PE NUMBER: 0602203F
PE TITLE: Aerospace Propulsion

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

Cost ($ in Millions)		FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	135.403	126.988	92.650	109.833	119.329	116.730	117.834	0.000	0.000
3012	Advanced Propulsion Technology	14.701	13.790	12.211	19.872	25.186	23.526	22.812	0.000	0.000
3048	Fuels and Lubrication	17.621	16.612	12.841	14.691	16.940	13.392	13.704	0.000	0.000
3066	Turbine Engine Technology	36.092	36.533	31.749	32.782	32.489	35.282	36.111	0.000	0.000
3145	Aerospace Power Technology	31.738	35.162	24.946	29.535	28.976	32.585	33.220	0.000	0.000
4847	Rocket Propulsion Technology	35.251	24.891	10.903	12.953	15.738	11.945	11.987	0.000	0.000

Note: In FY 2003, only the space unique tasks in Projects 3012 and 4847 were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities. In Project 4847, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles.

(U) A. Mission Description and Budget Item Justification

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has five projects, each focusing on a technology area critical to the Air Force. The Advanced Propulsion Technology develops high-speed airbreathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies to enable revolutionary propulsion capability for the Air Force. The Fuels and Lubrication project develops new fuels, lubricants, and combustion concepts and technologies for new and existing engines and directly supports the Integrated High Performance Turbine Engine Technology (IHPTET) and the Versatile Affordable Advanced Turbine Engine (VAATE) programs. The Turbine Engine Technology project develops enabling capabilities to enhance performance and affordability of existing weapon systems to include efforts that are part of the IHPTET and VAATE programs. The Aerospace Power project develops efficient energy storage, power generation, and thermal management techniques for ground, air, and space military applications. Finally, the Rocket Propulsion Technology project pursues advances in rocket technologies for space access, space maneuver, and tactical and strategic missiles to include efforts that are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) and Technology for the Sustainment Systems (TSSS) programs. Note: In FY 2004, Congress added $3.0 million for Center for Security of Large-Scale Systems; $2.5 million for High-Power, Advanced Low-Mass Power (HPALM); $2.2 million for HVEPS for Supersonic Aircraft; $1.0 million for Cell-Level Battery Control; $4.3 million for Engineering Tool Improvement Program (ETIP); $1.0 million for Integrated High Payoff Rocket Propulsion Technology Program; $4.5 million for Advanced Vehicle and Propulsion Center; $1.0 million for Lightweight Photovoltaics for Portable Power and Hydrogen Generation; $3.0 million for Pulse Detonation Engine and Laser Induced Thermal Acoustics Instrument; $1.0 million for Hybrid Plastics; and $3.0 million for High Powered Electrical Aircraft Capabilities (HiPEAC).

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	132.285	101.575	88.859
(U)	Current PBR/President's Budget	135.403	126.988	92.650
(U)	Total Adjustments	3.118	25.413	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-1.087	
	Congressional Increases		26.500	
	Reprogrammings	5.500		
	SBIR/STTR Transfer	-2.382		
(U)	Significant Program Changes:			
	Not Applicable.			

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3012 Advanced Propulsion Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3012 Advanced Propulsion Technology	14.701	13.790	12.211	19.872	25.186	23.526	22.812	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

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

(U) A. Mission Description and Budget Item Justification

This project develops combined/advanced cycle airbreathing high-speed (up to Mach 4) and hypersonic (Mach 4 to 8+) propulsion technologies to enable revolutionary propulsion options for the Air Force. These new engine technologies will enable future high-speed/hypersonic weapons and aircraft concepts. The primary focus is on hydrocarbon-fueled engines capable of operating over a broad range of flight Mach numbers. Technologies developed under this program enable capabilities of interest to both DoD and NASA. Efforts include modeling, simulators, and proof of concept demonstrations of critical components; advanced component development; and ground-based demonstrations.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	3.454	0.000	0.000
(U) In FY 2003: This project previously included space unique funding, which was transferred to PE 0602500F, Project 5027. These funds represent the civilian salaries and in-house support for the work effort transferred.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop advanced hydrocarbon scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future warfighter needs.	11.247	13.222	7.441
(U) In FY 2003: Fabricated and ground tested world's first flight weight hydrocarbon fueled scramjet engine in a wind tunnel. Showed structural durability in 25 engine tests. Determined engine operability and performance.			
(U) In FY 2004: Continue developing flight weight engine components including flight weight fuel control valves, fuel pumps, and engine controllers. Initiate detailed analysis for mating scramjet flight engines with demonstrator vehicles. Perform trajectory optimization for flight test. 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. Verify operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation. Initiate fabrication of a ground test engine with a fuel cooled structure incorporating a variable geometry inlet for a flight experiment. Note: In FY 2004, several of these activities were moved from PE 0602500F, Project 5027, to consolidate all 6.2 scramjet demonstration efforts.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3012 Advanced Propulsion Technology**

(U)	In FY 2005: Continue flight weight engine components development including flight weight fuel control valves, fuel pumps, and engine controllers. Continue detailed analysis mating scramjet flight engines with demonstrator vehicles. Continue performing trajectory optimization for flight test. Continue evaluating 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. Continue verification of operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation. Complete fabrication of a ground test engine for a flight experiment. Initiate testing of the ground test engine for a flight experiment.			
(U)				
(U)	MAJOR THRUST: Conduct assessments, system design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies into future missiles and into manned and unmanned air and space vehicle concepts.	0.000	0.568	0.256
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiate system trade studies to determine military payoff and establish component technology goals. Initiate defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and the Defense Advanced Research Projects Agency.			
(U)	In FY 2005: Continue system trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and the Defense Advanced Research Projects Agency.			
(U)				
(U)	MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies and integrate into advanced combined cycle engine designs for future missiles and for manned and unmanned aerospace vehicles. Note: In FY 2005, these activities will be moved from PE 0602500F, Project 5027 to consolidate all 6.2 scramjet development efforts.	0.000	0.000	4.514
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Develop techniques to decrease scramjet take-over from Mach 4.5 to Mach 3 to provide robust options for combined cycle engines. Support development of low internal drag flame stabilization devices and flight test engine components.			
(U)	Total Cost	14.701	13.790	12.211

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603211F, Aerospace Structures.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE: 3048 Fuels and Lubrication	

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3048 Fuels and Lubrication	17.621	16.612	12.841	14.691	16.940	13.392	13.704	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops improved fuels, lubricants, mechanical systems, and combustion concepts for advanced turbine engines, scramjets, pulse detonation, and combined cycle engines. Systems applications include missiles, aircraft, sustained high-speed vehicles, and responsive space launch. Analytical and experimental areas of emphasis include fuels and fuels logistics, lubricants, bearings, electromagnetic rotor, oil-less engine technology, optical diagnostics, fundamental combustion, and detonations. Fuels and lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Advanced combustion concepts must be cost-effective, durable, and reduce pollutant emissions.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop low-cost additive and fuel system approaches to improve fuel properties and to expand the flight envelope for manned and unmanned aircraft.	2.245	1.835	1.613
(U) In FY 2003: Developed flow-improving additives for low temperature properties to enable replacement of specialty fuels with JP-8. Developed fuel technologies to increase the temperature limit of JP-8 to 900 degrees Fahrenheit to reduce thermal-oxidative and pyrolytic deposits. Completed development of an initial computer model based on chemical structure-activity relationships for fuel additives design and performance modeling. Developed particulate reducing additives to reduce soot emissions and infrared signatures from propulsion systems.			
(U) In FY 2004: Continue development of additive packages to enable JP-8 to achieve jet propulsion thermally stable low temperature (high altitude) performance. Continue developing approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit, including thermal stability additives, fuel deoxygenation, and improved coatings. Enhance existing fuel modeling and simulation capabilities by incorporation of more realistic additive performance models and detailed fuel chemistry. Note: In FY 2004, the emissions and signature reduction activities became a separate effort in this Project.			
(U) In FY 2005: Optimize additive packages and test protocols to enable JP-8 to achieve jet propulsion thermally stable low temperature performance. Conduct lab-scale tests to increase JP-8 temperature capability to 900 degrees Fahrenheit, including thermal stability additives, fuel deoxygenation, and improved materials and coatings. Continue enhancing existing fuel modeling and simulation capabilities by incorporation of more realistic additive performance models. Develop engine thermal management models.			
(U)			
(U) MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature, including biotechnology, molecular imprinting, and nano-scale reactivity enhancement. Note: In FY 2004, the emissions and signature reduction activities became a separate effort in this Project.	0.000	1.026	1.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

(U) In FY 2003: Not Applicable. (U) In FY 2004: Develop emission reduction additives. Verify additive performance in laboratory-scale combustion tests. Initiated development of improved diagnostics for sub-micron scale particulate emissions from combustors. (U) In FY 2005: Continue assessing additive performance in laboratory scale combustion tests. Complete development and application of advanced diagnostics for sub-micron particulate emissions.			
(U) (U) MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to simplify logistics and reduce cost, including field and on-board additive injections and improvements to existing fuel additive packages. (U) In FY 2003: Defined improvements in specific additive packages and fuel dispensing methods to reduce logistics footprint, including on-board fuel evaluation and additization. Completed screening candidate technologies for fuel field diagnostic techniques, including on-line quality assessments. (U) In FY 2004: Develop improvements to existing fuel additive packages to simplify logistics and reduce cost. Assess performance of fuels from alternative (non-petroleum) sources, including Fischer-Tropsch fuels. Test candidate technologies for field-fuel quality diagnostics. Investigate the use of field-portable equipment to measure biological contamination in fuels. (U) In FY 2005: Develop improvements to existing fuel additive packages to simplify logistics and reduce cost. Assess performance of fuels from alternative (non-petroleum) sources, including Fischer-Tropsch fuels. Continue testing field fuel quality diagnostics. Further investigate biological contamination in fuels and develop mitigation techniques.	1.171	1.061	1.000
(U) (U) MAJOR THRUST: Investigate hydrocarbon and other high energy density fuels for advanced and combined cycle engines for high-speed aerospace vehicles and low-cost access to space. (U) In FY 2003: Completed analyses and configuration trade studies to define and evaluate common fuels for future aircraft and military vehicles. Assessed additive approaches to improve thermal stability and ignition/combustion properties in reduced scale component testing. (U) In FY 2004: Initiate development of fuel property and performance data for industry and Government use in selecting alternative hydrocarbon fuels for advanced propulsion. Investigate approaches to assess fuel thermal stability under high heat flux conditions relevant to advanced rockets and combined cycle engines. (U) In FY 2005: Develop fuel property and performance database for industry and Government use in selecting alternative hydrocarbon fuels for space applications. Test approaches to assess fuel thermal stability under high heat flux conditions relevant to advanced rockets and combined cycle engines.	1.502	0.482	0.500
(U) (U) MAJOR THRUST: Develop, test, and evaluate revolutionary combustor and propulsion concepts for gas turbine, pulsed detonation, and combined-cycle engines for missiles, manned and unmanned systems, and reuseable access to space; perform payoff analyses and configuration trade studies for these systems; and evaluate the combustion and	3.901	3.268	3.485

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emissions characteristics of fuels and fuel additives.

(U) In FY 2003: Demonstrated an ultra-compact combustor at design operating conditions for use as an inter-turbine burner. Investigated incorporating pulsed detonation engine (PDE) propulsion technologies into gas turbine engines. Investigated inlet and nozzle configurations for a PDE. Performed modeling and simulation and initiated experiments to identify fuel additives and combustor designs to reduce emissions from gas turbine engines. Investigated non-traditional thermodynamic cycles for military propulsion systems through simulation/modeling and experimentation.

(U) In FY 2004: Evaluate advanced combustor concepts and the inter-turbine burner combustor at conditions that simulate turbine-wake and turbine-inlet interactions. Investigate the performance of a rudimentary combined-cycle PDE. Evaluate the technical issues associated with incorporating PDE propulsion technologies into gas turbine engines. Perform experiments to validate the high-speed performance of a pure PDE. Complete tests to evaluate promising fuel additives used to reduce particulates and emissions from gas turbine engines.

(U) In FY 2005: Evaluate the inter-turbine burner combustor at realistic operating conditions with rotating turbine machinery. Develop and evaluate combined-cycle PDE concepts. Address the operational issues associated with incorporating PDE propulsion technologies into gas turbine engines. Conduct experiments to extend the operability limits of pure PDE for application to high-speed missiles. Evaluate fundamental combustion issues associated with combustors fed by high-temperature fuel systems like those required for supersonic cruise aircraft.

(U)

(U) MAJOR THRUST: Develop approaches to extend the life of endothermic fuels and fuel system components for sustained supersonic and reusable hypersonic cruise applications. Note: In FY 2004, the endothermic fuel activities in other parts of this Project were consolidated into this activity.	0.000	0.900	0.500

(U) In FY 2003: Not Applicable.

(U) In FY 2004: Develop approaches to improve fuel heat sink capability. Develop systems to minimize regenerative cooling heat loads absorbed by endothermic fuel systems. Develop means to improve fuel combustion performance, especially during cold start and cycle transition. Improve fuel system modeling and simulation tools to better simulate endothermic fuel behavior.

(U) In FY 2005: Continue developing approaches to improve fuel heat sink capability. Test systems to minimize regenerative cooling heat loads absorbed by endothermic fuel systems. Test means to improve fuel combustion performance, especially during cold start and cycle transition. Continue improving fuel system modeling and simulation tools to better simulate endothermic fuel behavior.

(U)

(U) MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary combustor and propulsion systems.	0.711	0.833	0.628

(U) In FY 2003: Investigated specific pollutant emissions formation pathways through computational and experimental methods. Evaluated methods to reduce gaseous and particulate pollutant emissions from legacy and future gas turbine

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engines. Applied advanced diagnostics to combustors to evaluate performance. Preliminary evaluated high intensity laser light interaction with matter.

(U) In FY 2004: Investigate pollutant emission formation pathways through computational and experimental methods. Evaluate methods to reduce gaseous and particulate pollutant emission from legacy and future gas turbine engines. Continue investigating high intensity laser light interaction with matter for micromachining and diagnostic capabilities. Initiate development and demonstration of sensors for the control of combustor performance and extension of component life.

(U) In FY 2005: Continue developing and testing sensors for the control of combustor performance and extension of component life. Develop diagnostic tools to evaluate the combustion issues related to engines burning high-temperature fuels. Investigate the interaction of high intensity laser light with matter for micromachining and diagnostic capabilities.

(U)

(U) MAJOR THRUST: Develop, test, and conduct qualification activities to provide the most reliable and affordable advanced turbine engine lubricants to the Air Force, Department of Defense (DoD), and commercial users.	1.320	1.799	1.940

(U) In FY 2003: Supported field activities for aviation lubrication technologies and DoD operational units. Developed and tested advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Performed payoff analyses and configuration trade studies to define, focus, and evaluate research in lubricants and mechanical systems for combined cycle engines.

(U) In FY 2004: Continue field support activities for aviation lubrication technologies and DoD operational units. Continued development and testing advanced bearing and lubrication system 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 man-rated, expendable, and unmanned air vehicle turbine engines. Begin transition of optimal ester lubricant to military and commercial turbine engines.

(U) In FY 2005: Continue field support activities for aviation lubrication technologies and DoD operational units. Expand development and testing of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring. Initiate testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and unmanned air vehicle turbine engines. Design test approaches for optimal ester lubricant to military and commercial turbine engines.

(U)

(U) MAJOR THRUST: Develop and test advanced technology concepts for small, intermediate, and large-sized turbine engine applications.	2.796	2.481	2.175

(U) In FY 2003: Developed advanced bearing concepts for small- and intermediate-sized turbine engine applications. Designed, fabricated, and tested electromagnetic rotor support and power generation concepts, components, and materials for advanced, oil-less engines. Developed and initiated testing of air and foil bearing technology for small-

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and intermediate-sized turbine engine applications. Initiated 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. Commenced advanced rotor support and power generation studies for turbine engine. Matured hybrid (metal/ceramic) bearing technologies to Joint Strike Fighter (JSF) F136 engine.

(U) In FY 2004: Continue developing advanced bearing concepts for small- and intermediate-sized turbine engine applications. Perform full-scale rig testing of electromagnetic rotor support and a power generation system for advanced, oil-less engines. Begin study and testing of air/foil bearings for propulsion turbine engine application. Continue development and testing of affordable rotor support technology for small, intermediate, and large-sized turbine engine applications. Continue modeling and simulation capabilities to advance design, shorten development time, and reduce testing requirements for mechanical and electromagnetic rotor support and power generation systems. Start modeling rotordynamics of air/foil bearing supported engine shafts. Conduct advanced rotor support and power generation studies and start testing for turbine and combined cycle engines. Continue to mature hybrid (metal/ceramic) bearing technology that could be applied to JSF F135 engine.

(U) In FY 2005: Continue developing and initiate testing of advanced bearing concepts for small-, intermediate-, and large-sized turbine engine applications. Conduct realistic engine front-end simulation testing of electromagnetic rotor support and a power generation system for advanced, oil-less engines. Conduct air/foil bearing testing to determine load capacity and rotor size limitations of this technology. Develop and test affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications. Enhance modeling and simulation activities to advance design, shorten development time, and reduce testing requirements for mechanical and electromagnetic rotor support and power generation systems. Conduct modeling of air/foil bearings and iterate results with test activity. Conduct advanced rotor support and power generation studies and start testing for turbine and combined cycle engines. Support rig testing of hybrid bearing designs for F136 engine. Continue to mature hybrid (metal/ceramic) bearing technology that could be applied to JSF F135 engine.

(U)

(U) MAJOR THRUST: Develop thermal management concepts and analysis tools for long-range strike applications of varying speed classes. Note: In FY 2004, these efforts were combined with the "additive and fuel system approaches" in this Project.	1.057	0.000	0.000

(U) In FY 2003: Conducted fuel trade studies to identify fuel options and capability shortfalls for long-range strike applications. Developed diagnostic approaches and sensors for control of fuel/thermal management systems across the flight envelope. Developed of engine fuel system and thermal management components identified in the Versatile Affordable Advanced Turbine Engine program.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Pulse Detonation Engine (PDE) including Laser Induced Thermal Acoustics Instrument	2.918	2.927	0.000

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efforts in FY 2004.

(U) In FY 2003: Established a design database relevant to the aerothermal and structural design of PDEs. Designed key components to include the inlet, intake valve, fuel injector, detonation initiator, controller, and thrust tube for an airbreathing PDE for use in subsonic and supersonic unmanned air vehicles. Performed ground demonstration testing of some of the key components and continued development of Pulse Detonation Engine (PDE) performance predictive models using experimental data. PDE's offer potential for low-cost propulsion systems that can be applied to unmanned vehicles and high-speed combined cycle engines.

(U) In FY 2004: Complete the design of key components to include the inlet, intake valve, fuel injector, initiator, controller and thrust tube for an airbreathing PDE for use in subsonic and supersonic unmanned air vehicles. Perform design validation testing of the key components and continue development of engineering models to guide the design. Continue the design of a demonstration vehicle for eventual flight test of the PDE.

(U) In FY 2005: Not Applicable.

(U) Total Cost	17.621	16.612	12.841

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602805F, Dual Use Science and Technology.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3066 Turbine Engine Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3066 Turbine Engine Technology	36.092	36.533	31.749	32.782	32.489	35.282	36.111	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, augmentor and exhaust systems, integrated power and thermal management systems, engine inlet integration, mechanical systems, and structural design. This project supports the Integrated High Performance Turbine Engine Technology and Versatile Affordable Advanced Turbine Engine (VAATE) programs, which are joint DoD, NASA, and industry efforts to focus turbine propulsion technology on national needs. The FY 2004 program plan reflects the technology base support for the VAATE activity relative to the turbine-based combined cycle technology development applicable to sustained high-speed flight and responsive space launch.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and high-pressure turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports. These components, made with advanced materials like Titanium Matrix Composites and gamma titanium aluminides, enable aircraft engines with higher performance, increased durability, reduced fuel consumption, and lower life cycle cost.	24.111	27.937	16.787

(U) In FY 2003: Completed preliminary testing on an advanced high-pressure ratio compressor for reduced fuel burn, and high reaction blading for reduced maintenance cost. Conducted testing on an active combustion control high response fuel valve reducing acoustically coupled fatigue and enhancing overall combustion efficiency resulting in fuel burn reduction. Modified the spar/shell turbine blade design system using component bench test results and transitioned this technology to engine demonstrator testing. Completed the sub-scale rotational intentional mistuning experiment and initiated the application of methodology to transonic rig hardware.

(U) In FY 2004: Complete airfoil design for a high-pressure ratio compressor to study unsteady flow interactions for reduced fuel burn, and high reaction blading and engine stall avoidance techniques for reduced maintenance cost. Begin full annular aerothermal tests of a trapped vortex combustor. Conduct design and begin fabrication of advanced high-pressure turbine rig hardware to evaluate advanced three-dimensional effects pm blade tip heat transfer for increased performance and durability. Develop advanced intentional mistuning methodology and begin experimental verification on transonic rig hardware.

(U) In FY 2005: Begin rig testing of a high-pressure ratio compressor including an assessment of unsteady flow interactions for reduced fuel burn, and high reaction blading and engine stall avoidance techniques for reduced maintenance cost. Continue full annular aerothermal tests of a trapped vortex combustor and begin rig testing of an integrated lightweight combustor with a ceramic matrix composite shell and advanced material panels representative of advanced combustor configurations. Complete fabrication and initiate tests of advanced high-pressure turbine rig

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	hardware to evaluate advanced three-dimensional effects on blade tip heat transfer for increased performance and durability. Enhance advanced intentional mistuning methodology and complete experimental verification on transonic rig hardware.			
(U)				
(U)	MAJOR THRUST: Develop turbine engine components (i.e., fans, low pressure turbines, engine controls, exhaust nozzles, and integration technologies) for turbofan/turbojet engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports. These components enable aircraft engines to have higher performance, increased durability, reduced fuel consumption, and lower life cycle cost.	7.093	8.151	10.511
(U)	In FY 2003: Conducted testing of a non-linear control system to simplify control logic development and to provide the component performance trend data necessary for transitioning this technology to the demonstrator engine program.			
(U)	In FY 2004: Begin design of an advanced tandem, forward swept fan incorporating hybrid blade construction and composite reinforced disks to achieve high efficiency and stage loading with reduced weight and cost. Perform three-dimensional computational fluid dynamics (CFD) analysis and detailed design of multi-stage low pressure turbine rig hardware to assess performance of advanced turbine blade configurations applicable to high altitude, long endurance systems including Global Hawk. Initiate testing of advanced control system hardware using component life models to verify real-time computational capabilities for transitioning this technology to a demonstrator engine program. Begin analysis and testing of advanced, low-observable compatible augmentor designs, resulting in improved design rules and tools to improve augmentor operability and reduce screech.			
(U)	In FY 2005: Begin fabrication of an advanced tandem, forward swept fan incorporating hybrid blade construction and composite reinforced disks to achieve high efficiency and stage loading with reduced weight and cost. Perform post-test analysis of multi-stage low-pressure rig test data to assess performance of advanced turbine blade configurations applicable to high altitude, long endurance systems including Global Hawk. Continue testing of advanced control system hardware using component life models to verify real-time computational capabilities for transitioning this technology to a demonstrator engine program. Expand analysis and testing of advanced, low-observable compatible augmentor designs, resulting in improved design rules and tools to improve augmentor operability and reduce screech.			
(U)				
(U)	MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. These components enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, thereby greatly expanding the operating envelopes of missiles and unmanned vehicles.	3.297	0.294	3.342
(U)	In FY 2003: Completed rig testing of an enhanced fan flow control treatment for an all-composite, forward swept shrouded rotor. Designed rub tolerant ceramics for advanced turbine rotor blades.			
(U)	In FY 2004: Begin the conceptual design and conduct configuration studies of an advanced versatile and affordable			

high-pressure core and engine component configurations for expendable engines using rub tolerant ceramic blades to meet the small engine performance and cost reduction objectives.

(U) In FY 2005: Complete configuration studies and continue conceptual design of an advanced versatile and affordable high-pressure core and low-pressure component configurations for expendable engines using rub tolerant ceramic blades to meet the small engine performance and cost reduction objectives.

(U)

(U)	MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports.	1.591	0.151	1.109
(U)	In FY 2003: Conducted durability tests of Ceramic Matrix Composite turbine blades under high temperature/ high-pressure/high moisture conditions to validate composite integrity and life models. Performed rig tests to demonstrate the feasibility of a very high fuel/air ratio combustor with a supercritical fuel delivery system.			
(U)	In FY 2004: Begin conceptual design and conduct configuration studies of advanced versatile and affordable high-pressure compressor, combustor, and high-pressure turbine configurations for turboshaft/turboprop engines to meet the small engine performance and cost reduction objectives.			
(U)	In FY 2005: Enhance conceptual design of advanced versatile and affordable high-pressure core engine component configurations for turboshaft/turboprop engines to meet the small engine performance and cost reduction objectives.			
(U)	Total Cost	36.092	36.533	31.749

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Materials:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602102F, Materials.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0602122N, Aircraft Technology.									
(U) PE 0603210N, Aircraft Propulsion.									
(U) PE 0603003A, Aviation Advanced Technology.									

(U) This project has been

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3066 Turbine Engine Technology

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

coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3145 Aerospace Power Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3145 Aerospace Power Technology	31.738	35.162	24.946	29.535	28.976	32.585	33.220	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops techniques for efficient power generation, energy storage, and thermal management for military aerospace applications. Power component technologies are developed to increase reliability, maintainability, commonality, and supportability of aircraft and flight line equipment. Research is conducted in energy storage technologies to enable the 10-20 year-long term energy storage goals of Air Force unmanned vehicles. Electrical power generation and thermal management technologies to enable all future military directed energy weapon systems. This project supports development of very high output power systems suitable for applications to air moving target indication radar and high power lasers for aerospace platforms. Lightweight power systems suitable for other aerospace applications are also developed.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop power generation/conditioning/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.	8.380	11.874	12.208
(U) In FY 2003: Tested an advanced-switched reluctance machine controller. Fabricated and conducted tests on full-scale lithium-ion batteries and fuel cells for manned and unmanned vehicles. Improved the development of lithium polymer cells.			
(U) In FY 2004: Continue testing of an advanced-switched reluctance machine controller. Initiate development of lithium-based solid-state electrolyte battery technology. Perform a dynamometer test of a starter/generator applicable for mid-thrust class turbine engine high spool applications.			
(U) In FY 2005: Fabricate and test small-scale lithium based solid-state cells. Fabricate and test modular fuel cell systems for manned and unmanned vehicles. Verify dynamic engine models for power extraction. Complete testing of an advanced switched reluctance machine controller.			
(U)			
(U) MAJOR THRUST: Develop thermal management, energy storage and power conditioning components, and subsystem technologies for air and space applications.	4.480	2.479	2.870
(U) In FY 2003: Tested and demonstrated an integrated Power Management and Distribution system for space-based distributed power systems that are half the weight and volume of conventional approaches. Fabricated and tested full-scale lithium-ion batteries for air and spacecraft applications. Developed preliminary integrated vehicle health monitoring algorithms.			
(U) In FY 2004: Continue development of integrated vehicle health monitoring algorithms. Study advanced packaging			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

techniques for silicon carbide power electronics.

(U) In FY 2005: Integrate vehicle health monitoring algorithms into power distribution unit. Fabricate and begin testing of a silicon carbide packaging concept for power electronic device development.

(U)

(U) MAJOR THRUST: Develop cryogenic power generation, high rate batteries, energy storage and power conditioning components, and system technologies with low volume displacement to enable delivery of high power for operation of directed energy weapons	8.301	8.215	9.868

(U) In FY 2003: Completed preliminary fabrication and testing of high-density power conditioning, to include capacitors and switches, for directed energy weapon systems. Tested a thermal management system with Yttrium Barium Copper Oxide coated wire and coils for cryogenic generator applications. Improved the development of higher rate (pulse power) lithium-ion batteries.

(U) In FY 2004: Design and fabricate advanced capacitors for pulsed power applications. Continue fabricating and begin testing liquid dielectric high voltage switches. Optimize processing techniques for long length Yttrium Barium Copper Oxide high temperature superconducting components. Fabricate and test small-scale, high rate lithium-ion cells.

(U) In FY 2005: Test advanced pulse power capacitors. Complete testing liquid dielectric high voltage switches. Test high temperature Yttrium Barium Copper Oxide superconducting coils in a rotating test rig for megawatt-class power applications. Scale-up and begin testing high rate lithium-ion (liquid) cells. Initiate preliminary design of proof-of-concept superconducting generator.

(U)

(U) MAJOR THRUST: Develop high-density electrical power system and thermal management technologies for a next generation aerospace long-range strike vehicle.	1.826	0.000	0.000

(U) In FY 2003: Developed power and thermal requirements for a long-range strike aircraft incorporating advanced weapon systems and performed preliminary compact high power conditioning, energy storage, and thermal management component designs that optimize secondary power system size, weight, and efficiency.

(U) In FY 2004: Not Applicable. Note: In FY 2004, funding for this effort was shifted to higher Air Force priorities.

(U) In FY 2005: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: PBO (poly-based: p-phenylene-2, 6-benzobisoxazole) Membrane for Advanced High Performance Fuel Cells. Note: For developing and certifying this material for the Air Force UCAV.	2.430	0.000	0.000

(U) In FY 2003: Developed poly-based membrane fuel cells that offer a lower cost, lighter weight, higher performance, and more energy efficient fuel cell over existing proton exchange membrane fuel cells. Using results from past single cell research, designed, and fabricated a preliminary model PBO-based membrane in multi-cell/stack configurations.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

(U)				
(U)	CONGRESSIONAL ADD: Lithium-ion Battery Development.	3.889	0.000	0.000
(U)	In FY 2003: Developed preliminary large ampere-hour cells for lithium-ion cell batteries that address cycle life technical issues for aircraft and Low Earth Orbit space applications and also addressed calendar life technical issues paramount for Geosynchronous Earth Orbit applications. Next generation, high energy density and high power density rechargeable lithium-ion cell batteries (for future lightweight, less expensive advanced spacecraft and aircraft (manned and unmanned) and possibly for high power weapons and ground support equipment) offer advantages over conventional, rechargeable systems by storing the same amount of energy at one-fourth the weight.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: High-Power, Advanced Low-Mass (HPALM).	1.459	2.479	0.000
(U)	In FY 2003: Developed component and system technologies for the HPALM solar thermionic power system, including inflatable concentrator materials and design, thermionic cell materials and advanced converter design, secondary concentrator design, thermal storage materials, and high temperature power conditioning aimed at supporting a ground demonstration of a 5 kW solar-thermionic power system. Potential HPALM applications in space are high power (>50 kW) orbital transfer propulsion, communication, radar or direct energy platforms. Performance analyses will continue with an emphasis on studying unique mission capabilities and comparing HPALM capabilities and launch characteristics (size, weight, and cost) to that of other space power systems.			
(U)	In FY 2004: Design, fabricate and test prototype components supporting a 5 kW HPALM solar-thermionic power system ground demonstration, including inflatable concentrator, thermionic inverted converter, secondary concentrator, thermal receiver with thermal storage and high temperature power conditioning. Investigate integration of prototype components as an initial ground demo system analysis. Continue performance and mission analysis of a conceptual 50kW HPALM space power system based on prototype data.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Unmanned Combat Air Vehicles (UCAV) Integral Starter/Generator.	0.973	0.000	0.000
(U)	In FY 2003: Provided hardware and technology supporting demonstrations, at an engine manufacturer, of integrated power extraction from an integral starter/generator for UCAV with a focus on anticipated Navy and Air Force Unmanned Combat Air Vehicles power requirements. The integral starter/generator allows the engine to be started electrically, provides electrical power to support aircraft operations, and fits internal to the case, thus requiring no aircraft volume.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004		
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology		
(U) CONGRESSIONAL ADD: Cell-Level Battery Control. Note: Only for SBIR Phase 3 cell level battery controller development.		0.000	0.992	0.000
(U) In FY 2003: Not Applicable.				
(U) In FY 2004: Design, fabricate, and test prototype components for monitoring and control of charge and temperature of battery energy storage systems of battery controller for Lithium Ion battery system to address cell level charge and thermal management.				
(U) In FY 2005: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Lightweight Photovoltaics for Portable Power And Hydrogen Generation.		0.000	0.992	0.000
(U) In FY 2003: Not Applicable.				
(U) In FY 2004: Investigate various photovoltaic solar cells to determine performance characteristics. Design, fabricate, test and integrate photovoltaic solar cells with a water electrolizer to generate hydrogen. Photovoltaics will be integrated into solar cell technology with a water electrolizer to generate hydrogen. This hydrogen can be used in a fuel cell to support applications ranging from low power special operations to high power, high altitude airships and long endurance unmanned aerial vehicles.				
(U) In FY 2005: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Hypersonic Vehicle Electric Power System (HVEPS) Technology.		0.000	2.181	0.000
(U) In FY 2003: Not Applicable.				
(U) In FY 2004: Design, fabricate, and test a small 10-100 kilowatt demonstration magnetohydrodynamic (MHD) generator. This demonstration includes the use of high temperature ceramic electrodes and modern commercial cryocoolers with superconducting magnets that are integrated, but thermally isolated from the high temperature MHD channel with active cooling.				
(U) In FY 2005: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: High Powered Electrical Aircraft Capabilities (HiPEAC).		0.000	2.975	0.000
(U) In FY 2003: Not Applicable.				
(U) In FY 2004: Perform system analyses of high-powered electrical systems including investigation of integrated subsystems and various component technologies. Design, fabricate, and test prototype components that are critical to high-powered electrical systems. HiPEAC is an electrical power system demonstrator and test bed that supports current and future high power systems, thus enabling new sensor, communications, and directed energy applications.				
(U) In FY 2005: Not Applicable.				
(U)				
(U) CONGRESSIONAL ADD: Center for Security of Large-Scale Systems.		0.000	2.975	0.000
(U) In FY 2003: Not Applicable.				

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

(U) In FY 2004: Develop accurate, high-speed computations for the implementation of fast-acting on-line control to enhance security and survivability of military installations and applications. Develop advanced distributed heterogeneous simulation techniques and implement their application to the security of large scale systems. Configure and exercise predictive simulations, and develop and test prototype hardware to verify and validate the modeling and simulation accuracy.

(U) In FY 2005: Not Applicable.

(U) Total Cost	31.738	35.162	24.946

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602102F, Aerospace Flight Dynamics.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0602805F, Dual Use Science and Technology.									
(U) PE 0603605F, Advanced Weapon Technology.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 4847 Rocket Propulsion Technology

Cost ($ in Millions)	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4847 Rocket Propulsion Technology	35.251	24.891	10.903	12.953	15.738	11.945	11.987	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique tasks in this project were transferred to PE 0602500F in conjunction with the Space Commission recommendation to consolidate all space unique activities. In this project, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles.

(U) A. Mission Description and Budget Item Justification

This project develops technologies for the sustainment of strategic systems (including solid boost/missile propulsion, Post Boost Control, aging and surveillance efforts) and tactical rockets. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Technologies are 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 Technology for the Sustainment of Strategic Systems program and support the Integrated High Payoff Rocket Propulsion Technology program.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	17.554	0.000	0.000
(U) In FY 2003: This project previously included space unique funding, which were transferred to PE 0602500F, Project 5026. These funds represent the civilian salaries for the work effort transferred.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST: Support Post Boost Control Systems (PBCS) and solid rocket motor development work being done in 0602500F, Project 5026. Efforts support the Technology for the Sustainment of Strategic Systems (TSSS) program - Phase I. Note: In FY 2005, the efforts in this activity will be moved to the Advanced Technology Development efforts in PE 0603216F, Project 4922.	0.000	1.650	0.000
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Complete risk reduction efforts supporting the Phase I missile propulsion demonstration. Continue Phase I full-scale risk reduction component developments and testing to support the advanced PBCS demonstration. Note: Note: In FY 2005, the efforts in this activity will be moved to the Advanced Technology Development efforts in PE 0603216F, Project 4922.			
(U) In FY 2005: Not Applicable.			
(U)			
(U) MAJOR THRUST/CONGRESSIONAL ADD: Develop missile propulsion and boost technologies for tactical and ballistic missile systems. Efforts support the Technology for the Sustainment of Strategic Systems program - Phase II. Note: This effort includes a FY 2003 Congressional Add of $5.7 million.	5.542	10.639	8.897

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology

(U)	In FY 2003: Began component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Commenced verifying performance and weight improvements of rapid densification nozzle technology, using improved strategic propellants for future ballistic missiles. Demonstrated low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Commenced formulating and characterizing new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion.			
(U)	In FY 2004: Conduct component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Verify performance and weight improvements of rapid densification nozzle technology, using improved strategic propellants for future ballistic missiles. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Continue formulating and characterizing new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion. Initiate development and updates to solid rocket motor modeling and simulation tools to improve industry capability to design ballistic missile components (cases, nozzles, insulation, etc.) and motors. Continue development of advanced tactical propulsion components begun under PE 0602500F, Project 5026.			
(U)	In FY 2005: Enhance component development and risk reduction efforts for the Phase II ballistic missile technology demonstration. Continue verifying performance and weight improvements of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon ceramic and hybrid polymer components for solid rocket motors. Continue formulating and characterizing new propellant formulations using new fuels and oxidizers developed the last couple years for the next phase of advanced solid propulsion. Continue modeling and simulation tool developments for solid rocket motors. Initiate component development efforts for the Phase II missile propulsion demonstration. Continue development of advanced tactical propulsion components.			
(U)				
(U)	MAJOR THRUST: Develop missile propulsion technologies and aging and surveillance technologies for Intercontinental Ballistic Missile (ICBM). Efforts support the Technology for the Sustainment of Strategic Systems program- Phase II.	0.000	1.893	2.006
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Initiated Phase II aging and surveillance technology developments in analysis codes, tools, and inspection tools for improved assessment of ballistic missile aging characteristics and status.			
(U)	In FY 2005: Continue Phase II aging and surveillance technology developments in analysis codes, tools, and inspection tools for improved assessment of ballistic missile aging characteristics and status.			
(U)				
(U)	CONGRESSIONAL ADD: Cryogenic Installation for Jet and Rocket Engine Test Site. Note: Only for cryogenic propellant storage and delivery systems with related control and safety systems.	7.488	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology

(U)	In FY 2003: Upgraded the existing Jet Engine Test Cell, located on the former Norton Air Force Base in San Bernardino, to enable the development testing of larger rocket engines, including those needing cryogenic propellants. The capability installed will enable medium-size rockets to be tested and is complimentary to component test facilities at Edwards Air Force Base.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Vehicle and Propulsion Center. Note: For a common AFRL/SMC product center co-located with the Rocket Propulsion Laboratory.	2.430	4.462	0.000
(U)	In FY 2003: Performed initial Analysis of Alternatives at the Advanced Vehicle and Propulsion Center to enable the next stage of acquisition planning for the following key Air Force Space Command missions: prompt global strike capability, land-based strategic nuclear deterrent, and operationally-responsive space lift system.			
(U)	In FY 2004: Continue technical support for the Analysis of Alternatives for the following key Air Force Space Command missions: prompt global strike, land-based strategic deterrent, and operationally responsive space lift.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Reusable Launch Vehicle (RLV) Technologies. Note: To upgrade space infrastructure to support RLV development.	2.237	0.000	0.000
(U)	In FY 2003: Upgraded space infrastructure facilities at the Air Force Research Laboratory's Edwards Air Force Base research site to provide data on the responsiveness of candidate new Reusable Launch Vehicle system designs.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Hybrid Polymers.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Build a pilot plant for the scale-up of Polyhedral Oligomeric Silsesquioxane (POSS) polymers producing much larger quantities at much cheaper prices and accelerating the further development and application of this new class of polymers for applications in liquid and solid rocket engines and spacecraft engines.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Engineering Tool Improvement Program (ETIP). Note: Efforts expand upon activities initiated in a FY 2003 Congressional Add in PE 0602500F, Project 5026.	0.000	4.263	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Develop and improve modeling and simulation tools to address spacecraft component interactions and solid rocket motor component contributions and technology payoffs. Develop improvements identified from previous			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology

work for liquid engine system modeling and simulation tools.

(U) In FY 2005: Not Applicable.

(U)

(U)	CONGRESSIONAL ADD: Integrated High Payoff Rocket Propulsion Technology.	0.000	0.992	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Conduct risk reduction efforts in the Technology for the Sustainment of Strategic Systems program-Phase I seeking a 25 percent cost reduction and 5:1 turndown ratio of a Post Boost Control Propulsion System using sustainable materials.			
(U)	In FY 2005: Not Applicable.			
(U)	Total Cost	35.251	24.891	10.903

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

	FY 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0602303A, Missile Technology.									
(U) PE 0602805F, Dual Use Science and 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.