PE NUMBER: 0603216F
PE TITLE: Aerospace Propulsion and Power Technology

## Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2006

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

| | Cost ($ in Millions) | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Program Element (PE) Cost | 76.110 | 97.163 | 115.546 | 119.310 | 128.770 | 134.887 | 137.886 | Continuing | TBD |
| 10SP | Space Rocket Prop Demo | 0.000 | 0.000 | 27.858 | 29.597 | 34.410 | 38.574 | 39.766 | 0.000 | 0.000 |
| 2480 | Aerospace Fuels | 0.345 | 0.193 | 2.868 | 4.811 | 5.237 | 5.344 | 5.442 | Continuing | TBD |
| 3035 | Aerospace Power Technology | 4.701 | 8.702 | 5.652 | 6.135 | 4.613 | 4.707 | 4.796 | Continuing | TBD |
| 4921 | Aircraft Propulsion Subsystems Int | 21.026 | 32.953 | 14.334 | 25.149 | 27.261 | 27.828 | 28.350 | Continuing | TBD |
| 4922 | Space & Missile Rocket Propulsion | 5.200 | 8.011 | 4.839 | 4.859 | 5.272 | 5.382 | 5.484 | Continuing | TBD |
| 5098 | Advanced Aerospace Propulsion | 23.004 | 22.882 | 34.167 | 22.832 | 23.838 | 24.331 | 24.789 | Continuing | TBD |
| 681B | Advanced Turbine Engine Gas Generator | 21.834 | 24.422 | 25.828 | 25.927 | 28.139 | 28.721 | 29.259 | Continuing | TBD |

Note: In FY 2005-2007, a portion of the funding in Projects 2480 and 4921 was shifted to Project 5098. In FY 2007, Project 310SP, Space Rocket Propulsion Demonstration, will transfer from PE 0603500F, Multi-Disciplinary Advanced Development Space Technology, Project 5033, Rocket Propulsion Demonstration, in order to more effectively manage and provide oversight of the efforts.

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

This program develops and demonstrates technologies to achieve enabling and revolutionary advances in turbine, advanced cycle, and rocket propulsion, as well as power generation and storage, and fuels. The program has six projects, each focusing on technologies with a high potential to enhance the performance of existing and future Air Force weapons systems. The Aerospace Fuels and Atmospheric Propulsion project develops and demonstrates improved hydrocarbon fuels and advanced propulsion systems for high-speed/hypersonic flight. The Aerospace Power Technologies project develops and demonstrates power and thermal systems for weapons and aircraft. The Advanced Turbine Engine Gas Generator (ATEGG) project develops and demonstrates core turbine engine technologies for current and future aircraft propulsion systems. The Aerospace Propulsion Subsystem Integration project integrates the engine cores demonstrated in the ATEGG project with low-pressure components into demonstrator engines. Turbine engine propulsion projects within this program are part of the Integrated High Performance Turbine Engine Technology and the Versatile Affordable Advanced Turbine Engine programs. The Advanced Aerospace Propulsion project develops the scramjet propulsion cycle to a technology readiness level appropriate for in-flight demonstration and for full integration with other engine cycles (including turbine and rocket based). Finally, the Space and Missile Rocket Technology project develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques. Rocket propulsion projects within this program are part of the Integrated High Payoff Rocket Propulsion Technology program, which includes the area of Technology for the Sustainment of Strategic Systems. Note: In FY 2006, Congress added $1.7 million for Advanced Satellite Thermal Control Program, $1.0 million for Field Renewable Energy System Hybrids (FRESH) Li Ion Battery Program, $2.1 million for More Electric Technology for Mission Critical Power Systems, $1.5 million for Solid Boost Power Technology, $6.0 million for VAATE (Versatile Affordable Advanced Turbine Engine) Advanced Supersonic Cruse Missile Engine, $1.2 million for Versatile Affordable Advanced Turbine Engine -- 5K-7K Trust Category, $6.8 million for Versatile Affordable Advanced Turbine Engine (Note: Only for the XTC 58F/1 Demonstrator Program), and $1.0 million for X-43C Development. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

| Exhibit R-2, RDT&E Budget Item Justification | DATE February 2006 |
|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology |

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

| | | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | Previous President's Budget | 86.050 | 77.268 | 86.690 |
| (U) | Current PBR/President's Budget | 76.110 | 97.163 | 115.546 |
| (U) | Total Adjustments | -9.940 | 19.895 | |
| (U) | Congressional Program Reductions | | | |
| | Congressional Rescissions | -0.066 | -1.405 | |
| | Congressional Increases | | 21.300 | |
| | Reprogrammings | -7.699 | | |
| | SBIR/STTR Transfer | -2.175 | | |
| (U) | Significant Program Changes: | | | |

Not Applicable.

C. Performance Metrics

(U) Under Development.

| Exhibit R-2a, RDT&E Project Justification | | DATE: February 2006 |
|---|---|---|
| BUDGET ACTIVITY: 03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE: 10SP Space Rocket Prop Demo |

| Cost ($ in Millions) | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|
| 10SP Space Rocket Prop Demo | 0.000 | 0.000 | 27.858 | 29.597 | 34.410 | 38.574 | 39.766 | 0.000 | 0.000 |
| Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

Note: In FY 2007, efforts will transfer from PE 0603500F, Aerospace Propulsion and Power Technology, Project 5033, Space Rocket Propulsion Demonstration, to this Project in order to more effectively manage and provide oversight of the efforts.

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

This project develops and demonstrates advanced and innovative low-cost rocket turbomachinery and components, low-cost space launch propulsion system technologies, and advanced propellants for launch and orbit transfer propulsion. Additionally, this project develops technologies for the Technology for Sustainment of Strategic Systems Phase 1. Characteristics such as environmental acceptability, affordability, reliability, responsiveness, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. This project also develops chemical, electrical, and solar rocket propulsion system technologies for stationkeeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program could improve the performance of expendable systems' payload capabilities by approximately20 percent, and reduce launch, operations, and support costs by approximately 30 percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Technology advances could also lead to seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload. The efforts in this project contribute to the Integrated High Payoff Rocket Propulsion Technology program (IHPRPT), a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national space launch needs.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Develop liquid rocket propulsion technology for current and future space launch vehicles. | 0.000 | 0.000 | 21.166 |
| (U) In FY 2005: Not Applicable. | | | |
| (U) In FY 2006: Not Applicable. | | | |
| (U) In FY 2007: Complete testing of advanced lightweight thrust chamber and nozzle technologies. Continue scale-up of advanced cryogenic upper stage technologies including higher efficiency energy conversion systems. Begin studies for advanced hydrocarbon engine technologies for future reusable launch vehicles. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Develop solar electric propulsion technologies for existing and future satellites, upper stages, orbit transfer vehicles, and satellite formation flying, station keeping, and repositioning. | 0.000 | 0.000 | 4.069 |
| (U) In FY 2005: Not Applicable. | | | |
| (U) In FY 2006: Not Applicable. | | | |
| (U) In FY 2007: Continue development of electric propulsion systems for orbit-transfer by developing high-power Hall | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>10SP Space Rocket Prop Demo |

**(U) B. Accomplishments/Planned Program ($ in Millions)**

| | | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| | thrusters capable of Low Earth Orbit to Geosynchronous Orbit transfer. Begin component integration for the high-power Hall thruster demonstration. Complete support of test flight of the advanced small satellite propulsion demonstration unit for a microsatellite demonstration. Support test flight of propulsive attitude control system microsatellite demonstration. Initiate hardware scale-up for an advanced dual mode (high thrust or high efficiency) hybrid propulsion system for satellites. Continue development of technologies for satellite sensors to analyze satellite thruster interactions. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Develop electric and advanced chemical based monopropellant propulsion technologies for future satellite propulsion systems. Phases are referring to IHPRPT program phases. | 0.000 | 0.000 | 2.623 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Not Applicable. | | | |
| (U) | In FY 2007: Initiate development of an advanced Phase III monopropellant thruster. | | | |
| (U) | Total Cost | 0.000 | 0.000 | 27.858 |

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

| | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| (U) Not applicable. | | | | | | | | | |

**(U) D. Acquisition Strategy**

Not Applicable.

# Exhibit R-2a, RDT&E Project Justification

DATE: February 2006

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT NUMBER AND TITLE: 2480 Aerospace Fuels

| Cost ($ in Millions) | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2480 Aerospace Fuels | 0.345 | 0.193 | 2.868 | 4.811 | 5.237 | 5.344 | 5.442 | Continuing | TBD |
| Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

Note: In FY 2005-2007, a portion of the funding in this project was shifted to Project 5098 in this PE due to higher Air Force priorities.

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

This project develops and demonstrates improved hydrocarbon fuels and advanced, novel aerospace propulsion systems, including systems for high-speed/hypersonic flight and technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. The advanced fuel emphasis is on developing and demonstrating new thermally stable, high-heat sink, and controlled chemically reacting fuels for a conventional turbine engine, turbine-based combined cycle engines, and other advanced propulsion systems. The project also develops and demonstrates fuel system components that minimize cost, reduce maintenance, and improve performance of future aerospace systems. The advanced propulsion emphasis is on demonstrating concepts for combined cycle, ramjet, and scramjet engines. This project is integrated into the Versatile Affordable Advanced Turbine Engine program.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Demonstrate thermally stable fuels and fuel system hardware concepts to enhance cooling capacity (performance), minimize fuel coking, and reduce fuel system maintenance. | 0.056 | 0.025 | 1.001 |
| (U) In FY 2005: Conducted a study, test, and demonstration at a pilot-light level, of advanced high heat sink fuels and hardware concepts that can increase fuel delivery system durability and performance at high temperatures and reduce maintenance due to fuel degradation in an aircraft fuel system and engine control hardware. | | | |
| (U) In FY 2006: Continue to study, test, and demonstrate at a pilot-light level, advanced high heat sink fuels including those produced from alternative energy resources and hardware concepts that can increase engine performance at high temperatures, improve fuel system durability, and reduce maintenance due to fuel degradation in aircraft and engine hardware. | | | |
| (U) In FY 2007: Continue to study, test, and demonstrate, advanced high heat sink fuels including those produced from alternative energy resources and hardware concepts that can increase engine performance at high temperatures, improve fuel system durability, and reduce maintenance due to fuel degradation in aircraft and engine hardware. Initiate demonstrations of fuel performance at fuel temperatures in the supercritical regime. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Determine fuel cooling requirements and specifications for advanced aircraft sensors and directed energy weapons that will meet the needs of evolving manned systems and unmanned aerial vehicle (UAVs). | 0.136 | 0.025 | 0.506 |
| (U) In FY 2005: Conducted pilot-light level demonstrations of low temperature additives for use in jet fuel to allow advanced manned and unmanned systems to sustain high altitude loiter for extended periods with focus on combustion performance of additized fuels | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>2480 Aerospace Fuels |

| | B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | In FY 2006: Continue, at a pilot-light level, to study, test, and demonstrate advanced fuels for UAV applications including advanced low temperature fuels and fuels to enable extended range and duration. | | | |
| (U) | In FY 2007: Demonstrate advanced low temperature and enhanced performance fuels for UAV applications focusing on technologies that expand the flight envelope, range, or duration of UAVs to include advanced thermal management concepts. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Develop and demonstrate efficacy of low-cost, environmentally friendly fuel additives to reduce soot particulate emissions from gas turbine engines using advanced research combustors and small turbine engines. | 0.056 | 0.025 | 0.506 |
| (U) | In FY 2005: Conducted pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent. | | | |
| (U) | In FY 2006: Continue pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent. | | | |
| (U) | In FY 2007: Demonstrate advanced additives to reduce soot and nitrogen oxides emissions in advanced propulsion concepts including combined cycle engines. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Develop and demonstrate enhancements to fuel system technology. | 0.053 | 0.025 | 0.349 |
| (U) | In FY 2005: Conducted pilot-light level design and development of hardware and fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling. | | | |
| (U) | In FY 2006: Continue pilot-light level design and development of hardware and fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling. | | | |
| (U) | In FY 2007: Continue design, development, and demonstration of hardware and fuel system simulators to evaluate key high temperature fuel system components of reusable aerospace vehicles focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of cooling. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Expeditionary Air Force. | 0.044 | 0.093 | 0.506 |
| (U) | In FY 2005: Conducted pilot-light development of novel methods including bio- and nano-technology for fuel analysis. | | | |
| (U) | In FY 2006: Continue pilot-light development of novel methods including bio- and nano-technology for fuel analysis. | | | |
| (U) | In FY 2007: Demonstrate advanced nano-technology fuel additives, nano-technology fuel sensors, and novel | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>2480 Aerospace Fuels |

**(U) B. Accomplishments/Planned Program ($ in Millions)**

| | | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| | detection and mitigation technologies for biological growth. | | | |
| (U) | | | | |
| (U) | Total Cost | 0.345 | 0.193 | 2.868 |

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

| | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| (U) Related Activities: | | | | | | | | | |
| (U) PE 0602203F, Aerospace Propulsion. | | | | | | | | | |
| (U) PE 0602102F, Materials. | | | | | | | | | |
| (U) PE 0602204F, Aerospace Sensors. | | | | | | | | | |
| (U) PE 0603112F, Advanced Materials for Weapons Systems. | | | | | | | | | |
| (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. | | | | | | | | | |

**(U) D. Acquisition Strategy**

Not Applicable.

# Exhibit R-2a, RDT&E Project Justification

DATE: **February 2006**

BUDGET ACTIVITY: **03 Advanced Technology Development (ATD)**

PE NUMBER AND TITLE: **0603216F Aerospace Propulsion and Power Technology**

PROJECT NUMBER AND TITLE: **3035 Aerospace Power Technology**

| Cost ($ in Millions) | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|
| 3035 Aerospace Power Technology | 4.701 | 8.702 | 5.652 | 6.135 | 4.613 | 4.707 | 4.796 | Continuing | TBD |
| Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

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

This project develops and demonstrates electrical power generation, energy storage, thermal management, and distribution systems for aerospace applications. This technology enhances reliability and survivability, and reduces vulnerability, weight, and life cycle costs for manned and unmanned aerospace vehicles. The electrical power system components developed are projected to provide a two- to five-fold improvement in aircraft reliability and maintainability, and a 20 percent reduction in power system weight. This project also develops and demonstrates high power generation, energy storage, and thermal management technologies to enable high power density sources for directed energy weapons.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Develop power generation and conditioning, high rate batteries, and energy storage component and subsystem technologies for integration of high power subsystems with directed energy weapons (DEW). These technologies will enable the delivery of high power for operation of DEW. Note: In FY 2006, the megawatt superconducting power system demonstration activity will be moved to a separate effort in this Project. | 1.491 | 0.976 | 0.917 |
| (U) In FY 2005: Performed analysis of power system integration into an airframe as part of a non-lethal weapon system. Initiated preliminary design of and developed analytical model for a megawatt class power system demonstrator. | | | |
| (U) In FY 2006: Develop technology roadmaps and complete analysis of power system integration into an airframe as part of a non-lethal weapon system. Initiate design for a megawatt non-superconducting low duty cycle generator system tailored to directed energy weapons. | | | |
| (U) In FY 2007: Complete design and perform modeling and simulation of a megawatt non-superconducting low duty cycle generator system tailored to directed energy weapons. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Develop power generation/conditioning/distribution component, energy storage, and thermal management components and subsystem technologies for manned and unmanned aircraft systems. These technologies will improve aircraft self-sufficiency, reliability, maintainability, and supportability, while reducing life cycle costs and enabling new capabilities. Note: In FY 2006, this activity will be completed. | 1.575 | 1.249 | 0.000 |
| (U) In FY 2005: Completed detailed design of demonstration electrical generator for integration into mid-thrust class engines. | | | |
| (U) In FY 2006: Complete engine integration and test of the internal starter generator in mid-thrust class engines. | | | |
| (U) In FY 2007: Not Applicable. | | | |
| (U) | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE: February 2006 |
|---|---|---|
| BUDGET ACTIVITY: 03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE: 3035 Aerospace Power Technology |

| | B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | MAJOR THRUST: Develop power generation/conditioning/distribution, energy storage, and thermal management components and subsystem technologies that are synergistic with aerospace and weapons platforms. | 0.670 | 0.000 | 1.467 |
| (U) | In FY 2005: Tested low volume/low weight high temperature motor drive. | | | |
| (U) | In FY 2006: Not Applicable. Note: The FY 2006 synergistic efforts will be delayed to FY 2007 to allow for multi-megawatt superconducting Applied Research activities to more fully develop. | | | |
| (U) | In FY 2007: Investigate alternative energy storage/generation systems for low power applications. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Develop analytical tools and subsystems for multi-megawatt superconducting electrical power systems including power generation, conditioning, and dynamic interaction. Note: Prior to FY 2006, the megawatt superconducting power system demonstration activity was included in the directed energy weapons effort in this Project. | 0.000 | 1.745 | 3.268 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Complete preliminary design for a megawatt class power system demonstrator. | | | |
| (U) | In FY 2007: Initiate detailed design of megawatt class power system demonstrator and begin fabrication of key components. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: Advanced Satellite Thermal Control Program. | 0.965 | 1.676 | 0.000 |
| (U) | In FY 2005: Expanded Electrochromics Coatings (EC) productions beyond the pilot scale level, developed processes incorporating EC into thin flexible films that can be bonded to satellite structures and tested EC devices in real application environments. | | | |
| (U) | In FY 2006: Develop EC's and prepare them for qualifying test on the Navy's Mid-Star micro-satellite, specifically addressing the electrode connection bonding with the EC. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: Field Renewable Energy System Hybrids (FRESH) Li Ion Battery Program. | 0.000 | 0.986 | 0.000 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Develop rechargeable batteries for the 12V applications of the Battlefield Renewable Integrated Tactical Energy System program. The batteries are to have individually imbedded charge electronics so that they can recharge from any power source in the field. The batteries will be designed for use as wearable power sources and will interface with a hybrid power system. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE: February 2006 |
|---|---|---|
| BUDGET ACTIVITY: 03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE: 3035 Aerospace Power Technology |

| | B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | CONGRESSIONAL ADD: More Electric Technology for Mission Critical Power Systems. | 0.000 | 2.070 | 0.000 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Select near-term and far term applications and then develop flightweight hardware, durability testing, and preliminary testing that would lead to eventual military qualification. The anticipated payoff of the technology is improved performance, reliability, and overall cost-effectiveness of mission-critical propulsion and power systems through replacement of fluid systems with magnetic and electrical components. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | Total Cost | 4.701 | 8.702 | 5.652 |

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

| | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| (U) Related Activities: | | | | | | | | | |
| (U) PE 0602201F, Aerospace Flight Dynamics. | | | | | | | | | |
| (U) PE 0602203F, Aerospace Propulsion. | | | | | | | | | |
| (U) PE 0602605F, Directed Energy Technology. | | | | | | | | | |
| (U) PE 0603605F, Advanced Weapons Technology. | | | | | | | | | |
| (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. | | | | | | | | | |

**(U) D. Acquisition Strategy**

Not Applicable.

# Exhibit R-2a, RDT&E Project Justification

DATE: February 2006

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT NUMBER AND TITLE: 4921 Aircraft Propulsion Subsystems Int

| Cost ($ in Millions) | | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 4921 | Aircraft Propulsion Subsystems Int | 21.026 | 32.953 | 14.334 | 25.149 | 27.261 | 27.828 | 28.350 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

Note: In FY 2005-2007, a portion of the funding in this project was shifted to Project 5098 in this PE due to higher Air Force priorities.

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

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. This project includes the Aerospace Propulsion Subsystems Integration (APSI) program, which includes demonstrator engines such as the Joint Technology Demonstrator Engine for manned systems and the Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. The demonstrator engines integrate the core (high-pressure spool) technology developed under the Advanced Turbine Engine Gas Generator project with the engine (low-pressure spool) technology such as fans, turbines, engine controls, mechanical systems, exhaust nozzles, and augmentors. Additionally, these efforts include activities under the national High Cycle Fatigue (HCF) program. This project also focuses on system integration of inlets, nozzles, engine/airframe compatibility, and power and thermal management subsystems technologies. APSI provides aircraft with potential for longer range and higher cruise speeds with lower specific fuel consumption, surge power for successful engagements, high sortie rates with reduced maintenance, reduced life cycle cost, and improved survivability, resulting in increased mission effectiveness. Technologies developed are applicable to sustained high-speed vehicles and responsive space launch. APSI supports the goals of the national Integrated High Performance Turbine Engine Technology (IHPTET) program, which is focused on doubling turbine engine propulsion capabilities while reducing cost of ownership. Anticipated technology advances include turbine engine improvements providing an approximate 30 percent reduction in tactical fighter aircraft takeoff gross weight and 100 percent increase in aircraft range/loiter. APSI is also fully integrated into the Versatile Affordable Advanced Turbine Engine program (VAATE). The IHPTET and VAATE programs provide continuous technology transition for military turbine engine upgrades and derivatives, and have the added dual-use benefit of enhancing the United States turbine engine industry's international competitiveness.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Design, fabricate, and demonstrate durability and integration technologies for turbofan/turbojet engines. These technologies will improve durability, supportability, and affordability of current and future Air Force aircraft. | 1.667 | 1.455 | 1.315 |
| (U) In FY 2005: Validated the HCF Test Protocol by completing structural durability tests of advanced engine components and instrumentation. | | | |
| (U) In FY 2006: Design and develop agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories. | | | |
| (U) In FY 2007: Fabricate and test agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories. | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>4921 Aircraft Propulsion Subsystems Int |

| | B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | | | | |
| (U) | MAJOR THRUST: Design, fabricate, and test advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, sustained supersonic and hypersonic cruise vehicles, and transports. Each of these component technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines enabling faster, more responsive systems with longer range and greater payload. | 10.971 | 11.820 | 9.125 |
| (U) | In FY 2005: Completed test of a HCF robust front frame, an affordable organic matrix composite fan frame and duct, a multi-stage forward swept fan, a damped low-pressure turbine (LPT) blade, a titanium matrix composite (TMC) shaft, and model-based flexible control with diagnostics. Completed advanced engine designs with an uncooled ceramic matrix composite (CMC) LPT blade and begin fabrication of multi-property rotor, fluidic control and modulated turbine cooling. | | | |
| (U) | In FY 2006: Complete fabrication and testing multi-property rotor, fluidic control, and modulated turbine cooling. Initiate advanced designs for lightweight engine (utilizes a hollow fan, radial compressor, and low profile combustor) capable of operating as primary propulsion or in a lift mode. Initiate advanced engine designs for a sustained supersonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, and lightweight CMC cases and ducts. | | | |
| (U) | In FY 2007: Enhance advanced designs for lightweight high bypass engine (utilizes a hollow fan, radial compressor, and low profile combustor) capable of operating as primary propulsion or in a lift mode. Enhance advanced engine designs for a sustained supersonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, and lightweight CMC cases and ducts. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Design, fabricate, and test advanced component technologies for limited life engines. These technologies improve the performance, durability, and affordability of engines for missile and unmanned air vehicles (UAVs), and subsonic to hypersonic weapon applications. | 2.692 | 5.878 | 3.894 |
| (U) | In FY 2005: Enhanced designs of advanced component technologies for intelligent and durability engine testing for UAVs. Completed initial designs of advanced component technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and improved oil-less bearings. | | | |
| (U) | In FY 2006: Enhance design and begin fabrication of advanced high temperature cooled turbine blade and combustor for UAV applications. Enhance designs of advanced components for technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and oil-less bearings. | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>4921 Aircraft Propulsion Subsystems Int |

| | B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | In FY 2007: Continue fabrication of advanced high temperature cooled turbine blade and combustor for UAV applications. Begin fabrication of advanced components for technologies for intelligent and durability engine testing to include an advanced fan/compressor, a ceramic turbine, turbine with new advanced cooling approach, and oil-less bearings. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: IHPTET Phase III Technology Demonstrator. | 3.379 | 0.000 | 0.000 |
| (U) | In FY 2005: Completed design, fabrication, instrumentation, and assembly of a multi-stage forward swept fan, an uncooled CMC low pressure turbine blade, and fluidic thrust vectoring in an advanced demonstrator engine. | | | |
| (U) | In FY 2006: Not Applicable. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: VAATE (Note: Only for the XTC 58F/1 demonstrator program) (this add was previously titled: Versatile Affordable Advanced Turbine Engine (Note: Only for the XTC 58F/1 for purposes demonstrating the integration of individual technologies for highly fuel efficient 10,000-15,000 pound thrust demonstrator engines needed for evolving UAVs)). | 2.317 | 6.703 | 0.000 |
| (U) | In FY 2005: Completed preliminary designs of advanced component technologies (includes an advanced fan and improved high temperature turbine blades) for intelligent and durability engine testing for UAVs. | | | |
| (U) | In FY 2006: Update the preliminary design and configuration of the common core by incorporating changes necessary to accommodate both UAV and heavy lift applications. Create detailed design of advanced component technologies for UAV applications. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: VAATE Advanced Supersonic Cruise Missile Engine. | 0.000 | 5.914 | 0.000 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Perform risk reduction rig designs for the critical turbine, afterburner and nozzle components. Conduct testing of the rigs when fabrication is complete and initiate design process development for fabrication of a cast blisk turbine utilizing an advanced cooling concept. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: Versatile Affordable Advanced Turbine Engine - 5K-7K Thrust Category. | 0.000 | 1.183 | 0.000 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Conduct system studies for the multipurpose core and associated design activities to extend its | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>4921 Aircraft Propulsion Subsystems Int |

**(U) B. Accomplishments/Planned Program ($ in Millions)**

| | | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| | applicability to engines in the 5,000 to 7,000 pound turbofan thrust class. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | Total Cost | 21.026 | 32.953 | 14.334 |

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

| | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| (U) Related Activities | | | | | | | | | |
| (U) PE 0602201F, Aerospace Flight Dynamics. | | | | | | | | | |
| (U) PE 0602203F, Aerospace Propulsion. | | | | | | | | | |
| (U) PE 0603003A, Aviation Advanced Technology. | | | | | | | | | |
| (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. | | | | | | | | | |

**(U) D. Acquisition Strategy**

Not Applicable.

# Exhibit R-2a, RDT&E Project Justification

DATE: February 2006

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology

PROJECT NUMBER AND TITLE: 4922 Space & Missile Rocket Propulsion

| Cost ($ in Millions) | | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 4922 | Space & Missile Rocket Propulsion | 5.200 | 8.011 | 4.839 | 4.859 | 5.272 | 5.382 | 5.484 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

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

This project develops and demonstrates technologies for the sustainment of strategic systems (including solid boost/missile propulsion, Post Boost Control, and aging and surveillance efforts) and tactical rockets. Characteristics such as environmental acceptability, affordability, reliability, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion systems, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program are being accomplished in two phases and that could improve the performance of expendable systems' payload capabilities by approximately 15 percent (Phase I)/20 percent (Phase II) and reduce hardware and operation costs by approximately 25 percent (Phase I)/30 percent (Phase II). Aging and Surveillance efforts that could improve lifetime prediction capabilities by 10 years and reduce non-destructive test costs by 50 percent. The projects in this program are part of the Technologies for the Sustainment of Strategic Systems program and support the Integrated High Payoff Rocket Propulsion Technology program.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Develop and demonstrate missile propulsion and Post Boost Control Systems (PBCS) technologies for ballistic missiles. | 2.159 | 2.251 | 0.981 |
| (U) In FY 2005: Completed Phase I full-scale risk reduction component developments for the advanced PBCS demonstration. Completed demonstration of component technologies with readily available materials to reduce hardware costs with increased performance for the PBCS. Enhanced hardware development integrating case, nozzle, insulation, and propellant for the Missile Propulsion Demonstration Phase I. Completed Critical Design Review for nozzle, case, nozzle and igniter for the interim demos. Successfully cast one interim motor. | | | |
| (U) In FY 2006: Continue hardware development integrating case, nozzle, insulation, and propellant for the Missile Propulsion Demonstration Phase I. | | | |
| (U) In FY 2007: Complete the Missile Propulsion Demonstration Phase I. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Develop and demonstrate missile propulsion, PBCS, aging, and surveillance technologies for strategic systems. Efforts support the Technology for Sustainment of Strategic Systems - Phase II. Note: After FY 2006, the aging and surveillance efforts in this activity will become a separate activity in this project. | 3.041 | 3.886 | 3.245 |
| (U) In FY 2005: Conducted initial validation testing code for modeling and simulation tool (Phase II) development for analyzing and developing missile components,. Completed this development effort of aging and surveillance tools for predicting the health of solid rocket motors. Developed methods to apply these tools on a motor-by-motor basis | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>4922 Space & Missile Rocket Propulsion |

| (U) B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| vice a fleet wide basis. | | | |
| (U) In FY 2006: Continue modeling and simulation tools (Phase II) development for analyzing and developing missile components. | | | |
| (U) In FY 2007: Begin development of subcomponents to test the accuracy of the previously developed modeling and simulation tools and update the models with the resulting data for use in an upcoming Missile Propulsion demonstration. | | | |
| (U) | | | |
| (U) MAJOR THRUST: Develop and demonstrate aging and surveillance technologies for strategic systems to improve lifetime prediction capabilities by 10 years and reduce non-destructive test costs by 50 percent. Efforts support the Technology for Sustainment of Strategic Systems Phase II. Note: Prior to FY 2006, the aging and surveillance efforts were part of another effort in this Project. | 0.000 | 0.395 | 0.613 |
| (U) In FY 2005: Not Applicable. | | | |
| (U) In FY 2006: Complete development of aging and surveillance tools for predicting the health of solid rocket motors and methods to apply these tools on a motor-by-motor basis vice a fleet wide basis. | | | |
| (U) In FY 2007: Initiate scale-up activities for an advanced service life prediction program integrating existing and advanced sensors, models, and tools to be able to predict the service life of a solid rocket motor on a motor-by-motor basis. | | | |
| (U) | | | |
| (U) CONGRESSIONAL ADD: Solid Boost Power Technology. | 0.000 | 1.479 | 0.000 |
| (U) In FY 2005: Not Applicable. | | | |
| (U) In FY 2006: Provide additional component testing and modeling, simulation, and analysis tool validation for solid rocket motor technologies supporting future ballistic missile upgrades. | | | |
| (U) In FY 2007: Not Applicable. | | | |
| (U) Total Cost | 5.200 | 8.011 | 4.839 |

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

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

(U) Related Activities:
(U) PE 0602102F, Materials.
(U) PE 0602203F, Aerospace Propulsion.

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>**03 Advanced Technology Development (ATD)** | PE NUMBER AND TITLE<br>**0603216F Aerospace Propulsion and Power Technology** | PROJECT NUMBER AND TITLE<br>**4922 Space & Missile Rocket Propulsion** |

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

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603500F, Multi-Disciplinary Advanced Development Space 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.

| Exhibit R-2a, RDT&E Project Justification | | | DATE February 2006 |
|---|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>5098 Advanced Aerospace Propulsion | |

| Cost ($ in Millions) | | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 5098 | Advanced Aerospace Propulsion | 23.004 | 22.882 | 34.167 | 22.832 | 23.838 | 24.331 | 24.789 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

Note: In FY 2005-2007, funds were shifted to accelerate the Air Force scramjet flight demonstration efforts. In 2007, funding increases to support ground demonstrations and fabricate test vehicles for out-year flight demonstrations.

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

This project develops and demonstrates via ground and flight tests the scramjet propulsion cycle to a technology readiness level appropriate for full integration with other engine cycles (including turbine and rocket-based) to provide the Air Force with transformational military capabilities. The primary focus is on the hydrocarbon-fueled, scramjet engine. Multi-cycle engines will provide the propulsion systems necessary to support aircraft and weapon platforms operating over the range of Mach 0 to 8+. Efforts include scramjet flow-path optimization to enable operation over the widest possible range of Mach numbers, active combustion control to assure continuous positive thrust (even during mode transition), robust flame-holding to maintain stability through flow distortions, and maximized volume-to-surface area to minimize the thermal load imposed by the high-speed engine. Thermal management plays a vital role in scramjet and combined cycle engines, including considerations for protecting low speed propulsion systems (e.g., turbine engines) during hypersonic flight.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation over a range of Mach 4 to 8. | 23.004 | 21.896 | 34.167 |

(U) In FY 2005: Fabricated flight weight scramjet engine with flight weight fuel control valves and closed loop control system. Performed initial preparation of Arnold Engineering Development Center (AEDC) and National Aeronautics and Space Administration (NASA) Langley tunnels for ground test of flight weight hydrocarbon-fueled, fixed geometry flow path. Completed component test of ramjet to scramjet mode transition in direct connect facility. Completed component level evaluation of engine ignition/start sequence and of engine control strategy. Conducted preliminary design of the Scramjet Engine Demonstrator (SED) vehicle and initiated detailed design of the scramjet engine demonstrator air vehicle. Conducted wind tunnel tests of the air vehicle models to determine aerodynamic forces and moments and vehicle stability and control. Conducted various design trade studies to ready the overall demonstrator design (includes air vehicle structures, avionics, instrumentations, scramjet propulsion systems, and boosters) for a critical design review.

(U) In FY 2006: Continue detailed design of the scramjet engine demonstrator air vehicle. Complete vehicle subsystem trade studies and designs for structures, avionics, instrumentation, booster and other necessary technologies. Conduct multiple risk reduction tests and analyses to reduce both aerodynamic and propulsion uncertainties prior to Critical Design Review. Conduct extensive transonic, supersonic, and hypersonic wind tunnel tests and simultaneously conduct computational fluid dynamics analyses of tested configurations. Conduct

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>5098 Advanced Aerospace Propulsion |

**(U) B. Accomplishments/Planned Program ($ in Millions)**

| | | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| | aero-thermodynamic tests to ensure vehicle thermal protection system design meets requirements. Conduct additional propulsion related risk reduction tests to mature propulsion system subcomponents (hot gas valves, digital engine controller, fuel pump) and broaden the engine ground test matrix to better align with expected flight profiles. | | | |
| (U) | In FY 2007: Complete engine and vehicle designs and conduct vehicle critical design review. Fabricate and test flight clearance engine and initiate fabrication of flight engines. Establish flight test profiles and margins. Initiate fabrication of air vehicle flight hardware and begin flight test preparations at supporting test centers. | | | |
| (U) | | | | |
| (U) | CONGRESSIONAL ADD: X-43C Development. | 0.000 | 0.986 | 0.000 |
| (U) | In FY 2005: Not Applicable. | | | |
| (U) | In FY 2006: Design combined cycle engine propulsion system for potential low-cost flight demonstration under X-43C. Design options include legacy X-43C, X-51 derivative, and other research flight test configurations. Combined cycle engine propulsion system will combine scramjet engines with high-speed turbine and/or rocket engines. Turbine, rocket and scramjet engine components will include technology elements traceable to full-scale vision concepts. Performance of combined cycle engine propulsion system will be assessed analytically for performance, thrust margin, and propulsion mode transition during takeoff, transonic acceleration, supersonic, and hypersonic flight. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | Total Cost | 23.004 | 22.882 | 34.167 |

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

| | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| (U) Related Activities: | | | | | | | | | |
| (U) PE 0602102F, Materials | | | | | | | | | |
| (U) PE060203F, Aerospace Propulsion | | | | | | | | | |
| (U) This project will be coordinated through the Reliance process to harmonize efforts and eliminate duplication. | | | | | | | | | |

**(U) D. Acquisition Strategy**

Not Applicable

| Exhibit R-2a, RDT&E Project Justification | | | DATE: February 2006 |
|---|---|---|---|
| BUDGET ACTIVITY: 03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE: 681B Advanced Turbine Engine Gas Generator | |

| Cost ($ in Millions) | | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 681B | Advanced Turbine Engine Gas Generator | 21.834 | 24.422 | 25.828 | 25.927 | 28.139 | 28.721 | 29.259 | Continuing | TBD |
| | Quantity of RDT&E Articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

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

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. The objective is to provide the continued evolution of technologies into an advanced gas generator in which the performance, cost, durability, reparability, and maintainability can be assessed in a realistic engine environment. The gas generator, or core, is the basic building block of the engine and nominally consists of a compressor, a combustor, a high-pressure turbine, mechanical systems, and core subsystems. Experimental core engine testing enhances rapid, low-risk transition of key engine technologies into engineering development, where they can be applied to derivative and/or new systems. These technologies are applicable to a wide range of military and commercial systems including aircraft, missiles, land combat vehicles, ships, and responsive space launch. Component technologies are demonstrated in a core (sub-engine) test. This project also assesses the impact of low spool components (such as inlet systems, fans, low pressure turbines, and exhaust systems) and system level technologies (such as integrated power generators and thermal management systems) on core engine performance and durability. The core performances of this project are validated on demonstrator engines in Project 4921 of this PE. Efforts are part of the Integrated High Performance Turbine Engine Technology (IHPTET) and the Versatile Affordable Advanced Turbine Engines (VAATE) programs.

| **(U) B. Accomplishments/Planned Program ($ in Millions)** | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|
| (U) MAJOR THRUST: Design, fabricate, and performance test demonstration core engines, using innovative engine cycles and advanced materials to provide greater durability, improved performance, and reduced fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, sustained supersonic and hypersonic cruise vehicles, and large transports. Each of these technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines, thus enabling new capabilities for faster, survivable, durable, more responsive systems with longer range and greater payloads. | 18.201 | 21.030 | 22.234 |

(U) In FY 2005: Completed design and fabrication of hardware for testing a cooled-cooling air system, micro-circuit cooled high pressure turbine blades, and blade outer air seals with advanced thermal barrier coating. Performed risk reduction tests of a magnetic bearing system for an advanced core engine. Initiated conceptual studies and preliminary designs of advanced core engine technologies, including systems level technologies residing within the core, applicable to advanced mobility, regional, and long range strike platforms.

(U) In FY 2006: Complete preliminary design and begin detailed design of advanced core engine technologies, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>681B Advanced Turbine Engine Gas Generator |

| | B. Accomplishments/Planned Program ($ in Millions) | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| | extraction. Begin preliminary design and risk reduction planning for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Begin design of unique compression system components. | | | |
| (U) | In FY 2007: Complete detailed design and begin fabrication of advanced core engine technologies, including advanced turbine blade materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Complete preliminary design and risk reduction planning for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Continue design and begin fabrication of unique compression system components. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Design, fabricate, and durability test demonstration core engines to provide increased durability and affordability for turbofan/turbojet engines for fighters, attack aircraft, bombers, sustained supersonic and hypersonic cruise vehicles, and large transports. Note: Beginning in FY 2006, this effort will be transferred to the remaining thrusts in this project since durability efforts are integral to Air Force turbine efforts. | 1.262 | 0.000 | 0.000 |
| (U) | In FY 2005: Completed the design and fabrication of long lead hardware for evaluation in the national durability program. | | | |
| (U) | In FY 2006: Not Applicable. | | | |
| (U) | In FY 2007: Not Applicable. | | | |
| (U) | | | | |
| (U) | MAJOR THRUST: Design, fabricate, and evaluate technology demonstration core engines to provide improved performance, greater durability, and lower fuel consumption for turboshaft/turbojet engines for trainers, rotorcraft and runway independent air vehicles, special operations aircraft, intratheater transports, subsonic powered munitions, and unmanned air vehicles (UAV). | 2.371 | 3.392 | 3.594 |
| (U) | In FY 2005: Completed core engine tests of a forward swept splittered compressor rotor, a high temperature rise combustor, a counter-rotating vaneless turbine, ceramic matrix composite turbine blades and vanes, and magnetic bearings. Initiated design of small versatile affordable core engine technologies, including eccentric high-pressure core components, monolithic ceramic rotor, and lubeless bearing system applicable to unmanned aerial vehicles (UAV) and powered munitions. | | | |
| (U) | In FY 2006: Further the design and begin selective risk reduction tests of UAV small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, nanolaminate coatings, and systems for thermal management and advanced power extraction. Begin planning for multi-Service demonstration of heavy fuel engine technologies for future rotorcraft. | | | |

| Exhibit R-2a, RDT&E Project Justification | | DATE February 2006 |
|---|---|---|
| BUDGET ACTIVITY<br>03 Advanced Technology Development (ATD) | PE NUMBER AND TITLE<br>0603216F Aerospace Propulsion and Power Technology | PROJECT NUMBER AND TITLE<br>681B Advanced Turbine Engine Gas Generator |

**(U) B. Accomplishments/Planned Program ($ in Millions)**

| | | FY 2005 | FY 2006 | FY 2007 |
|---|---|---|---|---|
| (U) | In FY 2007: Complete design, initiate hardware fabrication, and continue selective risk reduction tests of UAV small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, nanolaminate coatings, and systems for thermal management and advanced power extraction. Continue planning for multi-Service demonstration of heavy fuel engine technologies for future rotorcraft. | | | |
| (U) | Total Cost | 21.834 | 24.422 | 25.828 |

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

| | FY 2005 Actual | FY 2006 Estimate | FY 2007 Estimate | FY 2008 Estimate | FY 2009 Estimate | FY 2010 Estimate | FY 2011 Estimate | Cost to Complete | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| (U) Related Activities: | | | | | | | | | |
| (U) PE 0602201F, Aerospace Flight Dynamics. | | | | | | | | | |
| (U) PE 0602203F, Aerospace Propulsion. | | | | | | | | | |
| (U) PE 0603003A, Aviation Advanced Technology. | | | | | | | | | |
| (U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. | | | | | | | | | |

**(U) D. Acquisition Strategy**

Not Applicable.