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

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2004

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and 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
	Total Program Element (PE) Cost	84.067	93.425	79.914	68.626	74.950	92.472	93.006	Continuing	TBD
2480	Aerospace Fuels and Atmospheric Propulsion	11.498	3.101	0.374	0.338	3.163	5.359	5.445	Continuing	TBD
3035	Aerospace Power Technology	5.728	4.185	4.297	4.332	4.412	4.487	4.560	Continuing	TBD
4921	Aircraft Propulsion Subsystems Int	33.809	28.600	16.719	19.647	15.036	26.533	26.920	Continuing	TBD
4922	Space & Missile Rocket Propulsion	1.344	12.739	6.039	7.065	5.038	5.123	5.204	Continuing	TBD
5098	Advanced Aerospace Propulsion	0.000	15.750	26.300	10.819	20.387	23.605	23.074	Continuing	TBD
681B	Advanced Turbine Engine Gas Generator	31.688	29.050	26.185	26.425	26.914	27.365	27.803	Continuing	TBD

Note: In FY 2003, space unique tasks in Project 4922 were transferred to PE 0603500F, Project 5033, in conjunction with the Space Commission recommendation to consolidate all space unique activities. In Project 4922, space unique includes all Integrated High Payoff Rocket Propulsion Technology activities except Technology for the Sustainment of Strategic Systems and tactical missiles. In FY 2004, Project 5098 is a new project, but not a New Start.

(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 technologies 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. In FY 2004, Congress added $2.5 million for the Advanced Turbine Engine Gas Generator and Aircraft Propulsion Subsystems Integration, and removed $23.0 million from the Space and Missile Rocket Propulsion efforts.

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2004
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology

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

		FY 2003	FY 2004	FY 2005
(U)	Previous President's Budget	88.236	114.726	62.578
(U)	Current PBR/President's Budget	84.067	93.425	79.914
(U)	Total Adjustments	-4.169	-21.301	
(U)	Congressional Program Reductions		-23.000	
	Congressional Rescissions		-0.801	
	Congressional Increases		2.500	
	Reprogrammings	-1.565		
	SBIR/STTR Transfer	-2.604		

(U) Significant Program Changes:

Changes to this program since the previous President's Budget are due to decreased funding for technologies supporting the National Aerospace Initiative.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE: 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE: 2480 Aerospace Fuels and Atmospheric 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
2480	Aerospace Fuels and Atmospheric Propulsion	11.498	3.101	0.374	0.338	3.163	5.359	5.445	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 improved hydrocarbon fuels and advanced, novel aerospace propulsion systems, including systems for high-speed/hypersonic flight. 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 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Evaluate and develop advanced (ramjet/scramjet) and combined cycle engine options for next generation aerospace vehicles and their weapons for long-range strike and low-observables. Note: In FY 2004, these activities will be moved to PE 06032163F, Project 5098.	4.473	0.000	0.000
(U) In FY 2003: Completed development of high fidelity analytical tools to evaluate combined cycle engine options, such as gas turbine and ramjet/scramjet combinations, for next generation aerospace vehicles and their weapons for long-range strike. Completed evaluation of advanced (ramjet/scramjet) and combined cycle engine options for next generation aerospace vehicles and their weapons for long-range strike. Developed key engine technologies to maximize the use of vehicle speed in force miniaturization and platform survivability for a capability beyond low-observables. Conducted analyses and experiments to optimize component technologies for transition between gas turbine engine and ramjet/scramjet engine cycles, and to optimize the cruise speed of ramjet/scramjet engines. Conducted a pre-design study to evaluate force-multiplier and bomber survivability as a function of a flight Mach number achievable for next generation aerospace vehicles and their weapons.			
(U) In FY 2004: Not Applicable.			
(U) In FY 2005: Not Applicable.			
(U)			
(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. Note: Due to FY 2005-2007 funding shifts, the FY 2004-2005 high heat sink fuel technologies demonstration efforts were slipped for completion in post FY 2007.	0.672	0.802	0.060
(U) In FY 2003: Studied, tested, and demonstrated specific advanced high-heat sink fuels that can increase fuel delivery			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **2480 Aerospace Fuels and Atmospheric Propulsion**

system durability at high temperatures and reduce maintenance due to fuel degradation in a sub-scale integrated fuel/air heat exchanger. Demonstrated long-term JP-8+225 performance in a fuel system simulator.

(U) In FY 2004: Continue to study, test, and demonstrate, at a pilot-light level, advanced high-heat sink fuels and hardware concepts that can increase fuel delivery system durability and performance at high temperatures and can reduce maintenance due to fuel degradation in aircraft fuel systems and engine control hardware. Develop bread-board, on-engine fuel additive injection hardware. Continue demonstrating long-term JP-8+225 performance in bench and full-scale fuel systems. Initiate demonstration of the performance of fuel developed from alternative (non-petroleum) sources in reduced scale fuel system simulators.

(U) In FY 2005: Continue to study, test, and demonstrate, at a pilot-light level, 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)

(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). Note: Due to FY 2005-2007 funding shifts, the FY 2004-2005 UAV fuel additive efforts were revised for a restart in post FY 2007.	0.384	0.415	0.150

(U) In FY 2003: Developed requirements for low temperature additives to prevent fuel from freezing to allow advanced manned and unmanned systems sustain high altitude loiter for extended periods. Commenced refining the design and building an UAV fuel system/tank simulator to study high and low temperature fuel behavior.

(U) In FY 2004: Demonstrate, at a pilot-light level, low temperature additives for use in jet fuel to allow advanced manned and unmanned systems to sustain high altitude loiter for extended periods. Continue refining the design and building an UAV fuel system/tank simulator to study low temperature fuel behavior. Demonstrate additive performance in aircraft like fuel system simulator.

(U) In FY 2005: Continue 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.

(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. Note: Due to FY 2005-2007 funding shifts, the FY 2005 combined cycle engine fuel additive efforts were revised for a restart in post FY 2007.	0.769	0.802	0.060

(U) In FY 2003: Expanded demonstration testing with low-cost fuel additives to reduce particulate emissions from gas turbine engines by 50 percent and to improve ignition characteristics and combustion in current and advanced propulsion concepts, including combined cycle engines. Demonstrated effectiveness of particulate mitigation

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603216F Aerospace Propulsion and Power Technology**	PROJECT NUMBER AND TITLE **2480 Aerospace Fuels and Atmospheric Propulsion**

	additives in a full-scale engine test.			
(U)	In FY 2004: Continue pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent. Continue developing additives to improve ignition and combustion characteristics in current and advanced propulsion concepts, including combined cycle engines. Qualify additives through material compatibility, toxicology, and hot section tests, and demonstrate additive effectiveness in engine component tests.			
(U)	In FY 2005: Continue pilot-light level demonstrations of additives that reduce soot emissions by at least 50 percent.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate enhancements to fuel system technology. Note: Due to FY 2005-2007 funding shifts, the FY 2005 combined cycle engine candidate/hardware efforts were revised for a restart in post FY 2007.	0.384	0.682	0.057
(U)	In FY 2003: Designed and developed concept hardware and fuel system simulators to evaluate key high temperature components of reusable aerospace vehicles, focusing on aerospace vehicles with advanced and combined cycle engines that require high levels of fuel cooling. Characterized hydrocarbon fuel candidates for combined cycle engines. Completed investigating fuel concepts that will maximize the performance of advanced or combined cycle engines and minimize logistic costs.			
(U)	In FY 2004: Continue to design and develop concept 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. Continue characterization of hydrocarbon fuel candidates and enhanced hardware concepts for combined cycle engines.			
(U)	In FY 2005: 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)				
(U)	MAJOR THRUST: Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Expeditionary Air Force. Note: Due to FY 2005-2007 funding shifts, the FY 2005 novel nozzle efforts were revised for a restart in post FY 2007.	0.841	0.400	0.047
(U)	In FY 2003: Determined the benefits of advanced additive packages to improve any commercially available jet fuel that can meet military standards. Developed novel methods to inject additives packages to improve fuels and advanced field diagnostic techniques, such as smart nozzles, to assess fuel quality, additive injection requirements, and aid in mission planning by monitoring mission limiting fuel properties. Demonstrated a field-capable concept for fuel identification and characterization.			
(U)	In FY 2004: Continue pilot-light development of novel methods for fuel analysis and additization in order to extend the usable temperature range of commercially available aviation fuel through application of novel technologies, including biologically related approaches. Demonstrate applicability of rapid fuel screening and identification using			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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chromatography-based statistical analysis methods and commercially available fuel analyzers.

(U) In FY 2005: Continue pilot-light development of novel methods including bio- and nano-technology for fuel analysis.

(U)

(U)	CONGRESSIONAL ADD: Variable Flow Ducted Rocket (VFDR) Propulsion System.	3.975	0.000	0.000

(U) In FY 2003: Develop a preliminary design for an integrated tactical missile technology demonstrator using a VFDR. Developed conceptual designs for VFDR tactical missiles that are compatible with the internal carriage in the F/A-22. Defined a preliminary flight test plan. Developed high-fidelity models and simulations for engineering, engagement, and mission analysis. Performed critical experiments to reduce the risk of key component technologies.

(U) In FY 2004: Not Applicable.

(U) In FY 2005: Not Applicable.

(U)	Total Cost	11.498	3.101	0.374

(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 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 2004
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 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
3035 Aerospace Power Technology	5.728	4.185	4.297	4.332	4.412	4.487	4.560	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 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate high-density secondary power systems and advanced weapons power technologies for a next generation aerospace vehicle.	1.921	0.000	0.000
(U) In FY 2003: Completed trade studies, detailed design, and critical technology development to optimize secondary power system size, weight, and efficiency. Completed evaluating electric power technology options for advanced weapon systems.			
(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) 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.	0.815	1.190	1.560
(U) In FY 2003: Developed a high power, low duty cycle generator for pulsed DEWs. Completed fabricating lengths of Yttrium Barium Copper Oxide sufficient to fabricate coated conductors for cryogenic generators.			
(U) In FY 2004: Fabricate and test high power, low duty cycle generator critical components for pulsed DEWs.			
(U) In FY 2005: Fabricate high power low duty cycle generator system for pulsed DEWs.			
(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.	1.009	2.043	1.974
(U) In FY 2003: Developed a power electrical generator system that is closely coupled with the propulsion system.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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**

(U)	In FY 2004: Initiate design of the demonstration electrical generator for integration into mid-thrust class engines. Fabricate and test large amp-hour (200) cells and batteries.			
(U)	In FY 2005: Complete detailed design of demonstration electrical generator for integration into mid-thrust class engines.			
(U)				
(U)	MAJOR THRUST: Develop power generation/conditioning/distribution, energy storage, and thermal management components and subsystem technologies that are synergistic with air, space, and weapons platforms.	1.983	0.952	0.763
(U)	In FY 2003: Demonstrated advanced power conditioning technologies with motor drives and lithium-ion batteries to provide reductions in both volume and weight.			
(U)	In FY 2004: Fabricate low volume/low weight high temperature motor drive.			
(U)	In FY 2005: Test low volume/low weight high temperature motor drive.			
(U)	Total Cost	5.728	4.185	4.297

(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 0602203F, Aerospace Propulsion.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602605F, Directed Energy Technology.									
(U) PE 0603605F, Advanced Weapons Technology.									
(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
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 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4921 Aircraft Propulsion Subsystems Int	33.809	28.600	16.719	19.647	15.036	26.533	26.920	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 gas turbine propulsion system technologies applicable to aircraft. The Aerospace Propulsion Subsystems Integration (APSI) project includes demonstrator engines such as the Joint Technology Demonstrator Engine for manned systems and the Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. The demonstrator engines integrate the core (high-pressure spool) technology developed under the Advanced Turbine Engine Gas Generator project with the engine (low-pressure spool) technology such as fans, turbines, engine controls, and exhaust nozzles. Additionally, these efforts include activities under the national High Cycle Fatigue program. This project also focuses on system integration of inlets, nozzles, engine/airframe compatibility, power and thermal management subsystems, and low-observable 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. The 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 2003	FY 2004	FY 2005
(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.	6.056	7.359	2.577

(U) In FY 2003: Completed analysis, fabrication, instrumentation, and assembly of an engine for structural/durability testing. Completed refurbishment of the Advanced Turbine Engine Gas Generator, fabrication, and instrumentation in preparation for final assembly of the Joint Technology Demonstrator Engine with fixed inlet guide vanes and Moderate Aspect Ratio rotor, Integrally Bladed Rotor repair, fan rim damper, High Cycle Fatigue mistuning and damping technologies, vaneless counter-rotating high/low pressure turbine, probabilistic rotor system design, gamma titanium aluminide low pressure turbine coverplate, sprayform cast hardware, and Ceramic Matrix Composite technologies.

(U) In FY 2004: Complete structural durability testing on an engine and performance testing of the Joint Technology Demonstrator Engine containing fixed inlet guide vanes and a Moderate Aspect Ratio rotor, fan rim damper, High Cycle Fatigue mistuning and damping technologies, vaneless counter-rotating high/low pressure turbine, probabilistic

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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rotor system design, sprayform cast turbine case, and a high fuel/air ratio Impingement Film Floatwall Combustor. Initiate advanced engine designs for a sustained supersonic engine with advanced aero, mistuned fan with ice phobic coatings, a Low Pressure Turbine with advanced thermal barrier coatings and microcircuit cooling scheme, thermoplastic externals and health monitoring.

(U) In FY 2005: Validate the High Cycle Fatigue Test Protocol by completing structural durability testing of advanced engine components and instrumentation. Enhance advanced engine designs for a sustained supersonic engine with advanced aero, mistuned fan with ice phobic coatings, a Low Pressure Turbine with advanced thermal barrier coatings and microcircuit cooling scheme, thermoplastic externals, and health monitoring.

(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 engineers.	17.521	14.762	12.072

(U) In FY 2003: Completed advanced engine designs and initiated fabrication of a High Cycle Fatigue robust front frame, an affordable Organic Matrix Composite (OMC) fan frame, a two-stage forward swept fan, a tiled low pressure turbine (LPT) blade, an uncooled Ceramic Matrix Composite LPT blade, a Metal Matrix Composite shaft, and model-based flexible control with diagnostics. Initiated advanced engine designs for tandem fan with (OMC) tip shroud, carbon counter-rotating intershaft seal, and active augmenter screech control.

(U) In FY 2004: Complete fabrication, instrumentation, assembly, and test of a High Cycle Fatigue robust front frame, an affordable OMC fan frame, a two-stage forward swept fan, a tiled LPT blade, an uncooled Ceramic Matrix Composite LPT blade, a Titanium Matrix Composite shaft, and model-based flexible control with diagnostics in an advanced demonstrator engine. Enhance advanced engine designs for a tandem fan with OMC tip shroud, carbon counter-rotating intershaft seal, and active augmentor screech control.

(U) In FY 2005: Complete fabrication and initiate testing of a High Cycle Fatigue robust front frame, an affordable OMC fan frame, a two-stage forward swept fan, a tiled LPT blade, an uncooled Ceramic Matrix Composite LPT blade, a Titanium Matrix Composite shaft, and model-based flexible control with diagnostics. Complete advanced engine designs for tandem fan with OMC tip shroud, carbon counter-rotating intershaft seal, and active augmentor screech control.

(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 vehicle, and hypersonic weapon applications.	7.561	4.000	2.070

(U) In FY 2003: Completed fabrication and commenced testing on an Organic Matrix Composite fan, uncooled ceramic high-pressure turbine, and slinger combustor. Completed fabrication of a low volume combustor. Prepared for

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	engine structural durability testing of a high stage loading splittered fan and uncooled ceramic low-pressure turbine. Completed study effort to identify critical technologies for a supersonic turbine engine powered missile.			
(U)	In FY 2004: Complete engine structural durability testing of a high stage loading splittered fan and uncooled ceramic low-pressure turbine. Complete testing of an Organic Matrix Composite fan, an uncooled ceramic high-pressure turbine, and slinger combustor. Complete testing of low volume combustor. Complete fabrication and conduct durability testing on an uncooled Ceramic Matrix Composite turbine blisk/nozzle, and a Carbon/Carbon exhaust nozzle. Initiate designs of advanced component technologies for intelligent and durability engine testing.			
(U)	In FY 2005: Initiate designs of advanced component technologies for intelligent and durability engine testing to include an advanced fan, a ceramic turbine, turbine with new advanced cooling approach, and oil less bearings.			
(U)				
(U)	MAJOR THRUST: Develop high-speed turbine engine technology for next generation air and space vehicles.	1.710	0.000	0.000
(U)	In FY 2003: Completed study to evaluate gas turbine technologies for long-range strike vehicles (e.g., gas turbine and ramjet/scramjet combined/combination cycle engines).			
(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: Joint Expendable Turbine Engine Concept (JETEC) Phase III.	0.961	0.000	0.000
(U)	In FY 2003: Designed and fabricated a fixed composite nozzle and added instrumentation to the combustor for the JETEC Phase III demonstrator engine test. The JETEC goal is to develop turbine engines that reduce fuel consumption, increase thrust/airflow ratio, and reduce production costs for supersonic expendable and limited life unmanned vehicle turbine engines. These efforts will contribute to the continued detailed design, fabrication, assembly, and test of materials and high pressure ratio technologies. Technologies include single crystal Lamilloy blades and advanced thermal barrier coated cast cool vanes.			
(U)	In FY 2004: Not Applicable.			
(U)	In FY 2005: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Turbine Engine Gas Generator And Aircraft Propulsion Subsystem Integration.	0.000	2.479	0.000
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Design and fabricate advanced component technologies for improved performance and fuel consumption of turbofan/turbojet engines for fighters, bombers, and transports. Refurbish, fabricate, instrument and assemble hardware from the advanced turbine engine gas generator. This gas generator will be used in engine testing of the following components: two-stage forward swept fan, uncooled Ceramic Matrix Composite low pressure turbine vane, Titanium Matrix Composite shaft and model-based flexible control with diagnostics. Each of these component technology innovations can be applied to the Air Force's engine inventory and offer potentially significant			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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performance enhancements to future aircraft engines.

(U) In FY 2005: Not Applicable.

(U) Total Cost	33.809	28.600	16.719

(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 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 2004
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 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
4922 Space & Missile Rocket Propulsion	1.344	12.739	6.039	7.065	5.038	5.123	5.204	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2003, space unique technology efforts in this project were transferred to PE 0603500F, Project 5033, 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 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 will improve the performance of expendable systems' payload capabilities by approximately 20 percent and reduce hardware and operation costs by approximately 30 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 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Civilian salaries.	1.344	0.000	0.000
(U) In FY 2003: This project previously included space unique funding, which was transferred to PE 0603500F, Project 5033. 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: Develop and demonstrate missile propulsion and Post Boost Control Systems (PBCS) technologies for Intercontinental Ballistic Missile (ICBM). Note: Efforts support work being conducted in 0603500F, Project 5033, for the Technology for the Sustainment of Strategic Systems-Phase I.	0.000	6.501	1.721
(U) In FY 2003: Not Applicable.			
(U) In FY 2004: Demonstrate component technologies with readily available materials to reduce hardware costs with increased performance for the PBCS. Continue hardware development integrating case, nozzle, insulation, and propellant for the Missile Propulsion Demonstration-Phase I.			
(U) In FY 2005: Complete Phase I full-scale risk reduction component developments for the advanced PBCS demonstration. Complete demonstration of component technologies with readily available materials to reduce hardware costs with increased performance for the PBCS. Enhance hardware development integrating case, nozzle,			

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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**

insulation, and propellant for the Missile Propulsion Demonstration-Phase I.

(U)

(U)	MAJOR THRUST: Develop and demonstrate missile propulsion, Post Boost Control Systems (PBCS), aging, and surveillance technologies for strategic systems. Efforts support the Technology for Sustainment of Strategic Systems-Phase II.	0.000	6.238	4.318
(U)	In FY 2003: Not Applicable.			
(U)	In FY 2004: Begin development of advanced modeling and simulation tools (Phase II) applying them to actual missile components for verification, design, and modification. Begin development of advanced aging and surveillance models and tools to further improve capability to analyze and predict motor life and system health.			
(U)	In FY 2005: Continue modeling and simulation tools (Phase II) development for analyzing and developing missile components. Begin to develop subcomponents to test the accuracy of the tools and update the models with the resulting data. Continue development of aging and surveillance tools for predicting the health of solid rocket motors. Develop methods to apply these tools on a motor-by-motor basis vice a fleet wide basis.			
(U)	Total Cost	1.344	12.739	6.039

(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 0602102F, Materials.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603401F, Advanced Spacecraft Technology.

(U) PE 0603853F, Evolved Expendable Launch Vehicle Program.

(U) PE 0603114N, Power Projection Advanced Technology.

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

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2004

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

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

PROJECT NUMBER AND TITLE: 5098 Advanced 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
5098 Advanced Aerospace Propulsion	0.000	15.750	26.300	10.819	20.387	23.605	23.074	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2004, this Project is a new project, but not a New Start. In FY 2005-2007, funding was shifted Projects 2480 and 4921 in this PE to this Project.

(U) A. Mission Description and Budget Item Justification

This 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) to provide revolutionary propulsion options for the Air Force. 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 potential low speed propulsion systems during hypersonic flight.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation over a range of Mach 4 to 8.	0.000	15.750	26.300
(U) In FY 2003: Not Applicable. Note: Activities were previously part of other projects in this PE.			
(U) In FY 2004: Design and fabricate a fixed geometry flow-path for a hydrocarbon-fueled scramjet with robust operations over a range of Mach 4.5 to 7+ to include optimization of the flow-path cross-section and the flame-holding/fuel-mixing geometry. Develop a robust engine start system to achieve full engine light after boost to Mach 4.5. Initiate design of an active engine sense-control system to manage start transient and engine mode changes during acceleration. Initiate vehicle design capable of rocket-boost to Mach 4, full integration with scramjet engine and hydrocarbon fuel system, and acceleration from Mach 4.5 to 7+. Initiate selection of rocket boosters.			
(U) In FY 2005: Initiate ground test of the hydrocarbon-fueled, fixed geometry flow path. Continue detailed design of the scramjet engine demonstrator air vehicle. Conduct wind tunnel testing of the air vehicle models. Conduct 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) Total Cost	0.000	15.750	26.300

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER AND TITLE 5098 Advanced Aerospace Propulsion

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

(U) D. Acquisition Strategy

Not Applicable

Exhibit R-2a, RDT&E Project Justification			DATE: February 2004
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 2003 Actual	FY 2004 Estimate	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	Cost to Complete	Total
681B	Advanced Turbine Engine Gas Generator	31.688	29.050	26.185	26.425	26.914	27.365	27.803	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 turbine engine gas generator technologies for current and future aircraft propulsion systems. The objective is to provide the continued evolution of technologies into an advanced gas generator in which the performance, cost, durability, reparability, and maintainability can be assessed in a real engine environment. The gas generator, or core, is the basic building block of the engine and it consists of a compressor, a combustor, and a high-pressure turbine. Experimental core engine testing enhances early, low-risk transition of key engine technologies into engineering development, where they can be applied to derivative and/or new systems. These technologies are applicable to a wide range of military and commercial systems including aircraft, missiles, land combat vehicles, ships, and responsive space launch. Component technologies are demonstrated in a core (sub-engine) test. The core performances of this project are proven in demonstrator engines in Project 4921 of this PE. Efforts are part of the Integrated High Performance Turbine Engine Technology and the Versatile Affordable Advanced Turbine Engine programs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2003	FY 2004	FY 2005
(U) MAJOR THRUST: Design, fabricate, and test performance demonstration core engines, using advanced materials including Titanium Matrix Composites, to provide improved performance and 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.	26.579	24.390	21.866

(U) In FY 2003: Completed design and continued hardware fabrication of a core engine test article with an advanced compressor aerodynamics, a trapped vortex combustor with a ceramic matrix composite combustor liner, a ceramic matrix composite vane, magnetic bearings, and an advanced high-pressure turbine blisk. Completed core engine testing of a high-pressure ratio four stage compressor with an integrated lightweight combustor that has microcircuit cooled turbine blade outer airseals, revolutionary hot section material, advanced Thermal Barrier Coating, and thinwall supercooled turbine blades. Preliminarily designed a core engine test article with a 6-stage compressor, an Integrated Lightweight Combustor with integrated vane pack, a cooled-cooling air system, and micro-circuit cooled high pressure turbine blades with advanced thermal barrier coating.

(U) In FY 2004: Continue hardware fabrication of a core engine test article with advanced compressor aerodynamics, a trapped vortex combustor with ceramic matrix composite combustor liners, magnetic bearings, and advanced turbine blisk and vane materials. Continue design of hardware for core engine testing of a high-pressure ratio six-stage compressor with an integrated lightweight combustor with integrated vane pack, a cooled cooling air system, and micro-circuit cooled high pressure turbine blades with advanced thermal barrier coating.

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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

(U)	In FY 2005: Continue hardware fabrication of a core engine test article with advanced compressor aerodynamics, a trapped vortex combustor with ceramic matrix composite combustor liners, magnetic bearings, advanced turbine blisk and advanced turbine vane materials. Complete design and initiate fabrication of hardware for core engine testing of a cooled-cooling air system, and micro-circuit cooled high pressure turbine blades with advanced thermal barrier coating.			
(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.	1.826	1.506	1.500
(U)	In FY 2003: Designed and initiated fabrication of long lead hardware for turbine engine advanced hardware for core engine evaluations in the national durability programs.			
(U)	In FY 2004: Enhance the design and continue fabrication of long lead hardware for turbine engine advanced core evaluations in the national durability programs.			
(U)	In FY 2005: Complete the design and continue fabrication of long lead hardware for turbine engine advanced hardware for core engine evaluation in the national durability programs.			
(U)				
(U)	MAJOR THRUST: Design, fabricate, and evaluate technology demonstration core engines to provide improved performance and fuel consumption for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, theater transports, and large unmanned air vehicles.	3.283	3.154	2.819
(U)	In FY 2003: Advanced core engine testing of a forward swept splittered compressor rotor, a high temperature rise combustor, a counter- rotating vaneless turbine, and ceramic matrix composite turbine blades and vanes.			
(U)	In FY 2004: Continue core engine testing 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.			
(U)	In FY 2005: Complete core engine testing 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. Initiate design of small versatile affordable core engine technologies.			
(U)	Total Cost	31.688	29.050	26.185

(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 0602201F, Aerospace Flight									

Exhibit R-2a, RDT&E Project Justification		DATE February 2004
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

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

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.