budget Submit/FY 2003 PBR | 61,171 | 60,932 | 42,315 | TBD |

(U) Significant Program Changes:

In FY 2003, decrease in funding due to the realignment of funding to higher priority S&T programs and the termination of Warfighter-1 operations in Project 3834.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 2181

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2181 | Spacecraft Payloads | 15,357 | 17,061 | 14,066 | 15,276 | 16,398 | 16,719 | 17,040 | Continuing | TBD |

**(U) A. Mission Description**

This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, and satellite control hardware and software for advanced satellite surveillance operations. Improved space-qualifiable electronics and software for data and signal processing 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 2001 ($ in Thousands)

(U) $8,311 Developed 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. Fabricated and demonstrated radiation-hardened Power PC. Insert Next Generation Space Processor design and hardware into flight demonstration system. Designed specifications, built, and demonstrated ground-based computer based on Improved Space Architecture concept. Demonstrated MEMS switches for reconfigurable space electronic applications. Continued the development of packaging and MEMS technologies that enhance/enable optical cross-links and demonstrate the 400 Megabit per second data transfer. Developed reconfigurable electronics and initial plug-and-play system approaches for space.

(U) $1,428 Continued to develop intelligent satellite system technologies for satellite control, precision spacecraft navigation, formation flying, and 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, an decrease anomaly resolution time and ground operations requirements. Demonstrated intelligent satellite software in the distributed-cluster ground testbed for satellite cluster command and control, cluster formation flying, and executive cluster management. Completed and demonstrated enhanced executive cluster controller and began developing formation flying and orbit determination flight test software and satellite control ground station software.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

(U) $1,306 Continued to develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. The modeling, simulation, and analysis (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 simulation architecture tools for satellite constellation-level modeling and validate these tools across the broader modeling and simulation space community. Demonstrated existing space surveillance simulations to support New World Vista's Global Awareness Virtual Testbed. Demonstrated MS&A software and tools in the distributed satellite architecture simulation testbed. Completed 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) $1,992 Developed 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. Designed low temperature, multi-color, and low background detectors and focal plane arrays and higher temperature focal plane arrays with higher levels of radiation-hardness. Began development of 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) $2,320 Developed satellite antenna technologies that maximize the use of high density interconnects, embedded the electronics directly onto the antenna itself, and used 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. Completed design of selected embedded-structural transmit-receive electronics antenna modules. Designed antenna modules which address the requirement for minimizing mass and power by embedding lightweight electronics in the structure itself. Continued fabrication of modular phased-array antenna tile. Completed data analysis on receive-only sub-antenna array data.

(U) $15,357 Total

(U) FY 2002 ($ in Thousands)

(U) $10,409 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 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 memory elements into high density, low power chips. Investigate integration of chalcogenide into other component applications. Extend

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

| | | |
|---|---|---|
| | | fabrication capability for application specific integrated circuit technology for upwards to eight million gate devices. Develop and demonstrate a micro-electro-mechanical systems 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) | $1,738 | 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) | $858 | 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) | $2,527 | 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) | $1,529 | 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) | $17,061 | Total |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 2181 |

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

(U) FY 2003 ($ in Thousands)

(U) $8,475 Develop spacecraft microelectronic devices, including radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications. Perform simulations and validate designs of a general purpose embedded processor at 500 million instructions per second and digital signal processors at 1 billion operations per second. Fabricate and characterize high density, low power chips comprised of innovative chalcogenide programmable memory elements. Begin integration of chalcogenide into components such as field programmable logic and analog microelectronics. Develop macrocell libraries for application specific integrated circuit technology for up to eight million gate devices. Develop and demonstrate a MEMS-based switch box multi-chip module and associated heuristics for multi-switch box applications to smart-wiring manifolds.

(U) $1,797 Continue to develop intelligent satellite system technologies for satellite control, precision navigation, formation flying, and cluster management technologies for spacecraft constellations. Complete and deliver microsatellite cluster management software and integrate the distributed architecture test bed in preparation for a flight demonstration of collaborating three microsatellite constellation. Continue development of command and control and navigational capability for high fidelity spacecraft proximity operations. Continue to develop automated planning and scheduling software for multiple satellite clusters and the spacecraft and simulation data archiving and storage system. Begin development of guidance, navigation, and control algorithms for a tethered power generation system.

(U) $929 Continue to develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems and distributed satellite architecture payloads. Complete 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. Complete models of sparse aperture RF distributed signal processing to be validated against flight experiment and for systems analysis. Begin building mission operations center to support the collaborating three microsatellite constellation flight experiment.

(U) $493 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. Demonstrate and characterize low temperature multicolor and low background detectors and focal plane arrays, and higher temperature arrays with improved radiation hardness. Fabricate and deliver 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. Transition multicolor quantum well photodetector designs and other promising infrared technologies to large focal plane arrays.

(U) $2,372 Develop satellite antenna technologies which 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. Test and integrate selected embedded-structural transmit-receive

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology |
| PROJECT: 2181 | |

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

(U) FY 2003 ($ in Thousands) Continued

electronics antenna modules with payloads for three microsatellite constellation space flight experiment. Test, integrate, and evaluate multi-beam, wide-bandwidth transmit-receive electronics antenna modules with payloads for possible airborne, multi-mode flight experiment. Fabricate and test antenna modules which address requirements for minimizing mass and power by embedding lightweight electronics in the structure.

(U) $14,066 Total

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

Not Applicable.

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

(U) Related Activities:
(U) PE 0303601F, MILSTAR Satellite Communications System.
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603311F, Ballistic Missile Technology.
(U) PE 0603215C, Limited Defense System
(U) PE 0603218C, Research and Support.
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.
(U) PE 0604609F, Reliability and Maintainability Technology Insertion Program (RAMTIP).
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 3834

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 3834 | Integrated Space Technology Demonstrations | 32,831 | 24,268 | 12,268 | 20,931 | 18,967 | 25,853 | 26,344 | 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 2002, Congress added $7.0 million ($6.0 million for Scorpius Low-Cost Launcher and $1.0 million for Next Generation Hybrid Orbital Maneuver Vehicle).

(U) FY 2001 ($ in Thousands)

(U) $4,803 Continued to develop Warfighter-1, the first in the series of Integrated Space Technology Demonstration systems. Warfighter-1 was an inexpensive space-based hyperspectral imagery system intended 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. Launched Warfighter-1, however, the payload did not reach orbit due to failure of the launch vehicle.

(U) $0 Develop and demonstrate precision ballistic missile navigation technologies to improve accuracy during reentry and in plasma and jamming environments. These technologies will mitigate the detrimental effects of reentry plasma and jamming on Global Positioning System (GPS) navigation performance. Conduct reentry plasma physics characterization and demonstration planning, and continue development and demonstration of miniaturized jam-resistant GPS receivers.

(U) $3,242 Developed microsatellite (10-100kg) technologies and integrated microsatellite technology concepts. Began design of second satellite in the XSS microsatellite series. Studied bus requirements and potential designs. Developed guidance and navigation and maneuvering software and hardware technologies and proximity operations sensor package.

(U) $1,860 Developed technologies for the Communications/Navigation Outage Forecasting System (C/NOFS) demonstration. C/NOFS will demonstrate the capability for forecasting outages to GPS navigation and satellite communications links, providing the warfighter with information on communications and navigation outages. This allows the preemptive use of backup systems and alternate links, which aids anomaly resolution, and facilitates mission/operations planning. Developed data processing unit. Verified payload interface and support spacecraft development and pre-planning of sensor suite integration and testing.

(U) $6,287 Developed scalable booster technologies for low-cost launch vehicles. Continued development of the Sprite orbital demonstration vehicle for launching small payloads at significantly reduced cost. Developed and tested 20,000-lb. thrust flight-weight ablative Sprite booster engine.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

Developed and tested all composite liquid oxygen propellant tank for the Sprite vehicle. Began systems analysis for a Sprite 2,000-lb. thrust upper stage engine. Continued development and demonstration of hydroxyl ammonium nitrate/triethanol amine nitrate mixing gas generator tank pressurization technology.

(U) $4,837 Developed and demonstrated a low-cost, liquid propellant, expendable upper stage in a cooperative effort with National Aeronautics and Space Administration (NASA). Designed, fabricated, and tested a flight ready integrated expendable upper stage.

(U) $9,287 Developed and demonstrated technologies for a military-unique, reusable, satellite bus and upper stage for the Military Spaceplane system. Developed advanced reusable rocket engine technologies for the Space Maneuver Vehicle (SMV) X-40 second tail number flight test article. Continued 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 applied the technologies to the X-37 demonstrator to improve military utility and leverage the NASA investment.

(U) $2,515 Developed and demonstrated propulsion and power technologies for solar thermal orbit transfer vehicle. These technologies will enable an affordable orbit transfer vehicle for inspection, reposition, and servicing of space assets above low earth orbit. Developed and built modular heat exchanger to enable scaling to operational size. Developed and built flight experiment scale test article of the inflatable concentrator and feedback control sensor and actuators. Developed control system algorithms and simulations and ground test algorithms with feedback control sensor.

(U) $32,831 Total

(U) FY 2002 ($ in Thousands)

(U) $594 Complete the Warfighter-1 technology demonstration effort, which was intended to provide an inexpensive space-based hyperspectral imagery system for user validation in a tactical environment. Complete final reports, detailing and evaluating lessons learned from the Warfighter-1 development and commercial leveraging efforts.

(U) $1,609 Develop autonomous microsatellite (10-100kg) technologies for an integrated, robust, flexible, modular microsatellite technology concept. Develop microsatellite technologies for non-cooperative, autonomous operational concept and mission planning tools.

(U) $10,749 Design, develop, integrate and test an autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative, resident space object. Perform design reviews and begin component/hardware fabrication for an autonomous operations microsatellite. Develop plans for launch vehicle integration and safety analysis.

(U) $4,383 Develop microsatellite system test scenarios and design microsatellite hardware-in-the-loop, software simulations, and mission

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| 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

planning/training tools.

(U) $5,942 Develop scalable booster technologies and a flight vehicle demonstrator for low-cost launch vehicles. Develop the detailed design and fabricate long-lead components for the SR-XM-2 suborbital flight vehicle. Perform post injector design modification developmental test firings and engine qualification firings for the 20,000 lb. thrust flight-weight ablative booster engine for the SR-XM-2.

(U) $991 Develop technologies for a small, hybrid propulsion module capable of transferring selected Space Shuttle payloads to higher operational orbits after deployment. This orbital maneuvering capability will reduce both launch cost and risk, while enabling payloads to reach optimal orbit. Develop a conceptual design for the propulsion module that meets National Aeronautics and Space Administration safety and performance requirements. Design, fabricate, and ground test critical, high-risk propulsion module components, evaluating both performance and safety aspects.

(U) $24,268 Total

(U) FY 2003 ($ in Thousands)

(U) $1,873 Develop autonomous microsatellite (10-100kg) technologies for an integrated, robust, flexible, modular microsatellite technology concept. Perform mission operations concept trades using hardware- software-in-the-loop simulations and mission planning tools for non-cooperative proximity operations.

(U) $8,908 Design, develop, integrate, and test autonomous microsatellite to demonstrate integrated technology concepts for operations around a non-cooperative resident space object (RSO). Complete component development and begin system level integration, functional, and environmental test activities in preparation for launch and operations. Perform final launch vehicle safety analysis and ground test and evaluation.

(U) $1,487 Use microsatellite hardware-in-the-loop and software simulations to perform comprehensive ground testing of the autonomous micro-satellite around a non-cooperative RSO.

(U) $12,268 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603401F Advanced Spacecraft Technology | 3834 |

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

(U) Related Activities:

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4400

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4400 Space Systems Protection | 5,302 | 6,050 | 2,798 | 3,075 | 3,545 | 3,617 | 3,685 | Continuing | TBD |

Note: In FY 2002, efforts were transferred from PE 0603410F, Space Systems Environmental Interactions Technology, into this project in order to align projects within the Air Force Research Laboratory organization. In FY 2003, selected efforts were transferred within this PE from this project into Project 5021 in order to focus on improving survivability of space systems in natural environments.

**(U) A. Mission Description**

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in potentially hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to radio frequency and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment.

(U) FY 2001 ($ in Thousands)

(U) $43 Used multi-threat assessment tool to evaluate space-based electro-optical sensor responses to various candidate laser countermeasures. Provides space platform designees a rapid and robust assessment tool for accurate assessment of various countermeasures. Began development of passive satellite countermeasures and appropriate mitigation techniques.

(U) $567 Continued 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. Began design of integrated RF receiver/laser sensor hardware with weight and power savings compared to individual sensor packages.

(U) $338 Developed RF threat warning receiver for a one-year space flight. Completed RF receiver data analysis, evaluated receiver performance to identify design changes to optimize performance, and incorporated changes into receiver design to reduce performance risk for the one-year flight. Conducted assessment of weapons effects on satellite components and systems.

(U) $1,452 Developed and demonstrated 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. Demonstrated threat reporting package on shuttle flight STS-107. Designed, fabricated, and demonstrated miniaturized instantaneous frequency measurement unit, power divider circuits, and high frequency circuit interconnects.

(U) $2,902 Developed spacecraft protection technologies applicable to commercial and military space satellites to assure operation of space assets. Developed the capability to assess hardware/software threat susceptibility and vulnerability and developed technologies to mitigate identified

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

vulnerabilities. Developed and exercised modeling and simulation tools to extend the current understanding of susceptibility of different commercial satellite subsystems to multi-threat environments. Developed radio frequency (RF) and laser threat and effects models to evaluate case studies of existing and developing space systems.

(U) $5,302 Total

(U) FY 2002 ($ in Thousands)

(U) $256 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) $2,065 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-infrared laser protection techniques in preparation for space demonstrations. Initiate assessments of the impact of satellite self-protection and situational awareness technologies on space systems operations.

(U) $1,441 Develop sensors to specify and forecast conditions in the space environment that degrade the operation of space-based systems. Support 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) $996 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) $1,292 Develop technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards and to mitigate the effect of the space environment on Department of Defense space systems. Space environment hazard warnings minimize loss of space assets due to component

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

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) $6,050 Total

(U) FY 2003 ($ in Thousands)

(U) $432 Use multi-threat assessment tool to assess space-based electro-optical responses to various candidate radio frequency and laser countermeasures. Begin verification and accreditation of weapons effects satellite assessment tools, complete documentation for users, and continue to develop additional tools for satellite subsystems, such as processor assemblies, optical trains, and satellite buses.

(U) $1,587 Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites. Continue development of the plasma shield to selectively filter the radio frequencies reaching the satellite communications antennas; prepare for conceptual space demonstration. Conduct design and trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Develop technologies to support automatic wartime deployment of protection technologies for satellites whose peacetime mission would be compromised by on-board protection systems. Investigate electronic protection techniques for optical sensors and systems.

(U) $779 Develop and demonstrate visible and near-infrared laser protection technologies. Continue evaluations and ground-based demonstrations of visible and near-infrared laser protection techniques in preparation for space demonstrations.

(U) $2,798 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603401F Advanced Spacecraft Technology | 4400 |

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

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 4938

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4938 Space Developmental Planning | 0 | 4,980 | 0 | 0 | 0 | 0 | 0 | 0 | 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 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $1,015 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 simulation models/tools to include processing and presentation hardware and software, model database upgrades, and networking and leased

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| 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

| | | |
|---|---|---|
| | | 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) | $4,980 | Total |

(U) FY 2003 ($ 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) 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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 5021

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5021 Space Systems Survivability | 0 | 0 | 4,030 | 4,256 | 4,874 | 5,008 | 5,142 | Continuing | TBD |

Note: In FY 2003, efforts were transferred within this PE from Project 4400 into this project, in order to focus on improving survivability of space systems in natural environments.

**(U) A. Mission Description**

This project develops and demonstrates technologies to improve space system survivability and reliability of current and future Department of Defense space systems that must continue operation despite natural space hazards. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.

(U) FY 2001 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $0 No Activity

(U) $0 Total

(U) FY 2003 ($ in Thousands)

(U) $985 Develop sensors to specify and forecast conditions in the space environment that degrade the operation of space-based systems. Support integration, launch, and on-orbit operations of instrumentation to provide improved space radiation hazard specification and forecasting. Complete validation of solar disturbances forecasting algorithms using space-based all-sky camera. Launch relativistic electron and proton detector and demonstrate ability to perform on-orbit mapping of the dynamic radiation belts to quantify hazards to space systems. Begin conceptual design of advanced all-sky, white light camera for operational space weather forecasting system.

(U) $1,004 Conduct collaborative experiments and develop tools to improve the survivability of advanced spacecraft power, communications, and surveillance systems. Complete design and begin fabrication design of second-generation miniaturized charge control system. Complete conceptual design of an experiment to quantify the effects of space plasma on tethered power generation systems and determine feasibility of a space flight test to demonstrate on-orbit electrical power generation. Complete interface between dynamic space plasma and meteor models and web-based spacecraft design tools.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology / PROJECT: 5021 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $2,041 | Develop technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards and to mitigate the effect of the space environment on Department of Defense space systems. Develop data assimilation techniques to produce improved dynamic radiation belt models using data from a fleet of compact environment anomaly sensors. Begin fabrication of miniaturized space environment distributed anomaly resolution sensor for on-orbit detection of space particle, chemical, and impact hazards. Develop detailed design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies. |
| (U) | $4,030 | Total |

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

Not Applicable.

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

(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.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT: 682J

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 682J Spacecraft Vehicles | 7,681 | 8,573 | 9,153 | 9,785 | 10,580 | 10,790 | 10,995 | 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 2001 ($ in Thousands)

(U) $1,863 Developed and evaluated 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. Continued development of lightweight flexible arrays of thin film solar cells and radiation resistant solar cell modules. Continued evaluation of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells.

(U) $788 Developed innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system which employs non-electrochemical energy storage. Continued flywheel ground demonstration and development of flywheel safety technologies. Began microflywheel development.

(U) $1,055 Developed technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications at temperatures ranging from 10K to 150K. Completed 10K model cryocooler.

(U) $1,254 Developed 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. Developed 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 tested and characterized operational grid stiffened structure. Continued development of inflatable structures. Begin ground test of multi-functional structures. Developed full-scale secondary payload adapter structure for an expendable launch vehicle.

(U) $2,721 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

communications systems. Developed 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. Tested miniature vibration suppression systems. Developed smart passive payload isolation systems. Ground demonstrated active acoustic attenuation system. Flight demonstrated simplified low shock separation device.

(U) $7,681 Total

(U) FY 2002 ($ in Thousands)

(U) $1,990 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) $822 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) $1,356 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) $1,303 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) $3,102 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

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) $8,573 Total

(U) FY 2003 ($ in Thousands)

(U) $1,833 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. Flight demonstrate deployment and operation of large, free-flying, lightweight, flexible, radiation resistant, array of thin film solar cells. Continue integration of 35% efficient multi-junction solar cells and 12% efficient thin film solar cells into full arrays.

(U) $925 Develop innovative space conventional energy storage technologies such as the lightweight flywheel integrated power and attitude control system. Flight demonstrate integrated attitude control and energy storage system. Develop operational microflywheel demonstration system.

(U) $1,386 Develop technologies for long-life, efficient, low vibration, lightweight mechanical cryocoolers for space applications. Continue development of high capacity multi-stage cryocooler technologies to meet the needs of high resolution, space-based infrared surveillance and tracking sensors with larger focal planes and optics.

(U) $1,324 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 multifunctional structures technologies. Complete evaluation of operational grid stiffened structures. Fabricate multifunctional spacecraft bus for small satellites. Flight demonstrate full-scale Evolved Expendable Launch Vehicle secondary payload adapter structure.

(U) $3,685 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. Flight demonstrate smart passive payload isolation systems. Ground demonstrate operational active acoustic attenuation system. Flight demonstrate passive acoustic attenuation system. Integrate low shock separation devices into multiple payload adapter. Ground demonstrate smart docking and deployment mechanisms. Continue development of modular vibration-isolating spacecraft transport container.

(U) $9,153 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 0603218C, Research and Support.

(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603410F Space Systems Environmental Interactions Technology

PROJECT: 2822

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2822 | Space Environmmental Impact Tests | 3,240 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts were transferred from this PE into PE 0603401F, Advanced Spacecraft Technology, Project 4400, Spacecraft Protection, in order to align projects within the Air Force Research Laboratory (AFRL) organization.

**(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 2001 ($ in Thousands)

(U) $1,325 Completed ground testing of space environmental sensor for flight with the Communications/Navigation Outage Forecast System (C/NOFS). Supported integration, launch, and on-orbit operations of instrumentation to provide improved space radiation hazard specification and forecasting. Completed space test of plasma sensor prototype for C/NOFS spacecraft. Completed integration of space-based, all-sky camera to detect solar disturbances. Began integration of relativistic electron and proton detector for mission to map the dynamic radiation belts and quantify the hazards to space systems.

(U) $1,017 Advanced spacecraft survivability through collaborative experiments and development of design tools needed for advanced power, communications, and surveillance systems. Completed web-based spacecraft charging design tool. Began analysis of miniaturized charge control system and space power tether system performance.

(U) $898 Developed technology to warn of spacecraft charging, chemical contamination, and kinetic impact hazards to DoD and commercial spacecraft. Developed 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. Continued compact environment anomaly sensor validation. Demonstrated new compact environment anomaly sensor capabilities for geosynchronous orbit environments on Air Force operational satellites. Began ground tests of global particle enhancement and depletion technologies.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| 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
(U) $3,240 Total

(U) FY 2002 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2003 ($ 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 3,381 | 0 | 0 | |
| (U) | Appropriated Value | 3,412 | | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -80 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -61 | | | |
| | e. Rescissions | -31 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | 0 | | |
| (U) | Current Budget Submit/FY 2003 PBR | 3,240 | 0 | 0 | TBD |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603410F Space Systems Environmental Interactions Technology |
| | PROJECT: 2822 |

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

(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.

**(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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603436F Transformational Wideband MILSATCOM

PROJECT: A006

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| A006 | Transformational Wideband MILSATCOM | 0 | 0 | 195,000 | 435,000 | 436,000 | 194,000 | 0 | 0 | 0 |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: 0603436, Transformational Wideband MILSATCOM, 63A006, Transformation Wideband MILSATCOM PE was created in order to Transform the Advanced Wideband System (PEs 63845F and 33602F) to incorporate an accelerated schedule and capabilities such as laser communications and additional protection for tactical users based on the Transformational Communications Architecture study.

**(U) A. Mission Description**

Transformational Wideband MILSATCOM(TWM) provides an opportunity to transform the current Advanced Wideband MILSATCOM System (PE's 0603845F and 0303602F) TWM programs for an accelerated schedule and capabilities such as laser communications and additional protection for tactical users (all within the emerging Transformational Communications Architecture study). TWM will initiate in FY2003 an Advanced Wideband System (AWS) that incorporates interoperable laser communications and is designed to meet the needs of the defense and intelligence communities for wideband tactical, protected tactical, broadcast, and relay communications; plan for the first launch in FY 2009. This PE addresses only acceleration of the design of the first two satellites which are accounted for in PE0603845F, and the additional capabilities. (Acceleration of procurement effort is reflected in PE 0603845F).

(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) FY 2003 ($ in Thousands)
(U) $5,000 Program Support. This New Start program is an effort to transform the current AWS by integrating laser communications into system development.
(U) $20,000 Technical Support
(U) $170,000 System Definition

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603436F Transformational Wideband MILSATCOM / PROJECT: A006 |

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

(U) FY 2003 ($ in Thousands) Continued
(U) $195,000 Total

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

Funding is in budget activity 3, Science and Technology, since this effort will support the transformation of the current Advanced Wideband System in order to incorporate laser communications.

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

| | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|
| (U) Previous President's Budget | | | | |
| (U) Appropriated Value | | | | |
| (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 | | | | |
| (U) Adjustments to Budget Years Since FY 2002 PBR | | | 195,000 | |
| (U) Current Budget Submit/FY 2003 PBR | | | 195,000 | 1,260,000 |

(U) Significant Program Changes:
FY 2003 funds added in order to begin the transformation of the current Advanced Wideband System.

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

(U) PE0603845F & PE0303602F contain the remaining funds for the Advanced Wideband Program

**(U) E. Acquisition Strategy**

Developing acquisition strategy during FY02 to add on-orbit laser comm capability. Expect to conduct market analysis to include evaluating industrial capability, currently available technology, use of advanced concept technology demonstrations, etc. Anticipate conducting full and open competition to the maximum extent feasible.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603436F Transformational Wideband MILSATCOM |
| PROJECT: A006 | |

**(U) F. Schedule Profile**

(U) This effort provides for first launch in FY 2009.

The Advanced Wideband System (AWS) will incorporate interoperable laser cross links.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603444F MAUI SPACE SURVEILLANCE SYSTEM

PROJECT: 4868

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4868 | Maui Space Surveillance System | 18,905 | 27,020 | 6,472 | 6,452 | 6,436 | 6,524 | 6,611 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**(U) A. Mission Description**

This program funds the operation and upgrading of the Maui Space Surveillance System (MSSS) in Hawaii. Note: In FY 2002, Congress added $17.4 million for the MSSS and $3.4 million for Pan-STARRS.

(U) FY 2001 ($ in Thousands)

(U) $1,950 Enhanced operational and research utility of MSSS data products. Developed, analyzed, and tested non-imaging space object identification tools for the Advanced Electro-Optical System (AEOS) sensors. Conducted studies in the feasibility of the use of the laser guidestar, and in applications for active tracking. Continued atmospheric characterization and advanced imaging algorithm development to support real-time post processing.

(U) $10,785 Provided technical support to research, development, and operational users and visiting experimenters using the MSSS assets.

(U) $3,857 Conducted upgrades for MSSS. Completed observatory control system upgrades on the 0.8 meter beam director telescope. Completed adaptive optics upgrades, sensor enhancements, and tool development. Demonstrated AEOS/MSSS enhancements through characterization and test. These upgrades significantly increased the ease-of-use and data turn-around for these telescopes.

(U) $2,313 Supported the Near Earth Asteroid Tracking mission and follow-up role on AEOS and lost satellite search. Continued non-imaging space object identification efforts and evaluation of MSSS systems to detect smaller/fainter objects.

(U) $18,905 Total

(U) FY 2002 ($ in Thousands)

(U) $3,383 Enhance operational and research utility of MSSS data products to include thermal mapping of long-wave infrared imagery. Study the feasibility of daylight imaging and active tracking with AEOS to include effects on sensor performance and safety issues. Analyze satellite orientation data for detailed characterization of space reconnaissance threats. Optimize exploitation tools and data dissemination architecture.

(U) $14,295 Provide technical support to research, development, and operational users and visiting experimenters using the MSSS assets.

(U) $3,944 Conduct and demonstrate AEOS/MSSS upgrades and enhancements. Complete the AEOS long-wave infrared imager upgrade background

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

subtraction effort by operationalizing the test code (algorithm) which will produce accurate radiometric data, temperature maps, and imagery. Upgrade radiometer to allow for simultaneous four-channel capability and increased processing speed. Improve resolution of the sensor on the 1.6-meter telescope by replacing the tracking system. Improve the reliability of the observatory control system to increase acquisition rate of targets.

(U) $2,030 Continue follow-up role on Advanced Electro-Optical System (AEOS) and lost satellite search and non-imaging space object identification to detect and characterize smaller/fainter objects.

(U) $3,368 Execute the Pan-STARRS effort. Define technical concept for execution of Pan-STARRS to include the development of advanced charged-coupled, devices (CCDs) to detect very-dim space objects up to the 24th magnitude, a telescope system that uses the CCD detectors, and the hardware/procedures to collect and display the data. Initiate data archiving to support future data collection

(U) $27,020 Total

(U) FY 2003 ($ in Thousands)

(U) $1,072 Enhance operational and research utility of the Maui Space Surveillance System (MSSS) data products. Develop improved exploitation tools and new data fusion techniques to provide real-time information and optimize system for small satellite data collection.

(U) $4,232 Provide technical support to research, development, and operational users and visiting experimenters using the MSSS assets.

(U) $1,168 Conduct upgrades for MSSS. Demonstrate AEOS/MSSS enhancements in daylight imaging to include partial daylight operations on the AEOS increasing availability for high priority taskings and new areas of research.

(U) $6,472 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|
| (U) Previous President's Budget | 19,445 | 6,484 | 6,488 | |
| (U) Appropriated Value | 19,625 | 27,284 | | |
| (U) Adjustments to Appropriated Value | | | | |
| a. Congressional/General Reductions | | -264 | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603444F MAUI SPACE SURVEILLANCE SYSTEM / PROJECT: 4868 |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | b. Small Business Innovative Research | -461 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -79 | | | |
| | e. Rescissions | -180 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -16 | |
| (U) | Current Budget Submit/FY 2003 PBR | 18,905 | 27,020 | 6,472 | TBD |

(U) Significant Program Changes:
Not Applicable.

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

(U) Related Activities:
(U) PE 0602605F, Directed Energy Technology.
(U) PE 0603605F, Advanced Weapons Technology.
(U) PE 0602500F, Multi-Disciplinary Space Technology.
(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) E. Acquisition Strategy**

Not Applicable.

**(U) F. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 0 | 0 | 50,538 | 45,417 | 52,216 | 50,381 | 52,203 | Continuing | TBD |
| 5031 | Advanced Optics & Laser Space Tech | 0 | 0 | 9,842 | 9,993 | 12,103 | 10,362 | 11,326 | Continuing | TBD |
| 5032 | Advanced Space Materials | 0 | 0 | 6,870 | 2,102 | 1,889 | 1,774 | 2,943 | Continuing | TBD |
| 5033 | Rocket Propulsion Demonstration | 0 | 0 | 26,370 | 29,169 | 30,734 | 31,141 | 31,547 | Continuing | TBD |
| 5034 | Advanced Space Sensors | 0 | 0 | 4,856 | 4,153 | 7,490 | 7,104 | 6,387 | Continuing | TBD |
| 5062 | Advanced Structures for Space Vehicles | 0 | 0 | 2,600 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities. In FY 2003, only the space unique tasks in the following PEs/Projects will be transferred to this PE in conjunction with the Space Commission recommendation: PE 0603605F, Projects 3150 and 3647, to Project 5031; PE 0603112F, Projects 2100 and 3946, to Project 5032; PE 0603216F, Project 4922, to Project 5033; and PE 0603203F, Project 665A/PE 0603270F, Projects 431G and 691X, to Project 5034.

**(U) A. Mission Description**

This program develops and demonstrates multi-disciplinary space technologies in four projects, each focusing on a separate technology area. 1) Advanced optics and laser space technology demonstrates and assesses space unique advanced optics and high energy laser weapon systems capabilities. 2) Advanced space materials develops and demonstrates materials and processing technologies for future space vehicle components and protection of space sensors from a variety of laser threats. 3) Rocket propulsion develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques for launch and spacecraft applications. 4) Advanced space sensors develops and demonstrates sensor technologies for targeting and electronic counter-countermeasures for spacecraft

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC |

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

applications.

**(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.

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 0 | 0 | 0 | |
| (U) | Appropriated Value | 0 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 50,538 | |
| (U) | Current Budget Submit/FY 2003 PBR | 0 | 0 | 50,538 | TBD |

(U) Significant Program Changes:

This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

PROJECT: 5031

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5031 Advanced Optics & Laser Space Tech | 0 | 0 | 9,842 | 9,993 | 12,103 | 10,362 | 11,326 | Continuing | TBD |

Note: In FY 2003, space unique tasks in PE 0603605F, Projects 3150 and 3647, will be transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project provides for the demonstration and detailed assessment of space unique technologies needed for advanced optics and high energy laser weapons for space mission areas. Near-term focus is on ground-based lasers for the space control mission.

(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) FY 2003 ($ in Thousands)
(U) $521 Develop optics technologies for very long-range laser beam projection, collection, and optical imaging with a space-based bifocal relay mirror. Continue design and development of brassboard laser beam control system utilizing innovative adaptive optics technology for advanced beam steering and aberration correction. Develop technology to demonstrate integration of various optical components scaled to a realistic relay mirror system. Perform theoretical analysis, modeling and simulation, and optical design of a relay mirror optical system, optimizing efficiency. Develop and build hardware associated with this task.
(U) $126 Perform directed energy and space environment vulnerability assessments on satellites in support of national Space Control and Space Situational Awareness requirements. Provide sure-safe data to U.S. Space Command for the performance of Laser Clearinghouse functions. Fuse finite state models with other satellite data and observables to produce a more complete space situational awareness posture.
(U) $9,195 Perform atmospheric compensation/beam control experiments from Starfire Optical Range 3.5-meter telescope for applications including antisatellite weapons, relay mirror systems, satellite tests and diagnostics, and high-resolution satellite imaging. Perform beam pointing and

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC | 5031 |

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

(U) FY 2003 ($ in Thousands) Continued

guidestar radiometry tests using sodium-wavelength laser beacon. Design and begin integration of full aperture point-ahead atmospheric compensation system for low-power laser projection to satellites on weapons-class beam director (3.5-meter telescope). Demonstrate high-accuracy active satellite tracking on 3.5m telescope with simultaneous compensated satellite imaging and compensated laser projection to a low-earth-orbit satellite (integrated beam control demonstration).

(U) $9,842 Total

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

Not Applicable.

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

(U) PE 0602500F, Multi-Disciplinary Space Technology.
(U) PE 0602605F, Directed Energy Technology.
(U) PE 0603444F, Maui Space Surveillance System.
(U) PE 0603605F, Advanced Weapons Technology.
(U) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

PROJECT: 5032

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5032 Advanced Space Materials | 0 | 0 | 6,870 | 2,102 | 1,889 | 1,774 | 2,943 | Continuing | TBD |

Note: In FY 2003, space unique tasks in PE 0603112F, Projects 2100 and 3946, will be transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project develops and demonstrates materials technologies for transition into Air Force space systems. The laser hardened materials project develops materials technologies for the broadband protection of space sensors from a variety of laser threats. The world laser market is rapidly expanding with easy export to any nation. Survivability solutions must account for a variety of lasers facing a mission. To harden systems against all potential lasers, a combination of approaches is required. The space materials transition task provides critical data for prospective users to make engineering decisions on both structural and non-structural materials for space. Reducing risk in materials technology improves the affordability, reliability, survivability, and operational performance of current and future space systems.

(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) FY 2003 ($ in Thousands)
(U) $1,559 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. Complete the demonstration of 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 affordability of spacecraft components. Validate measured effects of space exposure on advanced material systems.
(U) $1,411 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. Demonstrate hybrid optical limiters for the protection of mid-wave infrared staring

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC | PROJECT: 5032 |

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

(U) FY 2003 ($ in Thousands) Continued

focal plane arrays. Demonstrate hardened coating process for Rugate fixed-wavelength filters and optical switches for mid-wave infrared space systems. Conduct tests of hardening solutions for critical space sensor designs and environments based on successful approaches employed in tactical sensors. Identify and evaluate optical limiter materials for the protection of near-infrared to short-wave infrared staring focal plane arrays. Identify coating materials and processes for filters and optical switches for long-wave infrared space systems.

(U) $3,900 Develop and demonstrate advanced materials and processing technologies to enable revolutionary improvements in the performance of airbreathing and rocket-based aerospace vehicles and weapons. Identify and evaluate cryogenic fluid compatible material and affordable processing technologies for large, lightweight, potentially load bearing tank structures for airbreathing and rocket-based vehicles. Evaluate and characterize ceramic and organic-based composite materials for durable, very high temperature aerospace vehicle and weapon leading edges.

(U) $6,870 Total

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

Not Applicable.

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

(U) PE 0602102F, Materials.
(U) PE 0602500F, Multi-Disciplinary Space Technology.
(U) PE 0603112F, Advanced Materials for Weapon Systems.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

PROJECT: 5033

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5033 Rocket Propulsion Demonstration | 0 | 0 | 26,370 | 29,169 | 30,734 | 31,141 | 31,547 | Continuing | TBD |

Note: In FY 2003, space unique tasks in PE 0603216F, Project 4922, will be transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project develops advanced and innovative low-cost rocket turbomachinery and components, low-cost space 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 stationkeeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program will improve the performance of expendable systems' payload capabilities by ~20 percent and reduce the launch and operations and support 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 program, a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national space launch needs.

(U) 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 February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC | 5033 |

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

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $12,032 | Develop liquid rocket propulsion technology for current and future space launch vehicles. Initiate fabrication of turbopumps for integration into an advanced hydrocarbon booster engine. Commence testing in an advanced hydrocarbon test-bed engine. |
| (U) | $3,715 | Develop solar thermal and solar electric propulsion technologies for existing and future upper stage and orbit transfer vehicles. 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-earth-orbit transfer. Initiate testing of the advanced small satellite propulsion demonstration to develop microsatellite formation flying capability for Air Force imaging requirements. |
| (U) | $3,711 | Develop propellant technologies for the sustainment of strategic systems. Continue testing of the Post Boost Control System program to demonstrate component technologies with available materials to reduce hardware costs and maintain system performance. Continue testing Strategic Sustainment Demonstration program technologies that integrates advanced propellant, case, and nozzle technologies and demonstrates cost and performance goals. |
| (U) | $412 | Develop electric propulsion technologies for satellite formation flying, stationkeeping, and repositioning. Complete brass board level testing of a pulsed plasma thruster system. Initiate hot fire testing of the thruster integrated with the power processing unit. Continue development of propulsion system for Air Force small satellites (<100kg) required for key Air Force Space Command concepts. Initiate acceptance and verification testing of flight hardware for formation flying demonstration spacecraft. |
| (U) | $6,500 | Component level evaluation of reusable hydrocarbon boost technology to support rocket-based combined cycle engines. Components to be evaluated are consistent with Integrated High Payoff Rocket Propulsion Technology Phase II hydrocarbon boost demonstration in FYs 2005-2006. Determines rocket component technology to be integrated into future combined cycle engine development, as well as hydrocarbon engine components for highly reusable launch. |
| (U) | $26,370 | Total |

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC | PROJECT: 5033 |

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

(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.
(U) PE 0602500F, Multi-Disciplinary Space Technology.
(U) PE 0602601F, Spacecraft Technology.
(U) PE 0603114N, Power Projection Advanced Technology.
(U) PE 0603216F, Aerospace Propulsion Power Technology.
(U) PE 0603401F, Advanced Spacecraft Technology.
(U) PE 0603853F, Evolved Expendable Launch Vehicle Program.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

PROJECT: 5034

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5034 Advanced Space Sensors | 0 | 0 | 4,856 | 4,153 | 7,490 | 7,104 | 6,387 | Continuing | TBD |

Note: In FY 2003, space unique tasks in PE 0603203F, Project 665A, and PE 0603270F, Projects 431G and 691X, will be transferred into this project in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project develops and demonstrates space sensor technologies, including radio frequency (RF) sensors, electro-optical sensors, laser warning sensors, targeting and attack radar sensors, and electronic counter-countermeasures (ECCM). By developing multi-function radar, laser, electronic combat (EC), and ECCM technologies for space applications, this project provides space platforms with the capability to precisely detect, track, and target air- and ground-based high-value, time-critical targets, while remaining invulnerable to hostile and natural threats.

(U) FY 2001 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2003 ($ in Thousands)
(U) $186 Develop a signature analysis capability to evaluate the physical/chemical origins of paint/camouflage thermal reflectance features, and to develop a forward predictive capability validated with empirical measurements. Perform chemical analyses and develop an enhanced surface scattering model. Develop and validate a baseline predictive signature prediction model for space qualified hyperspectral electro-optical sensors.
(U) $991 Develop and demonstrate technologies to maximize Global Positioning System (GPS) jam resistance, positional accuracy, timing accuracy, and exploitation techniques to improve offensive and defensive combat capabilities. Design advanced M-Code technologies. Develop reference technologies to operate in space to provide precise time, position, and velocity for multiple platforms. Demonstrate virtual flight test technology for improved assessment of GPS anti-jam technologies.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC | 5034 |

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

(U) FY 2003 ($ in Thousands) Continued

| | | |
|---|---|---|
| (U) | $430 | Develop and demonstrate advanced wide-band EC RF receiver encoding/pre-processing/sorting concepts and techniques to handle increasing digitization of the modern complex RF signal environment for applications in existing and future space EC systems. These concepts and techniques will stress reconfigurability, modularity, interconnectivity and affordability by using advanced digital technologies, such as Field Programmable Gate Arrays. Initiate requirements analysis, and hardware and software designs of future space electronic combat systems. |
| (U) | $1,632 | Complete study of and continue developing space-based support jamming technologies and techniques that will counter advanced radio frequency threats. Continue developing and assessing physical requirements for applying these technologies in space unique environments. |
| (U) | $1,617 | Complete design of space hardened processor, geo-location, and spectrometer modules. Develop space laser warning sensor technologies for timely alert to advanced laser acquisition/tracking sensors, including detecting and locating both high power (dazzle/damage) and low power (laser-guided ordnance) signals. Complete false alarm package hardware and begin integration onto flight platform. Complete false alarm test planning. Continue risk reduction analysis for space hardened geo-location, spectrometer, and processor modules. Initiate fabrication of space laser warning sensor modules. |
| (U) | $4,856 | Total |

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

Not Applicable.

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

(U) PE 0602204F, Aerospace Sensors.
(U) PE 0602500F, Multi-Disciplinary Space Technology.
(U) PE 0603203F, Advanced Aerospace Sensors.
(U) PE 0603270F, Electronic Combat Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC

PROJECT: 5062

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 5062 Advanced Structures for Space Vehicles | 0 | 0 | 2,600 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: This is a new PE, but not a New Start, resulting from the Space Commission recommendation to consolidate all space unique activities. Outyear funding profiles will be addressed in future budget activities.

**(U) A. Mission Description**

This project identifies, develops, and demonstrates the technologies to enable advanced access-to-space aerospace vehicles that deliver revolutionary capability, operability, responsiveness, and cost effectiveness. Enabling technologies include thermal protection, structures, vehicle systems, configurations, aerodynamics, and controls. Technology demonstration includes multi-disciplinary system level integration of the enabling technologies.

(U) FY 2001 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2002 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2003 ($ in Thousands)
(U) $2,600 Develop the airframe and payload technologies required to enable next generation reusable access to space systems including the thermal protection, structural, configuration and vehicle and payload system technologies that enable aerospace vehicles to exhibit revolutionary capability, operability, responsiveness, and cost effectiveness. Investigate integration of the multidisciplinary technologies required to design and demonstrate these aerospace vehicle configurations such as materials, munitions, human effectiveness, and both rocket- and airbreathing-based hypersonic propulsion.
(U) $2,600 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 | |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603500F MULTI-DISCIPLINARY ADV DEV SPACE TEC | PROJECT: 5062 |

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

(U) PE 0602500F, Multi-Disciplinary Space Technology

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 21,398 | 39,729 | 38,001 | 25,017 | 22,859 | 23,312 | 23,765 | Continuing | TBD |
| 670A | Ordnance Technology | 21,398 | 12,399 | 18,158 | 15,967 | 14,111 | 14,380 | 14,650 | Continuing | TBD |
| 670B | Guidance Technology | 0 | 27,330 | 19,843 | 9,050 | 8,748 | 8,932 | 9,115 | Continuing | TBD |
| | Quantity of RDT&E Articles | 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.

**(U) A. Mission Description**

This program develops, demonstrates, and integrates ordnance and advanced guidance technologies for air-launched conventional weapons. The program includes two projects: (1) development of conventional ordnance technologies including warheads, fuzes, and explosives; and (2) development of advanced guidance technologies including seekers, navigation and control, and guidance. Note: In FY 2002, Congress added $3.8 million to the Low-Cost Autonomous Attack System (LOCAAS) program.

**(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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 22,523 | 37,617 | 23,827 | |
| (U) | Appropriated Value | 22,731 | 40,117 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -388 | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| | b. Small Business Innovative Research | -534 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -591 | | | |
| | e. Rescissions | -208 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | 14,174 | |
| (U) | Current Budget Submit/FY 2003 PBR | 21,398 | 39,729 | 38,001 | TBD |

(U) Significant Program Changes:

FY 2003 increases are due to increased emphasis of Project 670A for Advanced Energetics and Payload Delivery Capability and Tunnel Defeat Weapons Concept, plus increased emphasis for Project 670B to further enhance the Low-Cost Autonomous Attack System Advanced Technology Demonstration flight test program.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology

PROJECT: 670A

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 670A Ordnance Technology | 21,398 | 12,399 | 18,158 | 15,967 | 14,111 | 14,380 | 14,650 | Continuing | 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.

**(U) A. Mission Description**

This project develops, demonstrates, and integrates ordnance technologies for enhancing the effectiveness of air-launched conventional weapons. The project develops conventional ordnance including warheads, fuzes, explosives, carriage and release, and munition integration technologies. This project improves capability for conventional ordnance supporting an Air Expeditionary Force.

(U) FY 2001 ($ in Thousands)

(U) $4,040 Developed and demonstrated advanced conventional armament warhead technologies, including heavy metal liners, dense metal cases, and less sensitive explosives. These warhead technologies improved target penetration capabilities, enhanced kill probability against fragmentation sensitive targets, reduced sorties to improve pilot survivability, and increased aircraft longevity. Ground tested a chemical and biological defeat warhead to characterize effectiveness against production and storage capabilities. Continued developing and evaluating concepts for neutralizing a broad spectrum of chemical and biological agents. Fabricated 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 Developed and demonstrated advanced air-delivered munition fuze technologies. These fuze technologies improved munitions effectiveness, and allowed smaller warheads and munition airframes, thereby increasing strike aircraft load-outs and improving sortie effectiveness. Conducted initial field test of multiple-event, hard-target fuze component design. Developed component design of an integrated fuze, improved target detection device, and directional warhead package.

(U) $2,489 Developed innovative air-delivered munition carriage and release equipment, miniature weapon release concepts, and airframe size reduction concepts. The innovative concepts provided 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. Continued Unmanned Combat Air Vehicle miniature munition integration and planning support for the flight test demonstration. Completed ground and flight test of a small munition dispenser.

(U) $2,495 Developed and demonstrated advanced conventional armament seeker technologies. These advanced seeker technologies were applied to the development of miniature munitions. The advanced seeker had the capability to autonomously detect, acquire, and guide to targets of interest

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

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. Developed preliminary design of a terminal, laser radar seeker for a miniature munition that will be effective against high value fixed targets. Fabricated and captive flight tested a low-cost, tactical sized laser radar terminal seeker for miniature munitions compatible with Unmanned Combat Air Vehicle.

(U) $2,410 Developed and demonstrated advanced conventional armament navigation and control technologies that provided increased armament navigation accuracy, improved standoff range, enhanced weapon control and operation in electronic jamming environments. Initiated interface design between target detection device, fuze, directional warhead, and weapon terminal guidance seeker. Completed design and fabrication of an integrated laser radar terminal seeker and Global Positioning System/Inertial Navigation System (GPS/INS) navigation and control system.

(U) $4,984 Integrated advanced conventional guidance technologies that provided 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 enhanced the effectiveness of miniature munitions against both mobile and hardened fixed ground targets to reduce sortie rates, improved mission effectiveness, and reduced collateral damage. Completed flight readiness review and final subsystem integration of an autonomous guidance seeker against ground fixed and mobile targets. Conducted free flight tests and analyzed flight test data of a powered miniature munition with integrated laser radar seeker and GPS/INS guidance to validate design and determine target false alarm rate.

(U) $21,398 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

(U) $3,123 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 integration technologies 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. Design a low-cost, precision-guided weapon with a Circular Error Probable of 1.4 meter.

(U) $12,399 Total

(U) FY 2003 ($ in Thousands)

(U) $6,812 Develop and demonstrate advanced conventional armament warhead technologies, including heavy metal liners, dense metal cases, and insensitive 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. Begin designing a unitary warhead penetrator capable of damaging weapons of mass destruction production and storage facilities with minimum collateral damage. Continue design and begin fabrication of a weapon capable of high-speed penetration of extremely hard targets by integrating a new warhead case technology, insensitive explosive, and multiple-event fuze. Begin a program to mature design of advanced reactive materials such as nano-scale aluminum.

(U) $6,715 Develop and demonstrate advanced air-delivered munitions fuze and mass focusing warhead technologies to improve munition effectiveness, allowing smaller warheads and munition airframes, thereby improving sortie effectiveness and increasing strike aircraft load-outs. Develop a fuzing capability that will transmit function data from penetrating weapons through various hard target mediums. Continue cooperative program with the United Kingdom to design an integrated fuze, an improved target detection device, and a directional warhead package. Continue design of a fuze using Microwave Monolithic Integrated Circuit technologies that will give burst accuracy of 0.5 meter for weapons that have closure rates up to 2,500 meters per second. Begin design trades for a precision-guided munitions with precise, time-of-arrival attributes that can be used to defeat hard and deeply buried targets. Simultaneous delivery of multiple, precise, time-of-arrival munitions will be used to overpower protective tunnel doors, destroying tunnel contents with intruding blast pressures.

(U) $4,631 Develop and demonstrate conventional munition subsystem and platform integration technologies. These integration 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 integration technologies will increase weapon load-outs and improve sortie effectiveness for current and future strike aircraft while reducing munition

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603601F Conventional Weapons Technology | 670A |

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

(U) FY 2003 ($ in Thousands) Continued

airlift requirements. Initiate design of a low-cost, precision-guided weapon with a Circular Error Probable of 1.4 meters and lethal effectiveness against 85% of the MK-83 and BLU-109 targets.

(U) $18,158 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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology

PROJECT: 670B

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 670B Guidance Technology | 0 | 27,330 | 19,843 | 9,050 | 8,748 | 8,932 | 9,115 | Continuing | 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.

**(U) A. Mission Description**

This 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 weapon 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 2001 ($ in Thousands)

(U) $0 This work was performed in Project 670A.

(U) $0 Total

(U) FY 2002 ($ in Thousands)

(U) $2,251 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 terminal seeker for a miniature munition that will be effective against high-value fixed and mobile targets.

(U) $2,133 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 laser radar terminal seeker and Global Positioning System/Inertial Navigation System (GPS/INS) navigation and control system.

(U) $3,146 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603601F Conventional Weapons Technology / PROJECT: 670B |

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

(U) FY 2002 ($ in Thousands) Continued

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 laser radar seeker and GPS/INS guidance to demonstrate design and determine target false alarm rate.

(U) $19,800 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 and preparing the LOCAAS flight test vehicle for carriage and release from a tactical fighter aircraft. Other ATD tasks will include 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 evaluating electronic safe and arm fuzing.

(U) $27,330 Total

(U) FY 2003 ($ in Thousands)

(U) $2,784 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. Begin developing a low-cost, laser radar seeker using DARPA-developed fixed, detector array technology.

(U) $1,932 Develop and demonstrate advanced conventional armament navigation and control technologies to increase armament navigation accuracy, improve stand off range, enhance weapons control, and operation in electronic jamming environments. Develop interface between a target detection device, fuze, directional warhead, and weapon terminal guidance seeker. Develop a munition navigation system using micro-electromechanical system technology to provide an accurate (less than one meter), miniature (less than 25 cubic inches), and affordable (less than $6,000 per unit) Global Positioning System/Inertial Measurement Unit navigation system.

(U) $4,127 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. Begin development and fabrication of a low-cost seeker, guidance hardware, and autonomous target recognition software for a small bomb to attack mobile and re-locatable targets.

(U) $11,000 Enhance the current LOCAAS ATD program by adding more flight and ground testing. Additional LOCAAS ATD tasks include flight testing

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603601F Conventional Weapons Technology | 670B |

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

(U) FY 2003 ($ in Thousands) Continued

of a LOCAAS with a live warhead to demonstrate that the integrated technologies perform as expected. Also, the ATD will include separating the LOCAAS flight test vehicle from a tactical fighter aircraft. Other ATD tasks will include continuing automatic target recognition algorithm development, designing the LOCAAS datalink to improve cooperative attack and communicate bomb damage assessment to the command and control network, and evaluating electronic safe and arm fuzing.

(U) $19,843 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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 41,407 | 66,905 | 28,271 | 32,420 | 33,998 | 37,305 | 38,140 | Continuing | TBD |
| 3150 | Advanced Optics Technology | 14,869 | 22,178 | 260 | 898 | 1,121 | 3,277 | 3,350 | Continuing | TBD |
| 3151 | High Power Solid State Laser Technology | 3,582 | 5,410 | 8,830 | 14,566 | 15,437 | 16,133 | 16,439 | Continuing | TBD |
| 3152 | High Power Microwave Technology | 8,022 | 11,114 | 12,952 | 11,614 | 11,765 | 11,954 | 12,117 | Continuing | TBD |
| 3647 | High Energy Laser Technology | 14,934 | 28,203 | 6,229 | 5,342 | 5,675 | 5,941 | 6,234 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2003, space unique tasks in Projects 3150 and 3647 will be transferred to PE 0603500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This PE provides for the development and demonstration of advanced directed energy and optical concepts that are not space unique. In solid state lasers, compact, reliable, relatively high power, cost-effective single devices and arrays of devices are demonstrated. In high power microwaves, technologies such as narrowband and wideband devices and antennas are demonstrated. In high energy lasers, technologies such as high power chemical lasers and beam control technologies are demonstrated. Note: In FY 2002, Congress added $7 million for Geo Light Imaging National Testbed (GLINT), $1.7 million for sodium wavelength laser, $1.7 million for Manufacturing Analysis for the Advanced Tactical Laser, $6.4 million for the Aerospace Relay Mirror System, $8.5 million for the Field Laser Demonstration Upgrades, and $1.5 million for Laser Spark Countermeasures.

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 42,973 | 43,758 | 37,744 | |
| (U) | Appropriated Value | 43,371 | 67,558 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -653 | | |
| | b. Small Business Innovative Research | -1,018 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -548 | | | |
| | e. Rescissions | -398 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -9,473 | |
| (U) | Current Budget Submit/FY 2003 PBR | 41,407 | 66,905 | 28,271 | TBD |

(U) Significant Program Changes:

In FY 2002, Congress added $7 million for Geo Light Imaging National Testbed (GLINT), $1.7 million for sodium wavelength laser, $1.7 million for Manufacturing Analysis for the Advanced Tactical Laser, $6.4 million for the Aerospace Relay Mirror System, $8.5 million for the Field Laser Demonstration Upgrades, and $1.5 million for Laser Spark Countermeasures.

Decrease in FY 2003 is due to space unique efforts being moved to PE 0603500F.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

PROJECT: 3150

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3150 Advanced Optics Technology | 14,869 | 22,178 | 260 | 898 | 1,121 | 3,277 | 3,350 | Continuing | |

Note: In FY 2003, space unique tasks in Project 3150 will be transferred to PE 0603500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project develops advanced optical technologies for locating, identifying, and analyzing distant and dim objects such as geosynchronous orbit satellites. 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 adaptive optics and specialized optical processing are being developed. The goal is high quality optical image reconstruction, concentrating on removing turbulent atmosphere-induced distortions. In addition to the primary defense applications, many of the technologies have significant astronomy research applications.

(U) FY 2001 ($ in Thousands)

(U) $197 Developed advanced optical technologies for correction of laser beams for projection and optical imaging applications. Demonstrated beam control technologies applicable to space-based systems in a controlled laboratory environment with laboratory scaled breadboards and components. These technologies support applications such as target acquisition, tracking and pointing, target designation, and remote sensing. Advances were made in the ability to project a wide range of laser wavelengths and powers in a single optical system and in minimizing the number of optical components to reduce weight and complexity with the goal of making large space-based optical systems viable.

(U) $184 Investigated advanced concepts to deploy and use large space-based mirrors for applications such as imaging, laser beam projection, and laser beam relay. Continued to pursue component development of advanced optical 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) $7,727 Continued to develop technologies for active imaging of geosynchronous space objects. Continued development and integration of hardware for the Geo Light Imaging National Testbed (GLINT) at White Sands Missile Range, NM. Developed/tested operating procedures and software for passive identification of satellites in support of GLINT experiments.

(U) $6,761 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. Investigated laser imaging of ground targets from unmanned aerial vehicles or satellites for standoff intelligence

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603605F Advanced Weapons Technology |
| | PROJECT<br>3150 |

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

(U) FY 2001 ($ in Thousands) Continued

detection.

(U) $14,869 Total

(U) FY 2002 ($ in Thousands)

(U) $489 Develop and laboratory test advanced adaptive optical technologies to support beam stabilization, imaging applications, and target acquisition, tracking, and pointing applications. Explore liquid crystal technology for advanced adaptive optics to demonstrate non-mechanical beam steering in scaled laboratory environment. Technology development work is aimed at reducing weight, power consumption, and complexity of optical systems to enable their use in space platforms.

(U) $6,338 Develop technologies for an aerospace relay mirror. Develop and optimize techniques for dual line of sight pointing from two separate telescopes in space and autonomous alignment of two telescopes. Design an optical payload to perform beam characterization and clean up. Develop point ahead beacon technology.

(U) $6,933 Develop technologies for active imaging of geosynchronous space objects. Continued development and integration of hardware for the Geo Light Imaging National Testbed (GLINT) at White Sands Missile Range, NM. Develop/test operating procedures and software for passive identification of satellites in support of GLINT experiments.

(U) $8,418 Continue to explore the utility of an operational Field Laser Demonstrator laser radar integrated with the Advanced Electro-Optical System for deep space metric and space object identification missions, microsatellite tracking and ballistic missile defense discrimination. Continue technology development with the objective of providing compact, remote sensing systems for integration onboard unmanned aerial platforms for a variety of battlefield surveillance mission applications.

(U) $22,178 Total

(U) FY 2003 ($ in Thousands)

(U) $260 This project previously included space unique efforts which have been transferred to PE 0603500F, Multi-disciplinary Space Advanced Development Technology. These funds represent the civilian salaries for the work effort transferred and they will be transferred at a later date.

(U) $260 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603605F Advanced Weapons Technology | 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) PE 0603883C, Ballistic Missile Defense Boost Phase Segment.

(U) PE 0602500F, Multi-Disciplinary Space Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

PROJECT: 3151

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 3151 | High Power Solid State Laser Technology | 3,582 | 5,410 | 8,830 | 14,566 | 15,437 | 16,133 | 16,439 | Continuing | |

**(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 payoff. Near-term goals include developing compact, reliable infrared sources that can be used for a range of applications including night vision systems, landing zone markers, remote sensing, and covert communication systems. Longer-term goals focus on producing compact, significantly higher power sources that could be applied to military weapons-type applications including aircraft self-protection. This project leads the development of, and builds upon, a wide range of commercial advancements. Commercially available solid state lasers are widely used due to their low-cost, small size and weight, high reliability, and high efficiency in converting electricity to laser energy. This project preserves these attractive features while continually scaling output to higher powers and efficiencies and to military application-specific wavelengths. This project is divided into two technology areas. The first area investigates methods to develop low-cost, scalable, high power solid state lasers. This effort builds upon a strong industrial technology base. Secondly, wavelength specific solid state lasers for military applications such as infrared countermeasures are developed.

(U) FY 2001 ($ in Thousands)

(U) $1,852 Developed low-cost, scalable, high power solid state laser architectures by integrating 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. Demonstrated a fiber laser module, with no free space optical elements, at several tens of watts of power.

(U) $1,037 Developed and demonstrated laser source and beam control technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Continued 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 Developed and demonstrated novel target coupling technologies needed to counter current and next generation air-to-air and surface-to-air missile threats. Demonstrated novel device structures and incoherent beam combining techniques for improving beam quality, required for fast jet aircraft and large aircraft self-protection.

(U) $3,582 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603605F Advanced Weapons Technology | PROJECT<br>3151 |

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

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $1,712 | Develop low-cost, scalable, high power solid state laser architectures by integrating 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. Begin work to demonstrate high electrical efficiency (approaching 30%) and beam combining at high power to enable applications requiring high power lasers. Demonstrate coherent beam combining of two 100 watt amplifiers showcasing the building block technology of future directed energy, weapons-class electric lasers. Demonstrate wavelength-versatile integrated laser/nonlinear optics at five watt power levels. Continue development of an all-fiber solution, with no free space optical elements, at power levels approaching 100 watts. |
| (U) | $2,835 | Develop and demonstrate laser source needed to counter current air-to-air and surface-to-air missile threats. Demonstrate a multi-wavelength source (two and four microns) with sufficient brightness, based on novel device structures and incoherent beam combining techniques developed in FY 2001, for countering current generation threats to aircraft platforms. |
| (U) | $863 | Develop and demonstrate high-energy laser and beam control, technologies for airborne tactical applications, including air-to-air and surface-to-air scenarios. Technologies being addressed include lasers for long-range detection of targets in clutter and advanced beam control to control platform vibration, atmospheric jitter, and aero-optic effects. Initiate laser effect testing using a multi-kilowatt laser to determine required energy levels for tactical applications that address next generation threats. |
| (U) | $5,410 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,951 | Demonstrate low-cost, scalable, high power solid state laser architectures by integrating 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 (goal greater than 30%) and coherent beam combining to enable applications requiring high power lasers. Demonstrate coherent beam combining to achieve one kilowatt and integration technologies for multiple fiber laser modules at moderate powers. Demonstrate wavelength-versatile integrated laser/non-linear optics at 10 watt power levels. Continue development of an all-fiber solution, with no free space optical element, at power levels greater than 100 watts. |
| (U) | $3,351 | Develop and demonstrate laser source technologies needed to counter current air-to-air and surface-to-air missile threats. Demonstrate a reliable and compact multispectral (bands I, II, and IV), solid state laser for countering current generation threats to aircraft platforms. |
| (U) | $528 | Develop and demonstrate high-energy laser technologies for airborne tactical applications, including air-to-air and surface-to-air scenarios. Technologies being addressed include lasers for long-range detection of targets in clutter, high-power compact lasers, and advanced beam control to control platform vibration, atmospheric jitter, and aero-optic effects. Complete laser effects testing using a multi-kilowatt laser to |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology | PROJECT: 3151 |

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

(U) FY 2003 ($ in Thousands) Continued

determine required energy levels for tactical applications that address next generation threats.

(U) $8,830 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 0603270F, Electronic Combat Technology.
(U) PE 0602605F, Directed Energy Technology.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

PROJECT: 3152

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 3152 | High Power Microwave Technology | 8,022 | 11,114 | 12,952 | 11,614 | 11,765 | 11,954 | 12,117 | Continuing | |

**(U) A. Mission Description**

This project develops high power microwave (HPM) generation and transmission technologies that support a wide range of Air Force missions such as the potential denial, degradation, damage, or destruction of an adversary's electronic infrastructure and military capability. These targeted capabilities include local computer and communication systems as well as large and small air defense and command and control systems. In many cases this effect can be generated covertly with no collateral structural or human damage. Millimeter wave force protection technologies are also developed. It also develops a susceptibility/vulnerability/lethality data base to identify potential vulnerabilities of U.S. systems to HPM threats and to provide a basis for future offensive and defensive 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.

(U) FY 2001 ($ in Thousands)

(U) $3,416 Developed and demonstrated HPM technologies to render inoperative electronic components of an adversary's integrated air defense system. Demonstrated and quantified the effectiveness of a repetitively pulsed system against electronic targets of interest. Conducted a full power breadboard demonstration to validate repetitively pulsed capability application development.

(U) $2,997 Developed and demonstrated HPM technologies to render inoperative command and control components of an adversary. Conducted field experiments with brassboard devices to demonstrate command and control warfare effectiveness. Investigated setup of ground-based, field experiments demonstrating effectiveness of air-delivered HPM sub-munition. Applied computer codes to predict coupling to targets and validate their accuracy.

(U) $1,609 Developed, demonstrated, and evaluated active denial technology for several non-lethal mission applications including future peacekeeping assignments. Began human testing demonstrations of vehicle-mounted non-lethal directed energy weapons technology. Continued investigations for man-portable applications. Analyzed critical technologies for airborne active denial applications, including beam control, source efficiency, antenna gain, and aircraft integration.

(U) $8,022 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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)

| | | |
|---|---|---|
| (U) | $4,370 | Develop and demonstrate narrowband high power microwave (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. Select repetitively pulsed HPM technology for multi-gigawatt application development. Evaluate narrowband technologies to address aircraft protection against surface to air missiles. 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. |
| (U) | $2,178 | Conduct effects experimentation on targets to refine 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. 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. |
| (U) | $2,066 | Develop and evaluate active denial technologies for non-lethal weapons applications. Continue analysis of critical technologies for airborne active denial. Investigate test cell development of millimeter wave source for airborne applications. |
| (U) | $2,500 | Develop the means to integrate HPM devices onto unmanned aerial platforms. 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 concept. |
| (U) | $11,114 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $4,970 | Develop and demonstrate narrowband HPM technologies to disrupt, degrade, damage, or destroy an adversary's electronic systems. Demonstrate pulsed power and narrowband HPM source capability applicable to munitions and airborne concepts. Demonstrate a repetitively pulsed gigawatt-class HPM experiment. Conduct wideband field experiments with integrated compact devices to demonstrate effectiveness of wideband HPM for munitions and airborne electronic attack. Conduct initial ground-based, field experiments demonstrating effectiveness of air-delivered HPM munitions. |
| (U) | $2,270 | Continue effects experimentation to expand database and support susceptibility predictions. Apply computer codes to predict coupling to targets and validate their accuracy. Continue to investigate and develop models to quantify the effectiveness of a narrowband repetitively |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603605F Advanced Weapons Technology | 3152 |

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

(U) FY 2003 ($ in Thousands) Continued

pulsed system against electronic targets of interest applicable to munitions or airborne platforms.

(U) $2,012 Develop and evaluate active denial technologies for non-lethal weapons applications. Demonstrate next generation vehicle-mounted non-lethal weapons technology. Begin development of millimeter wave source for airborne applications.

(U) $3,700 Develop the means to integrate high power microwave (HPM) devices onto unmanned aerial platforms. Continue integration and target studies for such concepts while beginning investigation of thermal control issues. Define the vehicle integration environment for a HPM device. Investigate the feasibility of using ultra-wideband HPM to geolocate and identify targets of interest, and perform battle damage assessment. Continue to perform lethality assessments of HPM on targets of interest to gauge the military utility and effectiveness of the integrated HPM concept.

(U) $12,952 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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology

PROJECT: 3647

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 3647 High Energy Laser Technology | 14,934 | 28,203 | 6,229 | 5,342 | 5,675 | 5,941 | 6,234 | Continuing | |

Note: In FY 2003, space unique tasks in Project 3647 will be transferred to PE 0603500F in conjunction with the Space Commission recommendation to consolidate all space unique activities.

**(U) A. Mission Description**

This project provides for the development, demonstration, and detailed assessment of technology needed for high energy laser weapons that are not space unique. Near-term focus is on airborne high energy laser missions, although the technology developed for this project is directly applicable to most high energy laser applications. Critical technologies developed and demonstrated include advanced high energy laser devices and laser beam control to efficiently compensate and propagate laser radiation through the atmosphere to a target. Correcting the laser beam for distortions induced by propagation through the turbulent atmosphere is the key technology in most high energy laser applications. Detailed computational models to establish high energy laser weapon effectiveness and target vulnerability are developed.

(U) FY 2001 ($ in Thousands)

(U) $664 Performed vulnerability assessments on potential high energy laser targets to provide critical design data for laser systems to defeat these targets. Reviewed/developed the system-level deny/disrupt/damage/destroy criteria for counterspace high energy laser systems, based on new data from satellite vulnerability assessments. Transitioned an improved tool for the analysis of high-resolution optical images to the National Air Intelligence Center.

(U) $5,849 Performed atmospheric compensation/beam control experiments from Starfire Optical Range 3.5-meter telescope for ground-based platforms to support applications including antisatellite weapons, satellite health and diagnostics, and high-resolution satellite imaging. Continued characterization of return signals from laser illuminated satellites to design system for active (laser-illuminated) tracking of unaugmented low earth orbit satellites. Analyzed data from previous satellite imaging and tracking experiments for design of 24-hour laser beam control system. Designed a target-loop atmospheric compensation system for laser projection to satellites on weapons-class beam director (3.5-meter telescope). Modeled and analyzed long-path atmospheric effects for design of advanced adaptive optics for low-elevation compensation of lasers and imaging.

(U) $5,449 Developed and evaluated enhanced beam control/compensation techniques for atmospheric attenuation and distortion on laser beam propagation from airborne platforms for applications such as theater missile defense. Continued computer simulation of additional advanced concepts for active tracking and atmospheric compensation using adaptive optics under propagation conditions representative of typical

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology / PROJECT: 3647 |

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

(U) FY 2001 ($ in Thousands) Continued

airborne laser engagement scenarios. Conducted advanced active tracking and adaptive optics laboratory experiments using representative turbulence phase screens. Performed passive tracking demonstrations, anisoplanatism studies, and common-path/common-mode studies. Developed and integrated 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 Continued to investigate the LaserSpark missile countermeasure technology. Developed and demonstrated the infrared countermeasures effectiveness of the multiple internal laser effects (MILE) associated with plasma/sparks. Continued laboratory testing of MILE on advanced focal plane array seeker mockups using properly formatted laboratory lasers. Developed flyout simulations of MILE on conical scan and focal plane array seekers. Continued design planning and coordination for a limited field demonstration of aimpoint control and countermeasure effectiveness on in-flight seekers.

(U) $14,934 Total

(U) FY 2002 ($ in Thousands)

(U) $498 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) $8,413 Perform atmospheric compensation/beam control experiments from the Starfire Optical Range 3.5-meter telescope for applications including antisatellite weapons, relay mirror systems, satellite health and diagnostics, and high-resolution satellite imaging. Perform compensated laser propagation to satellite targets and use the detailed measurements of energy and beam profile on target to characterize anisoplanatic effects and validate propagation models. Design and begin integration of laser beam control system using active tracking and target return loop adaptive optics with higher bandwidth signal processing and enhanced data capture capabilities. Integrate scoring laser and sensors for integrated beam control demonstration. Design Rayleigh beacon point-ahead atmospheric compensation system for laser projection to satellites on weapons-class beam director (3.5-meter telescope).

(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. These efforts will enhance high energy laser delivery from an airborne laser weapon system to missile targets. Develop and demonstrate in the laboratory advanced tracking and adaptive optics methods to mitigate the negative optical turbulence effects on an uncompensated high energy laser beam under propagation conditions scaled to represent those expected in airborne laser engagements. Begin wave-optics simulation of two wavefront sensors to enhance the ability to correct for

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology | PROJECT: 3647 |

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

(U) FY 2002 ($ in Thousands) Continued

atmospheric disturbances. Update wave-optics computer simulations based on field test results to more effectively evaluate and improve subsequent advanced concepts.

(U) $2,067 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. 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) $1,683 Develop and analyze technology that supports manufacturing of the Advanced Tactical Laser (ATL). Collect vibration data on appropriate aircraft to better understand the dynamic disturbances that would be encountered on an ATL. Evaluate other effects, such as thermal blooming and aero-optical aberrations, that have the potential to severely limit an ATL's performance. Evaluate designs and manufacturing capability for compact inertial reference units, including upgrades to the Stabilized Inertial Measurement System stable platform, to reject base motion disturbances due to aircraft vibration and acoustics.

(U) $1,486 Continue to investigate the LaserSpark missile Infrared Countermeasure (IRCM) technology and develop/demonstrate the infrared countermeasure effectiveness of the multiple internal laser effects (MILE) associated with plasma/sparks. Conduct critical experiments on components and subsystems to establish error budgets and performance specifications. Continue testing of MILE on advanced focal plane array seeker mockups. Assess IRCM effectiveness on flyout simulations of MILE on conical scan and focal plane array seekers. Conduct laboratory hardware experiments to validate flyout modeling and anchor computer simulations.

(U) $1,684 Fabricate brassboard sodium-wavelength laser to be used as mesospheric beacon for adaptive optics systems on large-aperture telescopes. Design and begin radiometry experiments to characterize sodium beacon performance. Begin design of hybrid beacon adaptive optics system combining sodium and Rayleigh laser beacons for atmospheric compensation of large telescopes at visible and near-infrared wavelengths.

(U) $28,203 Total

(U) FY 2003 ($ in Thousands)

(U) $1,192 This project previously included space unique efforts which have been transferred to PE 0603500F, Multi-disciplinary Space Advanced Development Technology. These funds represent the civilian salaries for the work effort transferred and they will be transferred at a later date.

(U) $371 Perform vulnerability assessments on potential high energy laser targets to provide critical design data for laser systems to defeat these targets.

(U) $3,564 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. These efforts will enhance high energy laser delivery from an airborne laser

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603605F Advanced Weapons Technology |
| PROJECT: 3647 | |

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

(U) FY 2003 ($ in Thousands) Continued

weapon system to missile targets. Demonstrate advanced tracking methods and adaptive optics compensation techniques that double the Strehl ratio (peak intensity on target) in stressing atmospheric turbulence. Evaluate the performance of various wavefront sensors to maximize the ability to correct for atmospheric disturbances. Assess candidate advanced track algorithms to increase stability of the high power beam on target. Initiate demonstration and evaluation of the compensated beacon illumination technique. Anchor wave optics propagation code to the demonstrated beam control performance.

(U) $1,102 Develop and demonstrate the technology for scalable, high energy laser devices with improved efficiency for insertion in airborne lasers and other potential weapon applications. Continue to evaluate and optimize multiple high pressure ejector nozzles performance using modeling and simulation and laboratory nozzle test stand evaluations. Begin integration of most promising iodine injection and iodine generation methods into an advanced chemical oxygen iodine test sequence utilizing a laboratory test stand.

(U) $6,229 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 0603883C, Ballistic Missile Defense Boost Phase Segment.

(U) PE 0602500F, Multi-Disciplinary Space Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space Technology.

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

(U) The technology efforts in this PE that are supporting future enhancements to airborne lasers have been coordinated with the Airborne Laser program office.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603723F Environmental Engineering Technology

PROJECT: 2103

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2103 | Environmental Quality Technology | 968 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | TBD |
| | Quantity of RDT&E Articles | 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 in FY 2000 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) A. Mission Description**

This program develops and demonstrates advanced technologies to address Air Force-unique environmental compliance, site remediation, and pollution prevention problems.

(U) FY 2001 ($ in Thousands)
(U) $968 Develop technologies for Joint Environmental Clean-up.
(U) $968 Total

(U) FY 2002 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

(U) FY 2003 ($ in Thousands)
(U) $0 No Activity
(U) $0 Total

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

This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates advanced technologies to address Air Force-unique environmental problems.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | | DATE: February 2002 |
|---|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603723F Environmental Engineering Technology | PROJECT: 2103 |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 991 | 0 | 0 | |
| (U) | Appropriated Value | 1,000 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -23 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -9 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | 0 | | |
| (U) | Current Budget Submit/FY 2003 PBR | 968 | 0 | 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 in FY 2000 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.
(U) PE 0604708F, Other Operational Equipment.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603723F Environmental Engineering Technology | 2103 |

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

(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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 6,964 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 2810 | Advanced Image/Information/Optical Memory Technology Applications | 4,053 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| 4850 | Collaborative C2 | 2,911 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note: In FY 2002, efforts in Projects 2810 and 4850 move into PE 0603789F Projects 4072 and 4925, respectively, as part of the Air Force Science and Technology (S&T) PE realignment.

**(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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration |

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

| | | FY 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 7,361 | 0 | 0 | |
| (U) | Appropriated Value | 7,429 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | | | |
| | b. Small Business Innovative Research | -175 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -222 | | | |
| | e. Rescissions | -68 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |
| (U) | Current Budget Submit/FY 2003 PBR | 6,964 | 0 | 0 | TBD |

(U) Significant Program Changes:

In FY 2002, efforts in this PE move to PE 0603789F, Projects 4072 and 4925.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration

PROJECT: 2810

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 2810 | Advanced Image/Information/Optical Memory Technology Applications | 4,053 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, efforts move into PE 0603789F, Project 4072 as part of the Air Force Science and Technology (S&T) PE realignment.

**(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 2001 ($ in Thousands)

(U) $1,030 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) $1,822 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) $1,201 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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 2001 ($ in Thousands) Continued

interactive simulation for distributed mission training.

(U) $4,053 Total

(U) FY 2002 ($ in Thousands)

(U) $0 Efforts move to PE 0603789F, Project 4072.

(U) $0 Total

(U) FY 2003 ($ 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 0602702F, Command, Control, and Communications (C3).

(U) PE 0603789F, C3I Advanced Development.

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

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable

.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603726F Aerospace Info Tech Sys Integration

PROJECT: 4850

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4850 Collaborative C2 | 2,911 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: In FY 2002, efforts move into PE 0603789F, Project 4925 as part of the Air Force Science and Technology (S&T) PE realignment.

**(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 2001 ($ in Thousands)

(U) $1,017 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) $934 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) $960 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) $2,911 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | | DATE: February 2002 |
|---|---|---|
| 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) FY 2003 ($ 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 0602702F, Command, Control, and Communications (C3).
(U) PE 0603789F, C3I Advanced Development.
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

**(U) D. Acquisition Strategy**

Not Applicable.

**(U) E. Schedule Profile**

(U) Not Applicable.

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

| | COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 18,252 | 33,217 | 34,288 | 36,190 | 32,728 | 32,921 | 33,283 | Continuing | TBD |
| 4072 | Dominant Battlespace Awareness | 9,411 | 11,128 | 16,093 | 15,765 | 12,244 | 12,478 | 12,716 | Continuing | TBD |
| 4216 | Battlespace Information Exchange | 3,889 | 11,640 | 6,984 | 6,564 | 6,602 | 6,729 | 6,856 | Continuing | TBD |
| 4872 | Dynamic Aerospace C2 & Execution | 4,952 | 7,436 | 9,303 | 11,549 | 11,963 | 11,757 | 11,717 | Continuing | TBD |
| 4925 | Collaborative C2 | 0 | 3,013 | 1,908 | 2,312 | 1,919 | 1,957 | 1,994 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Continuing | TBD |

Note: 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.

**(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 (C2) project provides the technology and demonstrations needed to establish virtual, distributed 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 products of this program will be technologies needed to build the capability to dynamically plan and replan over a secure network. Note: In FY 2002,

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603789F C3I Advanced Development |

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

Congress added $1.7 million for Adaptive Information Protection Technologies and $3.0 million for Information Hiding, Steganography, and Digital Watermarking for Information Protection and Authentication 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 19,289 | 32,273 | 34,497 | |
| (U) | Appropriated Value | 19,468 | 33,542 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | | -325 | | |
| | b. Small Business Innovative Research | -257 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | -780 | | | |
| | e. Rescissions | -179 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | -209 | |
| (U) | Current Budget Submit/FY 2003 PBR | 18,252 | 33,217 | 34,288 | TBD |

(U) Significant Program Changes:

Not Applicable..

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

PROJECT: 4072

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4072 | Dominant Battlespace Awareness | 9,411 | 11,128 | 16,093 | 15,765 | 12,244 | 12,478 | 12,716 | 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 2001 ($ in Thousands)

(U) $1,504 Developed passive exploitation algorithms to enhance the identification of time-critical targets. Exploited information in acoustic, image, and signal intelligence to identify targets for situational awareness and targeting. Developed the technologies to use multiple source correlation of sensor reports to perform target identification and optimize allocation of sensor resources.

(U) $1,618 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, identify, and track moving air and ground targets, and to detect and track targets employing camouflage, concealment, and deception techniques. Continued 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 Developed and demonstrated 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. Demonstrated 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. Demonstrated a two times improvement in high performance computing software affordability through the continued maturation of software standards, such as Vector Signal Image Processing Library and Message Processing Interface, which serve to protect the software investment over hardware generations.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603789F C3I Advanced Development |
| | PROJECT<br>4072 |

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

(U) FY 2001 ($ in Thousands) Continued

(U) $2,915 Continued to develop advanced fusion technology to evaluate the capability of Unmanned Combat Aerial Vehicles 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. Developed and demonstrated command and control (C2) technologies for the dynamic C2 of multiple vehicles under a highly dynamic mission environment. Developed and demonstrated, 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 Developed and demonstrated technologies to support the affordable Unmanned Combat Aerial Vehicle unit recurring flyaway goal in a C4ISR data-rich environment as part of an integrated C3 network. Initiated the integration of the C2 software elements into the Mission Control Station and UCAV air vehicle. State-of-the-art tools were used to maximize the reuse of software components.

(U) $9,411 Total

(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) $6,519 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 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603789F C3I Advanced Development |
| PROJECT<br>4072 | |

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

(U) FY 2002 ($ in Thousands) Continued

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) $11,128 Total

(U) FY 2003 ($ in Thousands)

(U) $4,168 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 image, and measurement and signature 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.

(U) $8,928 Develop and demonstrate advanced data and information fusion capabilities to support multi-source capabilities, 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. Demonstrate fusion systems and architectures capable of exploiting multiple sources to find, fix, identify, and track moving air and ground targets, and to detect and track targets employing camouflage, concealment, and deception techniques. 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. Initiate collaborative collection and fusion of intelligence, surveillance, and reconaissance information to improve accuracy and timeliness for situational awareness and targeting.

(U) $2,997 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 in-time situational awareness. Continue development of tools for timeline, event, and motion pattern recognition to support analysis, visualization, and decision aids to detect enemy activity. Continue to develop probabilistic approaches for accumulation of data/information to support target/activity identification and situational awareness. Develop 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 of sensor resources.

(U) $16,093 Total

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

Not Applicable.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603789F C3I Advanced Development | 4072 |

**(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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

PROJECT: 4216

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4216 | Battlespace Information Exchange | 3,889 | 11,640 | 6,984 | 6,564 | 6,602 | 6,729 | 6,856 | Continuing | TBD |

**(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 2001 ($ in Thousands)

(U) $807 Designed, developed, integrated, and demonstrated advanced expert system decision algorithms to prioritize and control resources for global reach in a mobility environment. Continued 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. Demonstrated to AMC the capabilities to perform heterogeneous data base access and mission/user profiles under a web-based architecture.

(U) $416 Designed, developed, integrated, and demonstrated modular, reprogrammable radio communications technologies for commercial and military global reach in an airborne mobility environment. Continued 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) $644 Designed, developed, integrated, and demonstrated 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. Continued to develop technology to dynamically reconfigure the network and communications systems to optimally match the requirements for information transfer with changing transmission path availability. Demonstrated the capability to perform adaptive routing, quality-of-service based architecture, and smart bandwidth management.

(U) $773 Developed and demonstrated 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. Developed and demonstrated an Intelligent Adaptive Communications Controller system to efficiently and effectively control the use of diverse

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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) Continued

communications media to provide increased aggregate bandwidth. Developed and integrated applications to provide mechanisms that intelligently and dynamically negotiate quality of service and bandwidth management techniques between applications and network transport services. Developed and integrated management mechanisms to provide dynamic, intelligent, management, and control of information system resources.

(U) $462 Developed and demonstrated intelligent networking technology to provide assured, seamless, battlespace connectivity to the aerospace forces with a greatly reduced footprint. Continued to develop a capability to support a multilevel secure information system manager. Developed and demonstrated 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) $787 Developed and demonstrated theater battle management and time-critical air operations technologies to provide field commanders essential operational decision support and rapid response capabilities. Completed weather impact decision aid capability and developed space weather impact decision aid capability. Developed master caution panel capability to centrally monitor and manage command and control assets.

(U) $3,889 Total

(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) $1,206 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,

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

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) $1,379 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) $1,191 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) $2,934 Develop and demonstrate an information assurance decision support system to provide real time defensive courses-of-action relating to 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. Develop and demonstrate Adaptive Information Protection Technologies that will allow systems to tolerate adversary attacks and intrusions, gracefully degrade, recover and reconstitute not only the system but also the critical processes, programs and data.

(U) $3,000 Develop and demonstrate Information Hiding, Steganography and Digital Watermarking for Information Protection and Authentications Systems. Develop stegongraphic algroithms that detect if infomation and information systems have been tampered with and demonstrate this capability in Air Force operational systems.

(U) $11,640 Total

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603789F C3I Advanced Development |
| | PROJECT: 4216 |

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

(U) FY 2003 ($ in Thousands)

(U) $1,295 Develop, integrate, and demonstrate advanced expert system decision algorithms to prioritize and control resources for global reach in a mobility environment. Continue to demonstrate an intelligent information manager agent that will throttle and regulate mission information flow among AMC components based on changing system capabilities. Continue to integrate in an Air Mobility Command airlifter the airborne components of Intelligent Information Manager, Integrated Network Controller, and the Global Media Access Controller to produce a combined commercial/military global communications system, a dynamically switched network, and an intelligent heterogeneous database access interface to prioritize and control resources in a mobility environment.

(U) $1,304 Develop, integrate, and demonstrate advanced network protocols and commercial management technologies to provide communications from deployed aircraft and ground elements to the Air Mobility Command (AMC) Tanker Airlift Control Center (TACC), as well as, in-transit visibility at the TACC of all aircraft, personnel, and cargo. Continue to demonstrate technology to dynamically reconfigure the network and communications systems to optimally match the requirements for information transfer with changing transmission path availability. Continue to integrate and demonstrate the ground-based components of the Intelligent Information Mannager, Integrated Network Controller, and Global Media Access Controller in AMC's TACC and AMC's forward deployed unit, the Tanker Airlift Control Element, resulting in a seamless information infrastructure providing total asset visibility and enhanced situation awareness.

(U) $1,000 Develop and demonstrate improved global networking and resource management technologies that provide reliable efficient, secure, interoperable, and dynamic deployable communications to Air Combat Command. Complete the adaptive communications controller system(s), integrating additional and emerging media types for increased bandwidth capability. Continue development and integration of mechanisms that intelligently and dynamically negotiate quality of service and bandwidth between applications and network transport services based on mission priorities. Complete development of affordable multi-level secure network management capabilities to provide commanders with status and control of information grid network resources.

(U) $1,411 Develop and demonstrate intelligent wireless networking technologies to provide seamless and assured connectivity to all aerospace forces while reducing the forward-deployed footprint. Continue to 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). Develop and demonstrate beyond line of sight wideband technologies between airborne platforms and ground terminals.

(U) $1,008 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 development and demonstrate technologies that integrate, illuminate, and manage command and control (C2) assets within the air operations center C2 process. Develop and demonstrate advanced application and network technologies that provide the capability to monitor, understand, and maintain the status of distributed C2 weapon systems. Continue

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603789F C3I Advanced Development |
| PROJECT: 4216 | |

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

(U) FY 2003 ($ in Thousands) Continued

development of interface methodologies for seamless integration of theater battle management applications into the joint battlespace infosphere.

(U) $966 Develop and demonstrate an information assurance decision support system to provide real-time defensive courses-of-action relating to intrusion detection, intrusion response, and information system recovery. Demonstrate data correlation and data fusion tools for detection of large-scale coordinated attacks, and provide automatic forensics analysis of attack information. Develop the capability to assess attacks and sophistication of the threat level against the mission. Initiate development and demonstration of automated deployment of defensive counter measures.

(U) $6,984 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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

PROJECT: 4872

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4872 | Dynamic Aerospace C2 & Execution | 4,952 | 7,436 | 9,303 | 11,549 | 11,963 | 11,757 | 11,717 | Continuing | TBD |

**(U) A. Mission Description**

In order to perform command, control, and execution for the Expeditionary Aerospace Force (EAF), the Air Force must be able to plan, assess, monitor, and replan missions rapidly in a dynamic environment. This project develops and demonstrates technologies necessary for dynamic command and control (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 2001 ($ in Thousands)

(U) $1,373 Developed and demonstrated 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. Developed the effects-based operations capability through active template technologies to provide recommended priorities, resource availability, and provide the information to the battle managers in time to achieve mission objectives. Developed and demonstrated 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) $1,594 Developed and demonstrated 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. Developed 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. Developed and integrated 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) $1,985 Developed and demonstrated knowledge-based intelligent information tools to support robust, real-time, large-scale aerospace C2 systems.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| 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

Demonstrated knowledge-based C2 technologies in support of continuous planning and scheduling. Developed and integrated planning and information-based intelligent agents for adaptive replanning. Developed and demonstrated 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) $4,952 Total

(U) FY 2002 ($ in Thousands)

(U) $1,928 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 Command and Control (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 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 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

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE February 2002 |
|---|---|
| BUDGET ACTIVITY<br>03 - Advanced Technology Development | PE NUMBER AND TITLE<br>0603789F C3I Advanced Development |
| | PROJECT<br>4872 |

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

(U) FY 2002 ($ in Thousands) Continued

Command's info-centric environment.

(U) $7,436 Total

(U) FY 2003 ($ in Thousands)

(U) $2,066 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. Demonstrate 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 effects-based tools to operate in the battlespace infosphere that will allow the commander and his/her staff to make decisions with uncertain, ambiguous, or vague information during the course of an aerospace campaign. Develop a dynamic tasking toolkit that enables the warfighter to develop a comprehensive, coherent, and integrated joint aerospace operations plan.

(U) $2,213 Develop and demonstrate distributed Command and Control (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 demonstrate multi-user collaborative interaction technology for adaptive visualization and presentation to enhance joint force battle plan simulation, assessment, and implementation focused on aerospace operations within the battlespace infosphere. Continue to 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. Develop embedded training technologies to provide rapid mission readiness for the warfighter.

(U) $2,257 Develop and demonstrate knowledge-based intelligent information tools to support robust, real-time, large-scale aerospace C2 systems. Continue to develop and integrate planning and information-based intelligent agents for adaptive replanning. Continue to develop and demonstrate improved integrated flight management capabilities for mobility operations such as an improved search, retrieval, and handling of data and information required for optimal use of available mobility resources. Develop and demonstrate continuous updating of the type, location, and status of DoD transportation assets to improve situational awareness

(U) $2,767 Continue to develop and demonstrate the techniques to produce and manage information objects within the joint battlespace infosphere (JBI) from numerous web-enabled information sources, to customize information products, and to deliver decision-quality information to any warfighter. Develop and demonstrate data system wrapper technologies to dynamically integrate disparate command and control, intelligence, surveillance, and reconnaissance information systems into the JBI. Evaluate and integrate core JBI information management services that

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|

| BUDGET ACTIVITY | PE NUMBER AND TITLE | PROJECT |
|---|---|---|
| 03 - Advanced Technology Development | 0603789F C3I Advanced Development | 4872 |

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

(U) FY 2003 ($ in Thousands) Continued

enable information exchange among disparate information systems.

(U) $9,303 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: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603789F C3I Advanced Development

PROJECT: 4925

| COST ($ in Thousands) | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| 4925 Collaborative C2 | 0 | 3,013 | 1,908 | 2,312 | 1,919 | 1,957 | 1,994 | Continuing | TBD |

Note: 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 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) $1,016 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 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.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit) | DATE: February 2002 |
|---|---|
| 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

(U) $3,013 Total

(U) FY 2003 ($ in Thousands)

(U) $255 Develop and demonstrate next generation distributed collaborative environments, and integrated aerospace information architectures. Continue to develop next generation collaborative environments, and integrated aerospace information architectures for advanced Air Force enterprises. Demonstrate technology to perform platform information mining and collaborative environments for simulation-based acquisition.

(U) $906 Develop communications technology to increase aerospace platform information transfer capacity. Continue to develop technology to increase aerospace platform information transfer capacity exchange of time-critical threat, sensor, and command and control (C2) information between aircraft and cooperating space, airborne, and surface communication assets. Complete the design and begin the fabrication of high capacity, bandwidth efficient, modem technology for point-to-point and multiple platform connectivity.

(U) $747 Develop and demonstrate embedded information system technologies to support a transparent framework for seamless, rapid insertion of battlespace infosphere technology. Continue to develop techniques for inserting battlespace infosphere technology that do not require a comprehensive re-test of the entire C2 system. Continue to develop capability for modernization of aerospace and C2 platforms to support system-of-systems interoperability within the battlespace infosphere.

(U) $1,908 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.

**THIS PAGE INTENTIONALLY LEFT BLANK**

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

DATE: February 2002

BUDGET ACTIVITY: 03 - Advanced Technology Development

PE NUMBER AND TITLE: 0603876F Space Based Laser

PROJECT: 4779

| COST ($ in Thousands) | | FY 2001 Actual | FY 2002 Estimate | FY 2003 Estimate | FY 2004 Estimate | FY 2005 Estimate | FY 2006 Estimate | FY 2007 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| 4779 | Space Based Laser | 67,522 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 136,447 |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In FY 2002, efforts were transferred to Ballistic Missile Defense Organization (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 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 will 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 with space 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 - FY2001. This project is classified as Budget Activity 3 because the Integrated Flight Experiment (IFX) is a technology demonstration.

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | DATE: February 2002 |
|---|---|
| BUDGET ACTIVITY: 03 - Advanced Technology Development | PE NUMBER AND TITLE: 0603876F Space Based Laser | PROJECT: 4779 |

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

(U) FY 2001 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $59,821 | Continued IFX Development |
| (U) | $500 | Continued Advanced Mirror System Development |
| (U) | $250 | continued Lethality, Analysis & Architecture (AFSPC and AFRL efforts) |
| (U) | $6,950 | Provided IFX Program Support |
| (U) | $67,521 | Total |

(U) FY 2002 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $0 | No activity - Program transferred to BMDO effective in FY02 |
| (U) | $0 | Total |

(U) FY 2003 ($ in Thousands)

| | | |
|---|---|---|
| (U) | $0 | No Activity - Program transferred to BMDO effective FY02 |
| (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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Previous President's Budget | 72,544 | 0 | 0 | TBD |
| (U) | Appropriated Value | 73,216 | 0 | | |
| (U) | Adjustments to Appropriated Value | | | | |
| | a. Congressional/General Reductions | -513 | | | |
| | b. Small Business Innovative Research | -5,023 | | | |
| | c. Omnibus or Other Above Threshold Reprogram | | | | |
| | d. Below Threshold Reprogram | | | | |
| | e. Rescissions | -159 | | | |
| (U) | Adjustments to Budget Years Since FY 2002 PBR | | | | |

| RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit) | | DATE: February 2002 |
|---|---|---|
| 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 2001 | FY 2002 | FY 2003 | Total Cost |
|---|---|---|---|---|---|
| (U) | Current Budget Submit/FY 2003 PBR | 67,521 | 0 | 0 | TBD |

(U) Significant Program Changes:
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 to BMDO

**(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

**THIS PAGE INTENTIONALLY LEFT BLANK**