Exhibit R-2, PB 2010 Air Force RDT&E Budget Item Justification									DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)					R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	139.591	180.554	175.676						Continuing	Continuing
6310SP: Space Rocket Prop Demo	32.871	24.265	0.000						Continuing	Continuing
632480: Aerospace Fuels	8.469	17.339	12.019						Continuing	Continuing
633035: Aerospace Power Technology	13.945	12.030	9.401						Continuing	Continuing
634921: Aircraft Propulsion Subsystems Int	25.870	47.451	36.568						Continuing	Continuing
634922: Space & Missile Rocket Propulsion	4.525	5.068	29.648						Continuing	Continuing
635098: Advanced Aerospace Propulsion	20.917	22.921	23.940						Continuing	Continuing
63681B: Advanced Turbine Engine Gas Generator	32.994	51.480	64.100						Continuing	Continuing

Note

Note: The funding in this PE has been increased due to emphasis on component development in support of adaptive cycle technologies, alternative hydrocarbon jet fuel, improved fuel efficiency, highly efficient embedded turbine engines, and small heavy fueled engines.

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 electrical power thermal management, and fuels. The program has seven projects, each focusing on technologies with a high potential to enhance the performance of existing and future Air Force weapons systems. The Aerospace Fuels project develops and demonstrates improved hydrocarbon fuels and advanced propulsion systems for high-speed/hypersonic flight. The Aerospace Power Technologies project develops and demonstrates power and thermal management systems for weapons and aircraft as part of the Integrated Vehicle Energy Technology (INVENT) program. 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

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Integration (APSI) 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 Versatile Affordable Advanced Turbine Engine (VAATE) program. A portion of the Fuels, ATEGG, and APSI projects supports adaptive cycle technology demonstrations which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs. 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). The Space and Missile Rocket technology project develops and demonstrates innovative rocket propulsion technologies, propellants, manufacturing techniques. Rocket propulsion projects within this program are part of the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, which includes the area of Technology for the Sustainment of Strategic Systems. In FY08 the Space and Rocket Propulsion Demonstration project develops and demonstrates advanced and innovative low cost rocket turbo machinery and components, low cost space launch propulsion system technologies, and advanced propellants for launch and orbit transfer propulsion. In FY10 work in 10SP will be consolidated into 4922 to better align work.

B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	142.543	170.856	189.246	
Current BES/President's Budget	139.591	180.554	175.676	
Total Adjustments	-2.952	9.698	0.000	
Congressional Program Reductions	0.000	-5.011		
Congressional Rescissions	0.000	-0.491		
Total Congressional Increases	0.000	14.400		
Total Reprogrammings	0.573	0.800		
SBIR/STTR Transfer	-3.525	0.000		

Change Summary Explanation

In FY 2009 Congress added $0.8 million for Hybrid Sounding Rocket Propulsion; $1.6 million for the Texas Research Institute for Environmental Studies; $1.6 million for Assured Aerospace Fuels Research; $0.8 million for Bio-JP8 Fuels Research; $2.0 million for Renewable Hydrocarbon Fuels for Military Applications (Great Lake Region); $3.2 million for Silicon Carbide (SiC) Power Electronics for More Electric Aircraft; $3.6 million for Versatile Affordable Advance Turbine Engine (VAATE) - Small Turbofan (STF);and, $1.6 million for Small Adaptive Cycle Turbine Engines. This program is in Budget Activity 3, Advanced Technology Development, since it develops and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address war-fighter needs. In FY09 and beyond, funds from Project 10SP have been moved to Project 4922 within this Program Element to more accurately align efforts.

C. Performance Metrics

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(U) Under Development.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
6310SP: Space Rocket Prop Demo	32.871	24.265	0.000						Continuing	Continuing

Note

Note: In FY10 and beyond, this work was moved to Project 4922 within this Program Element to better align efforts.

A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced and innovative low-cost rocket turbo-machinery and components, low-cost space launch propulsion technologies, and advanced propellants for launch and orbit transfer propulsion. Additionally, this project develops technologies for the Technology for Sustainment of Strategic Systems Phase 1. Characteristics such as environmental acceptability, affordability, reliability, responsiveness, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. This project also develops chemical, electrical, and solar rocket propulsion technologies for station-keeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion technologies, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program could improve the performance of expendable payload capabilities by approximately 20 percent, and reduce launch, operations, and support costs by approximately 30 percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Technology advances could also lead to seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload. The efforts in this project contribute to the Integrated High Payoff Rocket Propulsion Technology program (IHPRPT), a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national space launch needs. In FY10 and beyond, this work was moved to Project 4922 within this Program Element to better align efforts.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop liquid rocket propulsion technology for current and future space launch vehicles. Note: In FY 2009 a portion of the funding was moved to support higher Air Force priorities. In FY 2008: Began hardware fabrication for advanced cryogenic upper stage technologies - turbopumps and thrust chambers. These components were used to validate modeling, simulation, and analysis tools being developed. Began preparations for testing of these components. Started component and engine designs for advanced hydrocarbon engine technologies for future reusable launch vehicles. Initiated an advanced manufacturing technology demo aimed at materials and processes to support the hydrocarbon engine	21.522	17.310	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
technology development effort. Initiated an advanced hydrocarbon fuels scale-up effort to prove out advanced hydrocarbons as fuels or additives to rocket engine fuels and for potential use in future reusable launch vehicles. In FY 2009: Complete advanced cryogenic upper stage hardware fabrication and begin testing components to validate and verify modeling and simulation tools developed. Develop hydrocarbon engine components for integration and demonstration in an advanced hydrocarbon engine concept for future reusable launch vehicles. Continue material manufacturing scale-up effort to support hydrocarbon boost demonstration program. Continue advanced hydrocarbon fuel/additive scale-up and proof efforts. In FY 2010: Not Applicable.					
MAJOR THRUST: Develop solar electric propulsion technologies for existing and future satellites, upper stages, orbit transfer vehicles, and satellite formation flying, station keeping, and repositioning. In FY 2008: Continued development of electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of Low Earth Orbit to Geosynchronous Orbit transfer. Continued component integration for the high-power Hall thruster demonstration. Continued hardware scale-up for an advanced multi-mode (high thrust or high efficiency) propulsion system for satellites. Completed development of satellite sensors to analyze satellite thruster interactions. In FY2009: Develop electric propulsion systems for orbit-transfer by developing high-power Hall thrusters capable of Low Earth Orbit to Geosynchronous Orbit transfer. Conduct and complete testing of the high-power Hall thruster demonstration. Continue hardware scale-up for an advanced multi-mode (high thrust or high efficiency) propulsion system for satellites. Continue demonstration of advanced chemical propulsion system for satellites. In FY 2010: Not Applicable.		2.148	0.220	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop electric and advanced chemical based monopropellant propulsion technologies for future satellite propulsion systems. Phases are referring to IHPRPT program phases. In FY 2008: Continued development of an advanced Phase III monopropellant thruster. In FY 2009: Continue development of advanced IHPRPT Phase III monopropellant thruster technologies. In FY 2010: Not applicable.		3.000	5.937	0.000	
CONGRESSIONAL ADD: Family of Motors Capability Demonstration. In FY 2008: Scaled-up & tested solid rocket motor component technologies to provide data on viability of a family of motors construct. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		6.201	0.000	0.000	
CONGRESSIONAL ADD: Hybrid Sounding Rocket Propulsion In FY 2008: Not Applicable. In FY 2009: Mature hybrid rocket propulsion technologies. In FY 2010: Not Applicable.		0.000	0.798	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/Not Applicable.	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
632480: Aerospace Fuels	8.469	17.339	12.019						Continuing	Continuing

Note

Note: The funding in this project has been increased in FY 2009 due to emphasis on component development in support of adaptive cycle technologies, alternative hydrocarbon jet fuel, and improved fuel efficiency.

A. Mission Description and Budget Item Justification

This project develops and demonstrates improved hydrocarbon fuels and advanced, novel aerospace propulsion technologies, including technologies for high-speed/hypersonic flight and technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. The advanced fuel emphasis is on 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 (VAATE) program. A portion of this project supports the demonstration of adaptive cycle technologies. This project develops component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Demonstrate thermally stable fuels and fuel system hardware concepts to enhance cooling capacity (performance), minimize fuel coking, and reduce fuel system maintenance. Identify, develop, and demonstrate technologies that enable the use of domestic fuel sources for military energy needs. Determine fuel cooling requirements and specifications for adaptive cycle engine architecture. Test key thermal management technologies, including high heat sink fuels, cooled cooling air systems, and high temperature/ thermally efficient fuel pumps for mission adaptive engines. Note: Funding shift caused delay in development of this effort. Increased funding in FY 2009 and out due to emphasis on component development in support of adaptive cycle technologies. In FY 2008: Demonstrated fuel combustion performance at fuel temperatures in the supercritical regime, as might be encountered in an engine employing a cooled cooling air system. Demonstrated engine durability benefits from the use of alternative fuels. Developed relationship between alternate fuel composition and	1.032	2.000	3.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
key properties, including low temperature viscosity and thermal/storage stability. Improved physical property models for alternative fuels. Developed relationship between fuel/material interactions and fuel (and material) structure. In FY 2009: Demonstrate engine and airframe durability and performance benefits from the use of alternative fuels. Develop knowledge base needed for Air Force-wide certification of alternative fuels, especially biofuels. Demonstrate cooled cooling air systems and other advanced aircraft thermal management systems. Determine fuel structure changes required to increase specific gravity to 0.775. Determine elastomer swell agents capable of increasing swell to typical JP-8 levels. Begin determination of new specification requirements for biomass-derived alternative fuels. Develop key thermal management technologies, including high heat sink fuels, cooled cooling air systems, and high temperature/thermally efficient fuel pumps. In FY 2010: Develop and asses an advanced ADVENT/HEETE integrated power/thermal management systems that include cooled cooling air systems, as well as approaches to deoxygenate fuel to improve thermal stability.					
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: In FY 2010 efforts in this and the next major thrust were combined to more accurately align efforts with organizational structure. In FY 2008: Demonstrated advanced low temperature and enhanced performance fuels for UAV applications and the Highly Efficient Embedded Turbine Engine (HEETE), focusing on advanced thermal management technologies that expand the flight envelope, range, or duration of UAVs. In FY 2009: Demonstrate an advanced UAV/HEETE thermal management system that includes a cooled cooling air system, as well as advanced approaches for ensuring fuel flow in wing tanks under high altitude, long endurance conditions.		1.874	2.354	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
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. In FY 2008: Demonstrated advanced particulate measurement diagnostics suitable for full-scale engine testing. Initiated demonstration of fuel/combustor concepts that reduce both soot and NOx. In FY 2009: Continue to demonstrate advanced particulate measurement diagnostics suitable for full-scale engine testing. Continue demonstration of fuel/combustor concepts that reduce both soot and NOx. In FY 2010: Assess fuel structure/combustion performance relationship in high pressure combustor. Demonstrate advanced particulate measurement diagnostics suitable for full-scale engine testing. Assess effectiveness of chemical kinetic models for jet fuels to match high pressure combustor flame data.		0.500	1.000	1.500	
MAJOR THRUST: Develop and demonstrate enhancements to fuel system technology. In FY 2008: Developed and demonstrated combined cycle engine cooling systems and technologies utilizing 2nd generation endothermic fuels and other advanced fuels. In FY 2009: Develop combined cycle engine cooling systems, utilizing 2nd-generation endothermic fuels and other advanced fuels. In FY 2010: Demonstrate extended duration operation of combined cycle engine regenerative cooling systems with 2nd generation endothermic fuels. Evaluate supersonic combustion of 2nd generation endothermic fuels.		0.500	1.000	1.500	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Expeditionary Air Force. In FY 2008: Developed model for growth and spread of biological materials through fuel handling systems. Demonstrated advanced nano-technology fuel additives, nano-technology fuel sensors, and novel detection and mitigation technologies for biological growth. In FY 2009: Develop ability to model spread of biological materials through fuel handling systems. Initiate demonstration of advanced additives to mitigate biological growth in conventional and alternative aerospace fuels. In FY 2010: Model the spread of biological materials (fungus, bacteria, etc) through fuel handling systems. Demonstrate advanced additives for mitigation of biological growth.	0.500	1.000	1.203	
MAJOR THRUST: Assured Fuels Initiative: Characterize and demonstrate the use of alternative hydrocarbon jet fuel to comply with Air Force certifications and standards for jet fuels. Note: Funding increase in FY 2009 due to increased emphasis on development of alternative hydrocarbon jet fuel. In FY 2008: Determined fuel structure changes required to increase specific gravity to 0.775. Determined elastomer swell agents capable of increasing swell to typical JP-8 levels. Began determination of new specification requirements for biomass-derived alternative fuels. In FY 2009: Determine fuel structure changes required to increase specific gravity to 0.775. Determine elastomer swell agents capable of increasing swell to typical JP-8 levels. Begin determination of new specification requirements for biomass-derived alternative fuels In FY 2010: Investigate biomass-derived fuel and specification requirements. Study elastomer swell agents for 100% synthetic paraffinic kerosene fuels. Initiate study of greenhouse gas footprint assessment for alternative aviation fuels.	2.900	4.000	4.816	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
CONGRESSIONAL ADD: Texas Research Institute for Environmental Studies. In FY 2008: Developed a small (air-portable) municipal wastewater treatment system. In FY 2009: Continue with technology development and demonstration of a deployable aerobic aqueous bioreactor that meets EPA standards for safe discharge of municipal wastewater into the environment. In FY 2010: Not Applicable.		1.163	1.596	0.000	
CONGRESSIONAL ADD: Assured Aerospace Fuels Research In FY 2008: Not Applicable. In FY 2009: Create sufficient alternative (non-petroleum) jet fuel to enable fuel composition-versus-properties studies. The facility will also be used for collaborative studies with fuel manufacturers on technology to produce suitable jet fuels for AF use. In FY 2010: Not Applicable.		0.000	1.596	0.000	
CONGRESSIONAL ADD: Bio-JP8 Fuels Research In FY 2008: Not Applicable. In FY 2009: Evaluation of an alternative biofuel production pathway. Currently, hydrotreated fats and oils are expected to be the initial "biokerosene" jet fuels to be evaluated.		0.000	0.798	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Not Applicable.				
CONGRESSIONAL ADD: Renewable Hydrocarbon Fuels for Military Applications (Great Lakes Region) In FY 2008: Not Applicable. In FY 2009: Conduct research to identify the most promising types of algae for use in military applications. In FY 2010: Not Applicable.	0.000	1.995	0.000	

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602203F/ Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
PE 0602102F/ Materials.	0.000	0.000							Continuing	Continuing
PE 0602204F/ Aerospace Sensors.	0.000	0.000							Continuing	Continuing
PE 0603112F/ Advanced Materials for Weapons Systems.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
633035: Aerospace Power Technology	13.945	12.030	9.401						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates electrical power, thermal management, and distribution 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 is integrated into the Integrated Vehicle Energy Technology (INVENT) and power and thermal programs. This project also develops and demonstrates electrical power and thermal management technologies to enable solid state high power density sources for directed energy weapons.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop electrical power and thermal management component subsystem technologies for integration with directed energy weapons (DEW). These technologies will enable the delivery of high power for operation of DEW. Note: In FY 2009 and FY 2010, the efforts in this thrust are reduced due to higher AF priorities. In FY 2008: Performed test of high power megawatt class low duty cycle power generation technology. In FY 2009: Complete analysis of high power magawatt class generator test results. In FY 2010: Initiate development of high energy laser flight demonstration power and thermal managment systems.	1.020	0.396	0.207	
MAJOR THRUST: Develop power generation/conditioning/distribution component, energy storage, and thermal management components and subsystem technologies for integration into current and future high power aircraft. These technologies will improve aircraft self-sufficiency, reliability, maintainability, supportability, and system weight/volume ratios, while reducing life cycle costs and enabling new capabilities. Note: Follow-on activities resume in FY 2009 after being delayed in FY 2007 and 2008 due to higher Air Force priorities.	0.000	3.443	3.992	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Not Applicable. In FY 2009: Begin design of high temperature demonstrator and fabrication of key components. In FY 2010: Complete detailed design of high temperature, energy optimized demonstrator and initiate fabrication of power and thermal management components.					
MAJOR THRUST: Develop electrical power and thermal management components and subsystem technologies for special purpose applications. Note: Effort completed in FY 2008. In FY 2008: Developed and fabricated high power density and high energy density fuel cell and battery energy storage and power and thermal management/distribution components and subsystems. Performed field tests and demonstrated a 50% weight reduction. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		1.540	0.000	0.000	
MAJOR THRUST: Develop analytical tools and subsystems for multi-megawatt superconducting electrical power systems including power generation, conditioning, thermal management, and dynamic interaction. Note: Effort completed in FY 2008. In FY 2008: Designed and fabricated multi-megawatt superconducting power and thermal management components. In FY 2009: Not Applicable.		3.150	0.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
MAJOR THRUST: Develop power and thermal management components and subsystems technologies for fielded and future high power aircraft systems applications. These technologies will enable efficient power and thermal management acquisition, storage, and transport for power on demand with increased system reliability and affordability. Note: In FY 2009 the efforts within this thrust were broken out from other efforts within this Project due to increased emphasis on component and subsystem development in support of energy optimized, high power aircraft systems providing near to far-term thermal management improvements for manned and unmanned aircraft. In FY 2008: Not Applicable. In FY 2009: Investigate, design, and develop efficient, lightweight, wide temperature range, rugged/robust power electronics, motor controls, actuators, heat exchangers, and thermal management components and subsystems. In FY 2010: Fabricate rugged/robust power electronics, motor controls, high performance electric actuators, and adaptive power and thermal management subsystems. Develop subsystems modifications to support integrated subsystems testing.		0.000	5.000	4.856	
MAJOR THRUST: Develop hybrid electrical power and thermal management components and subsystem technologies for special purpose applications. These technologies will enable long endurance small Unmanned Aerial Systems (UAS). Note: This is a continuation of the fuel cell and battery work previously applied to BAO kit. A new thrust was started to clearly show application of these technologies to Unmanned Aerial Systems (UAS). In FY 2008: Not Applicable.		0.000	0.000	0.346	

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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 633035

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2009: Not Applicable. In FY 2010: Investigate optimization of advanced hybrid fuel cell/battery subsystem designs to achieve minimum volume/weight, maximum power/energy density, and increased battery/fuel cell ruggedness, efficiency, and reliability. Assess hybrid energy management systems for expanded special purpose applications to address needed strike, intelligence, surveillance, and reconnaissance capabilities. Integrate hybridized energy electrical power and thermal management components with end-user operational subsystems such as sensors and communication devices.				
CONGRESSIONAL ADD: Field Renewable Energy System Hybrids (FRESH) Li Ion Battery Program. In FY 2008: Investigated, designed, and developed lightweight rechargeable batteries for airman portable power applications enabling carry lightweight energy systems in the field for sustained operations using renewable/portable energy sources. Focused on decreased size/weight of batteries; increased energy density and extreme environmental functionality, and implementing state-of-charge communication. In FY 2009: Not Applicable. In FY 2010: Not Applicable.	0.968	0.000	0.000	
CONGRESSIONAL ADD: Development of Bi-Polar Wafer-cell NI-MH battery. In FY 2008: Modified the existing Ni-MH battery bipolar wafer cell design and chemistry for use with Li-ion technology for potential application in the F-35 aircraft in both the 28 V and the 270 V batteries. Demonstrated and delivered a prototype 28 V Li-ion cell pack. In FY 2009: Not Applicable.	1.938	0.000	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER 633035	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Silicon Carbide (SiC) Power Electronics for More Electric Aircraft. In FY 2008: Developed JFET technologies, beyond FY07 accomplishments, for large area devices rated at 800 and 1200V for enhancement mode VJFETs with low specific on-resistance. In FY 2009: Development of reliable, high voltage(600-1200V), high current(50-100A/die) enhancement mode vertical junction field effect transistors and Schottky diodes, manufacturing yield limiter evauation and enhancement, applications engineering, and reliability testing. In FY 2010: Not Applicable.		5.329	3.191	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 633035

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602201F/ Aerospace Flight Dynamics.	0.000	0.000							Continuing	Continuing
PE 0602203F/ Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
PE 0602605F/ Directed Energy Technology.	0.000	0.000							Continuing	Continuing
PE 0603605F/ Advanced Weapons Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology					PROJECT NUMBER 634921	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
634921: Aircraft Propulsion Subsystems Int	25.870	47.451	36.568						Continuing	Continuing

Note

Note: The funding in this project has been increased in FY 2009 due to emphasis on component development in support of adaptive cycle technologies.

A. Mission Description and Budget Item Justification

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. This project includes the Aerospace Propulsion Subsystems Integration (APSI) program, which includes demonstrator engines such as the Joint Technology Demonstrator Engine for manned systems and the Joint Expendable Turbine Engine Concept for unmanned air vehicle and cruise missile applications. The demonstrator engines integrate the core (high-pressure spool) technology developed under the Advanced Turbine Engine Gas Generator project with the engine (low-pressure spool) technology such as fans, turbines, engine controls, mechanical systems, exhaust nozzles, and augmentors. Additionally, these efforts include activities under the national Propulsion Safety And Readiness (PSAR) program. This project also focuses on integration of inlets, nozzles, engine/airframe compatibility, and power and thermal management subsystems technologies. APSI provides aircraft with potential for longer range and higher cruise speeds with lower specific fuel consumption, surge power for successful engagements, high sortie rates with reduced maintenance, reduced life cycle cost, and improved survivability, resulting in increased mission effectiveness. Technologies developed are applicable to sustained high-speed vehicles and responsive space launch. APSI supports the goals of the national Versatile Affordable Advanced Turbine Engine (VAATE) program, which is focused on improving propulsion capabilities while at the same time reducing the cost of ownership. Anticipated technology advances include turbine engine improvements providing approximately twice the range for a sustained supersonic combat aircraft, doubling the time on station with 10 times the power output for surveillance aircraft, and propulsion for a high speed supersonic missile with double the range for time sensitive targets. The VAATE program provides continuous technology transition for military turbine engine upgrades and derivatives, and has the added dual-use benefit of enhancing the United States turbine engine industry's international competitiveness. A portion of this project supports the demonstration of adaptive cycle technologies, which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Design, fabricate, and demonstrate durability and integration technologies for turbofan/ turbojet engines. These technologies will improve durability, supportability, and affordability of current and future Air Force aircraft.	1.146	1.621	2.625	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER 634921	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Began testing agile combat support engine technologies to increase durability of components to include advanced aerodynamics for fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories. In FY 2009: Complete testing and begin validation of engine life models for engine components for agile combat support technologies. Initiate design of advanced features for durable fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories. In FY 2010: Conduct preliminary design and begin detailed design of advanced features for durable fans, turbines, mechanical systems, interactions between the inlet and fan, and controls/accessories. To include advanced cooling design for low pressure turbine blades, health monitoring, light weight externals, and repair validation.					
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, surveillance aircraft and transports. Each of these component technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines enabling faster, more responsive systems with longer range and greater payload. Design, fabricate, and test advanced component technologies for improved performance, fuel consumption, durability, and cost for mission adaptive engines in full-engine environments. Note: In FY 2009, increased funding is for final assembly and substantial testing that will begin on large demonstrator engines and component development in support of adaptive cycle technologies. In FY 2008: Finished rig testing of lightweight high bypass engine components (utilizes a hollow fan and radial compressor) capable of operating as primary propulsion or in a lift mode. Began fabrication and assembly of advanced engine designs for a supersonic engine using variable cycle features, advanced fan, improved turbine using cooled metal and cooled CMCs, advanced augmentor, and lightweight CMC cases and ducts. Finished preliminary design of advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced		9.686	33.650	28.949	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
exhaust nozzle for subsonic to sustained supersonic flight. Began detailed design and procurement of long lead hardware for an advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. In FY 2009: Finish assembly and begin testing of engine designs for a supersonic and subsonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, advanced augmentor, and lightweight CMC cases and ducts. Finish detailed design of advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. Finish procurement of long lead hardware for an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. Initiate conceptual design for a high bypass/high overall pressure ratio engine for improved fuel consumption. In FY 2010: Finish assembly testing of engine designs for a supersonic and subsonic engine using variable cycle features, an advanced fan, improved turbine using cooled metal and cooled CMCs, advanced augmentor, and lightweight CMC cases and ducts. Fabricate advanced adaptive cycle (third air stream) engine technologies, including an advanced fan, high work variable low turbine for long dwell time, controls, inlet integration, and advanced exhaust nozzle for subsonic to sustained supersonic flight. Conduct preliminary design for a high bypass/high overall pressure ratio engine for improved fuel consumption.				
MAJOR THRUST: Design, fabricate, and test advanced component technologies for limited life engines. These technologies improve the performance, durability, and affordability of engines for missile and unmanned air vehicles (UAVs), and subsonic to hypersonic weapon applications. Note: In FY 2010 funding dips to account for higher Air Force priorities. In FY 2008: Finished fabrication of engine components of advanced high temperature cooled turbine blade and combustor for UAV applications. Finished fabrication and began assembly of advanced components for technologies for engine testing to include an advanced lightweight fan/compressor, turbines with new advanced	6.989	6.994	4.994	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER 634921	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
cooling approaches, oil-less bearings and high through flow combustors for missile applications. Began testing of advanced components for technologies for engine testing to include an advanced light weight fan/ compressor, turbines with new advanced cooling approaches, oil-less bearings and high thru flow combustors for missile applications. In FY 2009: Finish testing of advanced components for technologies for engine testing to include an advanced light weight fan/compressor, turbines with new advanced cooling approaches, oil-less bearings and high thru flow combustors for high mach missile applications. Initiate design of a higher specific thrust low cost expendable turbine engine for improved fuel efficiency improving range. Initiate design of low spool components for fuel efficient subsonic unmanned turbofan engines. In FY 2010: Conduct preliminary design of a higher specific thrust low cost expendable turbine engine for improved fuel efficiency improving range. Conduct preliminary design of advanced fan, advanced low spool turbine, and advanced engine components for improved fuel efficient subsonic unmanned turbofan engines.					
CONGRESSIONAL ADD: Versatile Affordable Advance Turbine Engine (VAATE)-Small Turbofan (STF). In FY 2008: Added additional high pressure turbine component test time, additional engine core test time, conceptual studies for Revolutionary Hunter-Killer core applications with air framers, and cover hardware costs. In FY 2009: Support the ongoing engine demonstrator, design and hardware, tip treatments for high pressure compressor, and thermal mechanical fatigue analysis/design for the turbine. In FY 2010: Not Applicable.		3.488	3.590	0.000	
CONGRESSIONAL ADD: Versatile Affordable Advance Turbine Engine (VAATE), High Speed Turbine Demonstrator.		4.561	0.000	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER 634921	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Developed an advanced variable nozzle design, developed hardware materials process, and continued risk reduction efforts for the high speed engine demonstrator. In FY 2009: Not Applicable. In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Small Adaptive Cycle Turbine Engines In FY 2008: Not Applicable. In FY 2009: Perform risk reduction for an advanced cooled metal turbine and for an advanced high tempurature rear bearing. In FY 2010: Not Applicable.		0.000	1.596	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities	0.000	0.000							Continuing	Continuing
PE 0602201F/ Aerospace Flight Dynamics.	0.000	0.000							Continuing	Continuing
PE 0602203F/ Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
PE 0603003A/ Aviation Advanced Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology					PROJECT NUMBER 634922	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
634922: Space & Missile Rocket Propulsion	4.525	5.068	29.648						Continuing	Continuing

Note

Note: In FY10, this work was moved from Project 10SP within this Program Element to better align efforts.

A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced and innovative low-cost rocket turbo-machinery and components, low-cost space launch propulsion technologies, and advanced propellants for launch and orbit transfer propulsion. Additionally, this project develops technologies for the Technology for Sustainment of Strategic Systems (TSSS) Phase II (including solid boost/missile propulsion, Post Boost Control, and aging and surveillance efforts) and tactical rockets. Characteristics such as environmental acceptability, affordability, reliability, responsiveness, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. This project also develops chemical, electrical, and solar rocket propulsion technologies for station-keeping and on-orbit maneuvering applications. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion technologies, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances developed in this program could improve the performance of expendable payload capabilities by approximately 20-50 percent, and reduce launch, operations, and support costs by approximately 30 percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Technology advances could also lead to seven-year increase in satellite on-orbit time, a 50 percent increase in satellite maneuvering capability, a 25 percent reduction in orbit transfer operational costs, and a 15 percent increase in satellite payload. Aging and Surveillance efforts for solid rocket motors could reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. The efforts in this project contribute to the Technology for the Sustainment of Strategic Systems (TSSS) program and Integrated High Payoff Rocket Propulsion Technology program (IHPRPT), a joint Department of Defense, National Aeronautics and Space Administration, and industry effort to focus rocket propulsion technology on national space launch needs. Note: In FY10, Funds from Project 10SP have been moved to Project 4922 within this Program Element to more accurately align efforts.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop liquid rocket propulsion technology for current and future space launch vehicles. In FY 2008: Not applicable. In FY 2009: Not applicable.	0.000	0.000	21.438	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Complete advanced cryogenic upper stage hardware testing to validate and verify modeling and simulation tools developed. Continue development of hydrocarbon engine components for integration and demonstration in an advanced hydrocarbon engine concept for future reusable launch vehicles. Continue material manufacturing scale-up effort to support hydrocarbon boost demonstration program. Continue advanced hydrocarbon fuel/additive scale-up and proof efforts. Initiate scale-up efforts for engine health management concepts, tools, and technologies to enable real-time assessment and management of highly reusable liquid rocket engines.				
MAJOR THRUST: Develop solar electric propulsion technologies for existing and future satellites, upper stages, orbit transfer vehicles, and satellite formation flying, station keeping, and repositioning. In FY 2008: Not applicable. In FY 2009: Not applicable. In FY 2010: Initiate scale-up of electric propulsion technologies for spacecraft with the need for high mobility on orbit. Continue hardware scale-up for an advanced multi-mode (high thrust or high efficiency) propulsion system for satellites. Complete demonstration of advanced chemical propulsion system for satellites.	0.000	0.000	1.051	
MAJOR THRUST: Develop electric and advanced chemical based monopropellant propulsion technologies for future satellite propulsion systems. Phases are referring to IHPRPT program phases. In FY 2008: Not applicable. In FY 2009: Not applicable.	0.000	0.000	5.065	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 634922

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Complete development and demonstration of IHPRPT Phase III monopropellant thruster technologies for spacecraft. Initiate scale-up of next generation of chemical thrusters for spacecraft propulsion systems.				
MAJOR THRUST: Develop and demonstrate missile propulsion and Post Boost Control Systems (PBCS) technologies for ballistic missiles. Note: Efforts within this thrust will be extended from FY 2008 to be completed following the second Missile Propulsion Demonstration in FY 2009. In FY 2008: Prepared for testing of second of two motors for the Missile Propulsion Demonstration Phase I. In FY 2009: Complete testing of motor demonstrating TSSS Phase I goals. In FY 2010: Not Applicable.	3.805	3.627	0.000	
MAJOR THRUST: Develop and demonstrate missile propulsion, PBCS, aging, and surveillance technologies for strategic systems. Efforts support the Technology for Sustainment of Strategic Systems - Phase II. In FY 2008: Developed subcomponents to test the accuracy of the previously developed modeling and simulation tools and update the models with the resulting data for use in an upcoming Missile Propulsion demonstration. In FY 2009: Conduct sub-scale component developments providing sub-scale validation of modeling and simulation tools. In FY 2010: Conduct sub-scale component developments providing sub-scale validation of modeling and simulation tools.	0.220	0.687	1.780	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 634922

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop and demonstrate aging and surveillance technologies for strategic systems to reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. Efforts support the Technology for Sustainment of Strategic Systems Phase II. In FY 2008: Conducted scale-up activities for an advanced service life prediction program integrating existing and advanced sensors, models, and tools to be able to predict the service life of a solid rocket motor on a motor-by-motor basis. In FY 2009: Conduct full-scale demonstration of advanced aging and surveillance tools for solid rocket motors to validate and verify modeling and simulation tools and component technologies. In FY 2010: Conduct full-scale demonstration of advanced aging and surveillance tools for solid rocket motors to validate and verify modeling and simulation tools and component technologies.	0.500	0.754	0.314	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 634922

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602102F/ Materials.	0.000	0.000							Continuing	Continuing
PE 0602203F/ Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
PE 0602601F/ Spacecraft Technology.	0.000	0.000							Continuing	Continuing
PE 0603401F/ Advanced Spacecraft Technology.	0.000	0.000							Continuing	Continuing
PE 0603500F/ Multi-Disciplinary Advanced Development Space Technology.	0.000	0.000							Continuing	Continuing
PE 0603853F/ Evolved Expendable Launch Vehicle Program.	0.000	0.000							Continuing	Continuing
PE 0603114N/ Power Projection Advanced Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 634922

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology					PROJECT NUMBER 635098	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
635098: Advanced Aerospace Propulsion	20.917	22.921	23.940						Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation over a range of Mach 4 to 8. In FY 2008: Completed fabrication of air vehicle flight hardware and finalized flight test preparations at supporting test centers (Air Force Flight Test Center and Point Mugu Test Center). In FY 2009: Conduct integrated air vehicle/propulsion flight tests and conduct post test data reduction and reporting. In FY 2010: Complete integrated air vehicle/propulsion flight tests; conduct post test data reduction and write X-51A final report. Demonstrate small scale scramjet engine to Technology Readiness Level 6.	20.917	22.921	23.940	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 635098

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602102F/ Materials.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ PE060203F, Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
Activity Not Provided/This project will be coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)				R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology					PROJECT NUMBER 63681B	
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
63681B: Advanced Turbine Engine Gas Generator	32.994	51.480	64.100						Continuing	Continuing

Note

Note: The funding has been increased in FY 2009 and 2010 due to emphasis on component development in support of adaptive cycle demonstrations, highly efficient embedded turbine engines, and small heavy fueled engines.

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Design, fabricate, and demonstrate performance predictions in core engines, using innovative engine cycles and advanced materials to provide greater durability, improved performance, and reduced fuel consumption for turbofan/turbojet engines for fighters, attack aircraft, bombers, sustained supersonic and combined cycle hypersonic cruise vehicles, and large transports. Each of these technology innovations can be applied to a significant part of the Air Force's engine inventory and offer potentially significant performance enhancements to future aircraft engines, thus enabling new capabilities for faster,	20.026	40.075	51.695	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 63681B

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
survivable, durable, more responsive systems with longer range and greater payloads for long range strike capability. Note: Funding increased in FY 2009 and 2010 to complete hardware fabrication and conduct engine demonstrations. In FY 2008: Completed fabrication and initiated instrumentation and assembly of advanced core engine components, including advanced turbine materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Completed detailed design, fabricated and tested rig hardware for a tip turbine concept, including a novel compression system, innovative annular combustor, and advanced rotating seals. Completed design and fabrication of unique compression system components. Initiated preliminary design of high temperature capable, durable compressor, combustor, and turbine for sustained supersonic long range strike core engine. In FY 2009: Complete assembly and demonstration of advanced core engine components, including advanced turbine materials incorporating next generation cooling schemes, novel coatings to reduce combustor and turbine heat loads, ceramic turbine components, and systems for active control, thermal management, and power extraction. Complete fabrication, assembly and experimental demonstration of unique compression system components. Complete preliminary design of high temperature capable, durable compressor, combustor, and turbine for sustained supersonic long range strike core engine. Conduct conceptual design and initiate preliminary design of component technologies for a core-centric durability engine demonstration. Conduct preliminary design of component technologies for increased reliability, maintainability, and affordability for potential transition to fielded systems. Conduct analysis and conceptual design of system level technologies and weapon systems integration on core engine performance. In FY 2010: Complete detailed design and initiate hardware fabrication of high temperature capable, durable compressor, combustor, and turbine for sustained supersonic long range strike core engine. Complete preliminary design and initiate detailed design of component technologies for a core-centric durability engine demonstration. Conduct detailed design of component technologies for increased reliability, maintainability, and affordability for potential transition to fielded systems. Conduct analysis and conceptual design of system level technologies and weapon systems integration on core engine performance.				

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
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B. Accomplishments/Planned Program ($ in Millions)		FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Design, fabricate, and demonstrate high overall pressure ration cores to provide increased durability and affordability with lower fuel consumption for turbofan/turboshaft engines for long endurance high altitude unmanned air vehicles for persistent intelligence surveillance reconnaissance, intertheater/intratheater transports, subsonic Unmanned Air Systems (UAS), and powered munitions. In FY 2008: Completed detailed design and initiated fabrication of highly efficient core engine components concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Created preliminary design of UAS small versatile affordable advanced core engine technologies including an efficient high pressure compressor, a high heat release combustor, and high performance turbine, and systems for thermal management and advanced power extraction. In FY 2009: Complete fabrication, assembly, and demonstrate a highly efficient core engine concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Initiate design of higher pressure ratio core components. Conduct preliminary design of core for highly efficient core engine concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Complete design, initiate hardware fabrication, and continue selective risk reduction experimental demonstrations of UAS small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, and systems for thermal management and advanced power extraction. Conduct preliminary design of efficient small scale propulsion technologies, including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness or uncooled turbine, for use in UAS applications.		12.000	11.405	12.405	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009			
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology			PROJECT NUMBER 63681B	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Complete preliminary design and initiate long lead fabrication of core for highly efficient core engine concept with advanced core technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness turbine with an integrated thermal management system and advanced mechanical systems. Complete hardware fabrication, and continue selective risk reduction experimental demonstrations of UAS small versatile affordable advanced core engine technologies including a high heat release combustor, durable high performance turbine, and systems for thermal management and advanced power extraction. Complete preliminary design and initiate long lead fabrication of efficient small engine component technologies including high efficiency, high pressure ratio, high temperature capability compressor, high efficiency, high heat release combustor, and high work, high cooling effectiveness or uncooled turbine, for use in UAS applications.					
CONGRESSIONAL ADD: Ceramic Matrix Composite (CMC) Airfoil Capability Enhancements. In FY 2008: Demonstrated CMC airfoil fabrication capability enhancements for application to advanced aerospace gas turbines. The focus was on the design, fabrication, and testing of critical airfoil sub-elements. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		0.968	0.000	0.000	

Exhibit R-2a, PB 2010 Air Force RDT&E Project Justification		DATE: May 2009
APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 3 - Advanced Technology Development (ATD)	R-1 ITEM NOMENCLATURE PE 0603216F Aerospace Propulsion and Power Technology	PROJECT NUMBER 63681B

C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
Activity Not Provided/ Related Activities:	0.000	0.000							Continuing	Continuing
PE 0602201F/ Aerospace Flight Dynamics.	0.000	0.000							Continuing	Continuing
PE 0602203F/ Aerospace Propulsion.	0.000	0.000							Continuing	Continuing
PE 0603003A/ Aviation Advanced Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate	0.000	0.000							Continuing	Continuing

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.

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