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 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					
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	217.266	252.024	196.529						Continuing	Continuing
623012: Advanced Propulsion Technology	21.133	18.006	17.568						Continuing	Continuing
623048: Combustion and Mechanical Systems	29.957	28.380	18.921						Continuing	Continuing
623066: Turbine Engine Technology	60.816	87.533	64.312						Continuing	Continuing
623145: Aerospace Power Technology	42.974	49.446	31.029						Continuing	Continuing
6233SP: Space Rocket Component Tech	52.024	58.698	0.000						Continuing	Continuing
624847: Rocket Propulsion Technology	10.362	9.961	59.101						Continuing	Continuing
625330: Aerospace Fuel Technology	0.000	0.000	5.598						Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has seven projects, each focusing on a technology area critical to the Air Force. The Advanced Propulsion Technology develops high-speed air breathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies to enable revolutionary propulsion capability for the Air Force. The Fuels and Lubrication project evaluates fuels, lubricants, and combustion concepts and technologies for new and existing engines and directly supports the Versatile Affordable Advanced Turbine Engine (VAATE) program. The Turbine Engine Technology project develops enabling capabilities to enhance performance and affordability of existing weapon systems to include efforts that are part of the VAATE program. The Aerospace Power Technology project develops electrical power and thermal management technologies for military applications that are part of the High Power Aircraft (HiPAC) program. The Rocket Propulsion Technology project develops advances in rocket propulsion technologies for space access, space maneuver, missiles, the sustainment of strategic systems and tactical rockets. Finally, the Aerospace Fuel Technology project evaluates hydrocarbon-based fuels for legacy and advanced turbine engines, scramjets, pulse detonation and combined cycle engines for missile, aircraft, high-speed vehicles, and responsive space launch vehicles.

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B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	217.172	218.049	202.683	
Current BES/President's Budget	217.266	252.024	196.529	
Total Adjustments	0.094	33.975	0.000	
Congressional Program Reductions	0.000	0.000		
Congressional Rescissions	0.000	-0.685		
Total Congressional Increases	0.000	33.060		
Total Reprogrammings	3.510	1.600		
SBIR/STTR Transfer	-3.416	0.000		

Change Summary Explanation

In FY 2009 and 2010 change in funding is due to increased emphasis on component development in support of adaptive cycle technologies, improved fuel efficiency, and highly efficient embedded turbine engines. Note: In FY 2009, Congress added $1.2M for advanced fuel cell based power system for small UAVapplications; $1.6M for advanced lithium ion battery manufacturing; $0.8M for aerospace lab equipment upgrade; $1.0M for affordable lightweight power supply development; $2.8M for development and testing of advanced paraffin-based hybrid rockets for space; $1.0M for electronics liquid cooling for advance military ground and aerospace vehicle projects; $1.6M for hybrid bearing development; $1.4M for hydrocarbon boost technology demonstrator; $2.0M for integrated aircraft energy management; $1.6M for integrated electrical starter/generator; $3.5M for integrated power for aircraft technologies (INPACTII); $2.0M for integrated propulsion analysis tool; $1.6M for lithium ion domestic materials develoment; $6.0M for manufacturing of high energy superior lithium battery technology; $0.8M for multi-mode space propulsion; $1.36M for national test facility for aerospace fuels and propulsion; $2.4M for vortex low cost rocket engine; and $0.8M for WASH oxygen sensor and cell-level battery controller. This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies. Starting in FY10, Funds from Project 33SP have been moved to Project 4847 within this Program Element to more accurately align efforts.

C. Performance Metrics
(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**
623012: Advanced Propulsion Technology	21.133	18.006	17.568						Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop advanced fuel-cooled scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future war fighter needs. In FY 2008: Continued development and demonstration of flight weight engine components and advanced engine control logic. Continued performing trajectory optimization for flight test. Continued evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Initiated design and testing of advanced scramjet start techniques. Continued verification of operation of engine control techniques, based on rapid shock train identification/characterization coupled with fuel control logic, to ensure stable scramjet operation. In FY 2009: Continue development and demonstration of flight weight engine components and advanced engine control logic. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Conduct design of ground test hardware of advanced scramjet start techniques. Complete development of scramjet engine control logic for flight test engines. Continue verification of operation of engine control techniques, based on rapid shock train identification/ characterization coupled with fuel control logic, to ensure stable scramjet operation.	1.138	3.200	1.650	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Develop and demonstrate flight weight engine components and advanced engine control logic. Perform trajectory optimization for flight test. Complete ground test of advanced scramjet start technique. Fabricate flight test hardware to demonstrate ramjet to scramjet transition.				
MAJOR THRUST: Conduct assessments, technology design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle air breathing hypersonic propulsion technologies into future missiles and into manned and unmanned air and space vehicle concepts. CCEs require the development and demonstration of components to integrate scramjets with high speed turbines and/or rocket engines for efficient propulsion over a broad range of Mach numbers. Note: In FY 2009, efforts in this thrust were reduced due to higher AF priorities. In FY 2008: Continued trade studies to determine military payoff and establish component technology goals. Continued defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Continued development of advanced components for turbine-based and rocket-based CCEs. Completed testing of advanced inlets for turbine-based CCEs capable of operating from Mach 0 to Mach 8. Designed an advanced nozzle for turbine-based and rocket-based CCEs. In FY 2009: Continue trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Develop advanced components for turbine-based and rocket-based CCEs. In FY 2010: Conduct trade studies to determine military payoff and establish component technology goals. Define component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Develop technology maturation plan for advanced components for turbine-based and rocket-based CCEs.	1.941	0.165	0.165	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future platforms. Note: Starting in FY 2008, efforts shifted towards much larger hot section testing and voluminous test data required to correlate the combustion scaling phenomena to the original baseline configuration to provide the knowledge to scale the scramjet configuration to larger applications potentially up to space launch. Note: In FY 2009 and FY 2010, efforts in this thrust were reduced due to higher AF priorities. In FY 2008: Continued development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continued development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Completed test of scramjet combustors 5 to 10 times baseline size for reusable applications with improved structural efficiency. Initiated development of improved durability engine concepts. Continued development of low internal drag flame stabilization devices and flight test engine components. In FY 2009: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Continue development of low internal drag flame stabilization devices and flight test engine components. Conduct assessment of ground test facilities and test techniques to demonstrate large (20 to 100 times) size scramjet engines. In FY 2010: Develop advanced engine components to improve scramjet operating margin and to refine scramjet scaling laws for reusable applications. Develop techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Develop low internal drag flame stabilization devices and flight test engine components. Fabricate subscale components/combustors to represent medium scale (5 to 20 times) scramjet engines.	18.054	14.641	15.753	

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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 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602201F/ Aerospace Flight Dynamics.	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Tech.	0.000	0.000							Continuing	Continuing
PE 0602602F/ Conventional Munitions.	0.000	0.000							Continuing	Continuing
PE 0602702E/ Tactical Technology.	0.000	0.000							Continuing	Continuing
PE 0603211F/ Aerospace Structures.	0.000	0.000							Continuing	Continuing
PE 0603216F/ Aerospace Propulsion and Power Technology.	0.000	0.000							Continuing	Continuing
PE 0603601F/ Conventional Weapons Technology.	0.000	0.000							Continuing	Continuing
Activity Not Provided/ Program is reported to/ coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committe	0.000	0.000							Continuing	Continuing
Activity Not Provided/ This project has been	0.000	0.000							Continuing	Continuing

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coordinated through the Reliance 21 process to harmonize efforts and eliminate

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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APPROPRIATION/BUDGET ACTIVITY 3600 - Research, Development, Test & Evaluation, Air Force/BA 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					PROJECT NUMBER 623048	
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**
623048: Combustion and Mechanical Systems	29.957	28.380	18.921						Continuing	Continuing

Note

Note: The fuels portion of this Project will be moved to Project 5330 within this Program Element from FY 2010 to more accurately align efforts with organizational structure.

A. Mission Description and Budget Item Justification

This project evaluates fuels, lubricants, mechanical systems, and combustion concepts for advanced turbine engines, scramjets, pulsed detonation, and combined cycle engines. This project also develops technologies to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. Applications include missiles, aircraft, sustained high-speed vehicles, and responsive space launch. Analytical and experimental areas of emphasis include fuels and fuels logistics, lubricants, bearings, electromagnetic rotor, oil-less engine technology, optical diagnostics, fundamental combustion, detonations, combustors and afterburners. Fuels and lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Advanced combustion concepts must be cost-effective, durable, and reduce pollutant emissions. A portion of this project supports adaptive cycle technologies. This effort develops component technology for an adaptive cycle engine architecture that provides optimized performance/fuel efficiency for widely varying mission needs. The fuels portion of this BPAC will be moved to Project 5330 in FY 2010 to more accurately align efforts with organizational structure.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop low-cost additive and fuel system approaches to improve fuel properties and to expand the flight envelope for manned and unmanned aircraft. Determine fuel cooling requirements and specifications for adaptive cycle engine architecture. Design, fabricate, and test of key thermal management technologies. In FY 2008: Conducted lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative fuels, and improved materials and coatings. Continued effort to validate component performance models on aircraft thermal management simulator. Completed the development of approaches to assess and improve additive combustion behavior at low fuel and air temperatures. Tested fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems and the Highly Efficient Embedded Efficient Turbine Engine (HEETE).	2.880	3.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
Developed a robust mechanical and integrated engine thermal management system (mechanical and fuel systems) for optimum engine performance and durability at sustained supersonic cruise conditions. In FY 2009: Conduct lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative energy fuels, and improved materials and coatings. Continue effort to validate component performance models on aircraft thermal management simulator. Test fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems and the HEETE. Conduct full-scale component rig testing of mechanical components with prototype lubricants. Conduct simulated high-Mach tests of an integrated thermal management system and mechanical system components. In FY 2010: Not Applicable.					
MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature (including nano-scale additives), as well as advanced emission diagnostic test protocols. In FY 2008: Completed assessing novel fuel additives including nano-technologies to reduce emissions in laboratory scale combustion rigs. Initiated improvement of combustion models for kerosene fuels. Continued higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion. In FY 2009: Continue higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion. Initiate study of NOx/soot tradeoffs in combustor design. Improve combustion models for kerosene fuels. In FY 2010: Not Applicable.		1.000	1.000	0.000	
		1.000	1.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to simplify logistics and reduce cost (including field and on-board additive injections and improvements to existing fuel additive packages), as well as study fuel logistics vulnerabilities and develop detection and mitigation technologies. In FY 2008: Expanded investigation of the performance of alternative fuels to include bio-derived fuels. Initiated development of bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Initiated development of knowledge base for certification of Fischer-Tropsch fuels for all Air Force tactical vehicles. Evaluated advanced nano-technology fuel sensors, nano-technology fuel additives, and novel detection and mitigation technologies for biological growth. In FY 2009: Expand investigation of performance of biomass-derived fuels for aircraft and other field hardware. Extend knowledge base to other alternative fuels, such as those derived from biomass. Develop bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Expand knowledge base for certification of Fischer-Tropsch fuels for all Air Force tactical vehicles. In FY 2010: Not Applicable.				
MAJOR THRUST: Investigate hydrocarbon and other high energy density fuels for advanced and combined cycle engines for high-speed aerospace vehicles and low-cost boost applications. In FY 2008: Completed study of refined kerosene propellants under high heat flux conditions and studied synthesized high-energy hydrocarbons. Improve fuel property database and share with industry to improve design tools. In FY 2009: Expand study of high-energy hydrocarbon propellant candidates. Complete improved physical property database for kerosene propellants at high pressure. Collect improved physical property for high energy hydrocarbons and improve physical property models. In FY 2010: Not Applicable.	0.500	0.500	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop, test, and evaluate revolutionary combustion and propulsion concepts for gas turbine, pulsed detonation, and combined cycle engines for missiles, manned and unmanned systems, and reusable access to space; perform payoff analyses and configuration trade studies for these systems; and evaluate the combustion and emissions characteristics of fuels and fuel additives. In FY 2008: Demonstrated small-scale inter-turbine burner (ITB) concepts in a relevant engine environment. Investigated the scalability of inter-turbine burners for large engines. Assessed an integrated pulsed detonation/ hybrid turbine concept performance with component fabrication and evaluation. Investigated combustor and augmentor systems for high-altitude low-high mach applications. Evaluated and optimized advanced combustor, augmentor, and pulsed detonation engine (PDE) concepts using modeling and simulation tools. In FY 2009: Evaluate advanced combustion system performance at realistic operating conditions. Demonstrate small-scale ITB concepts in small engines. Identify concept designs of inter-turbine burning concepts for large gas turbine engines. Optimize component efficiency of the integrated pulsed detonation/hybrid turbine. Evaluate and optimize advanced combustor, augmentor, and PDE concepts using modeling and simulation tools covering wider flight conditions and applications. In FY 2010: Test concept designs for larger-scale inter-turbine burners at relevant gas turbine engine conditions. Evaluate performance characteristics in small engines burning military fuels. Identify potential performance improvements for small engines. Investigate novel combustor, augmentor and pulse-detonation concepts that reduce fuel burn and improve system performance. Study combustion processes using alternative fuels. Develop new chemistry models for combustion processes. Employ modeling and simulation tools to evaluate advanced combustion systems. Investigate high-efficiency direct injection methods for PDE's.		4.576	7.493	7.180	
MAJOR THRUST: Develop approaches to extend the life of endothermic fuels and fuel system components for sustained supersonic and reusable hypersonic cruise applications.		0.500	0.500	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Evaluated improved coke-mitigating surfaces/catalysts with 2nd generation endothermic fuels in bench-scale heat exchanger rigs. Assessed unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads in panel tests. Initiated study of relationship between fuel structure/ properties and combustion behavior including blowout. In FY 2009: Conduct bench-scale tests to evaluate improved surfaces/catalysts for 2nd generation endothermic fuels. Assess unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads. Study relationship between fuel structure/properties and combustion behavior including blowout. In FY 2010: Not Applicable.					
MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies. In FY 2008: Demonstrated high-bandwidth (e.g., MHz-rate) planar laser-induced fluorescence for high-speed digital imaging of key combustion species in fundamental laboratory flames and relevant engine environments. Applied terahertz radiation (T-rays) for combustion temperature sensing and non-destructive inspection/ evaluation of turbine engine components. Integrated current and next-generation combustion diagnostics to support RDT&E of augmentor solutions for fighter aircraft. In FY 2009: Develop high-speed techniques for measuring carbon monoxide (CO) to evaluate CO oxidiation/ combustion efficiency in near constant volume combuston turbine environments. Exploit ultrafast (e.g., femtosecond), ultraintense (e.g., terawatt) laser systems to generate ultrashort x-ray bursts for soot-mitigation studies and dense-fuel-spray imaging. Develop multi-pulse femtosecond ballistic imaging to understand and improve fuel sprays in combustor, augmentor, scramjet, and rocket applications. Develop ultrafast (picosecond, femtosecond) coherent anti-Stokes Raman scattering (CARS) for measuring temperature and critical species in combustion devices. Apply advanced optical diagnostics suites to characterization and improvement of engine combustors and afterburners.		1.000	1.000	1.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Develop MHz-rate high-speed measurement techniques for combustion species. Use two-color planar laser-induced fluorescence techniques to measure temperature in experimental combustion systems. Develop robust line-of-sight measurement techniques for temperature and species and apply to relevant combustion devices. Apply ultrafast CARS techniques developed in FY2009 to practical combustion devices and engine systems. Apply advanced optical diagnostics suites to characterization and improvement of engine combustors and afterburners.					
MAJOR THRUST: Develop, test, and qualify advanced turbine engine lubricants. Establish target requirements and transition opportunities for new oils by working with DoD agencies, industry, and users. Generate and maintain military specifications for aviation engine lubricants, as well as conducted field support activities for aviation lubrication technologies and DoD operational units. In FY 2008: Completed qualification testing of two enhanced 5cSt ester candidates, transitioned to demo engine program and draft new oil specification. Ramped up qualification testing of hi-mach 7cSt ester in preparation of engine demo. Developed an integrated and effective bearing/oil health monitoring system with prognostics capability to address critical DoD safety, readiness, and life-cycle cost concerns. Conducted preliminary technology assessment of long-term, low-temperature (hi-altitude) performance of engine lubricants and initiated concepts for efficient mechanical system for highly efficient embedded turbine engines. In FY 2009: Demonstrate enhanced 5cSt ester lubricant in JSF thrust growth demo engines. Finalize new enhanced 5cSt oil specification. Initial testing of new hi-mach 7cSt ester lubricant. Demonstrate an integrated bearing/oil health monitoring/prognostic system in full-scale setting and validate life models. Fabricate and test an efficient mechanical system for highly efficient embedded turbine engine and adaptive versatile turbine engines (ADVENT). Continue development of high-temperature lubricants for Long Range Strike aircraft. In FY 2010: Publish enhanced ester oil specification and support transition activities to fighter aircraft. Conduct component level testing of hi-Mach ester lubricant for future Long Rang Strike (LRS) aircraft. Develop intelligent prognostics for lubrication system health monitoring.		2.600	5.435	5.241	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-sized turbine engine applications. In FY 2008: Conducted subscale fatigue life and spall propagation studies of bearing materials with enhanced ester hi-mach 7cSt oil candidates. Develop preliminary design of propfan gearbox and conduct trade study of energy efficient mechanical system components (ie. rolling element vs. foil vs. magnetic bearing) for HEETE. In FY 2009: Continue sub-scale fatigue life and spall propagation studies of bearing materials and validate spall propagation models with oil candidates and begin full-scale tests. Conduct full-scale bearing evaluation to map out and transfer thermal models in support of ADVENT. In FY 2010: Test bearing concepts for high Mach missile and other future applications.		2.600	5.500	5.500	
CONGRESSIONAL ADD: Hybrid Bearings. In FY 2008: Successfully demonstrated hybrid bearing for the F135 core thrust bearing in rig tests and over two hundred hours of operation in F135 SDD engine test. Developed critical flaw size for Non Destructive Evaluation of ceramic rolling elements. Initiated bearing cage evaluation program. In FY 2009: Complete fabrication on, and endurance test, full-scale 2nd Gen P675 hybrid bearings for transition into P&Ws F135 engine in 2010. Continue towards demonstrating and quantifying the performance benefits of light-weight composite bearing cages thru full-scale bearing testing. In FY 2010: Not Applicable.		2.347	1.596	0.000	
CONGRESSIONAL ADD: Alternative Energy Research.		9.781	0.000	0.000	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Performed research on alternative energy, focusing on alternative hydrocarbon based aviation fuels made from coal, biomass, and oil shale. Research included fuel property evaluation and enhancement, as well as component and engine testing of alternative fuels and fuel blends. In FY 2009: Not Applicable. In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: WASH Oxygen Sensor and Cell Level Battery Controller. In FY 2008: Developed oxygen sensors for aircraft wing tanks to help prevent risk of explosion. Developed a Smart Battery Module (SBM) for use with the Harris Manpack Radio Set (AN/PRC-117G). Prepared a demonstration of a large scale SBM to verify the scalability and performance of the system. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		1.173	0.000	0.000	
CONGRESSIONAL ADD: National Test Facility for Aerospace Fuels and Propulsion In FY 2008: Not Applicable. In FY 2009: Upgrade eductional facilities at Purdue that are part of the "National Test Facility for Aerospace Fuels and Propulsion". In FY 2010: Not Applicable.		0.000	1.356	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 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602805F/ Dual Use Science and Technology.	0.000	0.000							Continuing	Continuing
PE 0603216F/ Aerospace Propulsion and Power 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 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					PROJECT NUMBER 623066	
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**
623066: Turbine Engine Technology	60.816	87.533	64.312						Continuing	Continuing

Note

Note: The funding in this project has been increased to provide emphasis on adaptive cycle technologies, increased fuel efficiency, and highly efficient embedded turbine engines.

A. Mission Description and Budget Item Justification

This project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, augmentor and exhaust systems, integrated power and thermal management systems, engine inlet integration, mechanical systems, and structural design. This project supports the Integrated Versatile Affordable Advanced Turbine Engine (VAATE) program, which is a joint DoD agency and industry effort to focus turbine propulsion technology on national needs. The program plan reflects the technology base support for VAATE activity applicable to global responsive strike, capable unmanned war-fighting, tactical and global mobility, responsive space lift, and persistent Intelligence, Surveillance, and Reconnaissance (ISR). A portion of this project supports adaptive cycle technologies. This effort develops component technology for an adaptive cycle engine architecture that provides optimized performance/fuel efficiency for widely varying mission needs.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and high-pressure turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports. Identify and evaluate technologies that enable the use of domestic fuel sources for military energy needs. Develop advanced concepts, designs, design rules, and computational tools to support component research and rig testing of components for an adaptive cycle engine. Develop advanced concepts, designs, design rules, and computational tools to support research and rig testing of component technologies to substantially improve specific fuel consumption by increasing overall pressure ratio and turbine rotor inlet temperature; by improving component efficiencies; and by reducing cooling air and pressure losses. In FY 2008: Continued to develop and apply advanced modeling and simulation rules and tools for advanced components. Developed and optimized novel dual fuel burner. Determined suitability of latest Titanium	34.903	65.204	46.284	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 623066

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Aluminide materials for Mach 4 compressor application. Developed and applied advanced modeling and simulation rules and tools to significantly improve component efficiencies, enabling reduced fuel consumption in emerging and future gas turbine propulsion systems. Developed and applied advanced modeling and simulation rules and tools to initiate definition and design of lightweight, simple, adaptive cycle features. Developed and applied advanced modeling and simulation rules and tools to initiate definition and design of an efficient, wide-flow range compressor. Initiated rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work, and an efficient, lightweight, LO-compatible exhaust system. Developed and applied advanced modeling and simulation rules and tools to initiate definition and design of an efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine Specific Fuel Consumption (SFC). In FY 2009: Develop and apply advanced modeling and simulation rules and tools for advanced components. Conduct rig testing of advanced high pressure turbine vane and blade nano-laminate thermal barrier coating (TBC) applied. Begin to develop computational fluid dynamics methodology for analyzing turbine flows. Begin to develop CMC lifing models. Conduct bench and rig tests for validation of components with significantly improved efficiency. Rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work and an efficient, lightweight, LO-compatible exhaust system. Fabricate and rig test an efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine SFC. In FY 2010: Develop and apply advanced modeling and simulation rules and tools for advanced components. Develop computational fluid dynamics methodology for analyzing turbine flows. Develop CMC lifing models. Conduct bench and rig tests for validation of components with significantly improved efficiency. Rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work, and an efficient, lightweight, LO-compatible exhaust system. Rig test efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine Specific Fuel Consumption (SFC.)				

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 623066	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop turbofan/turbojet engine components (i.e., fans, low pressure turbines, engine controls, exhaust nozzles, and integration technologies) for turbofan/turbojet engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports. In FY 2008: Continued to develop and apply advanced modeling and simulation rules and tools for advanced components. Conducted risk reduction testing of variable bypass ratio fan concept. Developed and rig tested reheat augmentor technology to significantly decrease burning length. Designed and fabricated an advanced lightweight, variable area exhaust nozzle. In FY 2009: Develop and apply advanced modeling and simulation rules and tools for advanced components. Develop durable damping/erosion coating systems. Conduct rig testing of advanced fan design for application to a variable cycle engine concept. Conduct rig testing of advanced low pressure turbine design for application to a variable cycle engine concept. Design and rig test lightweight, simple, LO-compatible inlet and exhaust system. In FY 2010: Develop and apply advanced modeling and simulation rules and tools for advanced components. Develop durable damping/erosion coating systems. Conduct rig testing of advanced fan design for application to a variable cycle engine concept. Conduct rig testing of advanced low pressure turbine design for application to a variable cycle engine concept. Rig test of lightweight, simple, LO-compatible inlet and exhaust system.		13.936	15.773	15.773	
MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. These efforts enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, thereby greatly expanding the operating envelopes of missiles and unmanned vehicles. Note: In FY 2010, efforts in this thrust were reduced due to higher AF priorities. In FY 2008: Utilized data from high speed turbine engine testing of a wide-range, lightweight carbon-carbon variable area exhaust nozzle and a compact, carbon-carbon ramburner to update and validate advanced modeling and simulation rules and tools.		4.536	5.246	0.945	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 623066	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2009: Utilize data from high speed turbine engine testing of a fuel cooled turbine and a slinger-fed, dual-fuel CRC to update and validate advanced modeling and simulation rules and tools. In FY 2010: Develop and apply advanced modeling and simulation rules and tools for advanced limited life components. Design and rig test advanced limited life components.					
MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. In FY 2008: Developed new and innovative design concepts and conduct bench and rig tests for validation of a mixed flow turbine design. In FY 2009: Utilize data from efficient small scale engine testing of an advanced forward swept, centrifugal compressor, and a silicon nitride mixed flow turbine to update and validate advanced modeling and simulation rules and tools. In FY 2010: Develop and apply advanced modeling and simulation rules and tools for advanced limited life components.		2.453	1.310	1.310	
CONGRESSIONAL ADD: Active Combustion Control System for Military Aircraft. In FY 2008: Conducted research and development on active combustion control systems In FY 2009: Not Applicable. In FY 2010: Not Applicable.		3.423	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 623066

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
CONGRESSIONAL ADD: VDVP for UAV/UCAV Aircraft Engines. In FY 2008: Conducted research and development on variable displacement vane pumps for UAV and UCAV engines. In FY 2009: Not Applicable. In FY 2010: Not Applicable.	1.565	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 623066

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 Materials:	0.000	0.000							Continuing	Continuing
PE 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602102F/ Materials.	0.000	0.000							Continuing	Continuing
PE 0603216F/ Aerospace Propulsion and Power Technology.	0.000	0.000							Continuing	Continuing
PE 0602122N/ Aircraft Technology.	0.000	0.000							Continuing	Continuing
PE 0603210N/ Aircraft 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 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					PROJECT NUMBER 623145	
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**
623145: Aerospace Power Technology	42.974	49.446	31.029						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops electrical and thermal management technologies for military aerospace applications. Power component technologies are developed to increase reliability, maintainability, commonality, affordability, and supportability of aircraft and flight line equipment. Research is conducted in energy storage and hybrid power system technologies to enable special purpose applications. Electrical power and thermal management technologies enable all future military directed energy weapon systems. This project supports development of electrical power and thermal management component and systems suitable for applications to legacy and future aircraft platforms including strike and mobility concepts. Lightweight power systems suitable for other aerospace applications are also developed.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop electrical power and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These technologies improve aircraft range, self-sufficiency, reliability, maintainability, and supportability, while reducing life cycle costs and enabling new capabilities. Develop hybrid electrical power and thermal management, including energy conversion/storage, components and subsystem technologies for special purpose applications enabling long endurance missions. In FY 2008: Developed and designed efficient, high power, high temperature power electrical components. Developed and tested air vehicle electromagnetic and radio frequency effects immune components. Designed and fabricated thermal management components and subsystems. Conducted studies, modeling and simulation, and developed preliminary designs for energy harvesting and energy dense, long endurance battery, and fuel cell components and subsystems. Developed and tested rechargeable/refuelable, lightweight, energy dense, high power hybrid battery, fuel cell and power management components and subsystems. In FY 2009: Fabricate, integrate, and test high efficiency, high power, wide temperature range power electrical components. Initiate integration and test air vehicle electromagnetic and radio frequency effects immune components. Integrate and test thermal management components and subsystems.	27.222	23.763	25.751	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion		PROJECT NUMBER 623145	
B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Assess component performance objectives needed to meet systems level, energy optimized performance goals. Develop integrated modeling with hardware-in-the-loop simulation test capability for power and thermal management components and subsystems.				
MAJOR THRUST: Develop lightweight electrical power and thermal management component and subsystem technologies with low volume displacement to enable delivery of high power for operation of directed energy weapons. Note: In FY 2009-11, this thrust is reduced due to higher AF priorities. In FY 2008: Developed and initiated design of a flight-weight superconducting generator, high rate charge/ discharge energy storage and high voltage/current components and subsystems. Developed concept designs for superconducting multimegawatt generator. In FY 2009: Investigate high-rate thermal energy storage for directed energy applications. In FY 2010: Complete investigation of high-rate thermal energy storage for directed energy applications. Develop preliminary design of power and thermal management system for high energy laser flight demonstration.	2.353	1.398	1.119	
MAJOR THRUST: Develop hybrid electrical power and thermal management, including energy conversion/ storage, components and subsystem technologies for special purpose applications enabling long endurance missions. Note: In FY 2009, efforts in this thrust are broken out from previous thrust to better address increased emphasis on component development in support of electric hybrid special programs. In FY 2008: Not applicable. In FY 2009: Integrate and test thermal management components and subsystems. Integrate and initiate subsystems test of flight-weight, efficient, energy harvesting, hybrid battery and fuel cell components.	0.000	4.039	4.159	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion		PROJECT NUMBER 623145	
B. Accomplishments/Planned Program ($ in Millions)	**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Investigate and develop hybrid energy harvesting storage, management and distribution architectures. Integrate the energy harvesting technologies with novel battery and fuel cell technologies. Integrate and test thermal management components and subsystems. Implement methods of energy harvesting and increased energy savings for special purpose applications. Demonstrate long endurance flight tests of integrated systems for unmanned aerial systems.				
CONGRESSIONAL ADD: Integrated Electrical Starter/Generator. In FY 2008: Completed detailed design and developed lightweight, compact, high temperature starter generator and Inverter-Converter Controllers (ICCs) to increase the technology readiness level (TRL). In FY 2009: Further develop starter/generator architecture for an advanced regenerative energy capable electrical power system. Special emphasis on overall thermal systems management. Integrated electrical and thermal management system will be tested in the Boeing Facility for Integration and Research of Subsystems Technologies (FIRST) Lab. In FY 2010: Not Applicable.	1.957	1.596	0.000	
CONGRESSIONAL ADD: Manufacturing of High Energy Superior Lithium Battery Technology. In FY 2008: Developed and designed equipment and processes for domestic production of SLPB batteries and developed appropriate anode, cathode and electrolyte materials for prototype production of cells and batteries. In FY 2009: Continue development and design of equipment and processes for domestic production of SLPB batteries and developed appropriate anode, cathode and electrolyte materials for prototype production of cells and batteries. In FY 2010: Not Applicable.	5.868	5.983	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 623145	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
CONGRESSIONAL ADD: Advanced Fuel Cell Based Power System for Small UAVs In FY 2008: Developed power systems for small/micro UAV systems. Examined mirco UAV systems requirements to determine the size, weight and power requirements needed to power these small aircraft. Performed feasibility studies and developed initial design of fuel cell systems to meet specifications resulting from the requirements study. In FY 2009: Improve power systems for small/micro UAV systems. Narrow mirco UAV systems requirements to determine the size, weight and power requirements needed to power these small aircraft. Extend feasibility studies and developed initial design of fuel cell systems to meet specifications resulting from the requirements study. In FY 2010: Not Applicable.		0.783	1.197	0.000	
CONGRESSIONAL ADD: Modified F-22 MaintenanceMaintneance-Free Nickel Cadmium Aircraft Batteries for the F-16. In FY 2008: Developed modifications of the cell designs, materials and electronics in the F-22 sealed Nickel-Cadmium battery for application in the F-16 aircraft. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		1.369	0.000	0.000	
CONGRESSIONAL ADD: Thermal and Energy Management for Aerospace (THEMA).		3.422	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion		PROJECT NUMBER 623145		
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Conducted research to advance the state of the art of thermal and energy management technologies for aerospace applications. In FY 2009: Not Applicable. In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Advanced Lithium Ion Battery Manufacturing In FY 2008: Not Applicable. In FY 2009: Develop solid state rechargeable lithium batteries for very high power and energy densities and long cycle life. In FY 2010: Not Applicable.		0.000	1.596	0.000	
CONGRESSIONAL ADD: Affordable Lightweight Power Supply Development In FY 2008: Not Applicable. In FY 2009: Develop alternative high performance electrolytes and low-cost membrane electrode assemblies (MEAs), which are capable of operating at high temperatures, zero or reduced humidities and which enable decreased system complexity and improved utilization of high energy fuels. In FY 2010: Not Applicable.		0.000	0.997	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 623145	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
CONGRESSIONAL ADD: Electronics Liquid Cooling For Advanced Military Ground and Aerospace Vehicle Projects In FY 2008: Not Applicable. In FY 2009: Develop cost-effective production methods and certified processes for implementing advanced liquid cooling technologies military ground and air platform power electronics and related embedded computing applications. In FY 2010: Not Applicable.		0.000	0.997	0.000	
CONGRESSIONAL ADD: Integrated Aircraft Energy Management In FY 2008: Not Applicable. In FY 2009: Use advanced modeling and simulation techniques to identify vehicle level thermal management issues and identify potential solutions. In FY 2010: Not Applicable.		0.000	1.995	0.000	
CONGRESSIONAL ADD: Integrated Power for Aircraft Technologies (INPACT II) In FY 2008: Not Applicable. In FY 2009: Develop technologies for increased efficiency in energy utilization, improved thermal management techniques and more effective energy management of systems and subsystems to enable meeting performance objective for future military aircraft.		0.000	3.491	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 623145	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Lithium Ion Domestic Materials Development In FY 2008: Not Applicable. In FY 2009: Research and development on synthesis of cathode materials for lithium ion batteries. In FY 2010: Not Applicable.		0.000	1.596	0.000	
CONGRESSIONAL ADD: WASH Oxygen Sensor and Cell Level Battery Controller In FY 2008: Not Applicable. In FY 2009: Develop technology that will monitor the state-of-heath (SOH) and state-of-charge (SOC) of each individual cell of a multicelled battery for the purpose of preventing over or under-charge of individual cells. Develop an O2 sensor for fuel tank inerting applications with specific customers such as the C-17 Support Group. In FY 2010: Not Applicable.		0.000	0.798	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 623145

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 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602102F/ Aerospace Flight Dynamics.	0.000	0.000							Continuing	Continuing
PE 0602605F/ Directed Energy Technology.	0.000	0.000							Continuing	Continuing
PE 0602805F/ Dual Use Science and Technology.	0.000	0.000							Continuing	Continuing
PE 0603605F/ Advanced Weapon Technology.	0.000	0.000							Continuing	Continuing
PE 0603216F/ Aerospace Propulsion and Power 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 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					PROJECT NUMBER 6233SP	
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**
6233SP: Space Rocket Component Tech	52.024	58.698	0.000						Continuing	Continuing

Note

Note: In FY10, work was moved to PE 0602203F Project 4847 to more accurately align efforts.

A. Mission Description and Budget Item Justification

This project develops advances in rocket propulsion technologies for space access, space maneuver, tactical and ballistic missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, Technology for Sustainment of Strategic Systems (TSSS), and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of future space and missile launch subsystems. Technologies are developed to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, a joint Department of Defense, NASA, and industry effort to focus rocket propulsion technology on national needs. Technologies developed under this program enable capabilities of interest to both the Department of Defense and the NASA. Efforts include modeling and simulation, proof of concept tests of critical components, advanced component development, and ground-based tests. In FY10, work was moved to PE 0602203F Project 4847 to more accurately align efforts.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellant ingredients, and reduced-toxicity monopropellants to increase space launch payload capability and refine new propellants synthesis methods. Efforts include evaluation and development of reduced-toxicity ionic salt, high-energy-density oxidizers, nano-materials, catalyst, and polymeric binders; development of supporting computational tools; determining optimized paths for incorporating these materials into propellants; and for selected propellants perform laboratory and demonstrator engine evaluations. Efforts seek monopropellants with performance equivalent to bipropellants that reduce the cost of space access and space operations. In FY 2008: Evaluatd and developed potential hydrocarbon fuel additives to improve performance of kerosene. Began downselect and scale-up promising high energy-density materials candidates. Completed efforts at development and characterization of high nitrogen ingredients. Evaluated scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale	4.086	4.441	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 6233SP	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
motor tests. Explored and developed ionic liquids meeting IHPRPT Phase III goals. Initiated scale up of promising ionic liquids for further characterization. Conducted proof of concept for new computational code to predict molecular properties. In FY 2009: Continue evaluation and development of potential hydrocarbon fuel additives to improve performance of kerosene. Continue downselect process and continue scaling-up promising high energy-density materials candidates. Continue development and characterization of high nitrogen ingredients. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Continue exploration and development of ionic liquids meeting Phase III goals. Initiate scale up of promising ionic liquids for further characterization. Continue proof of concept for new computational code to predict molecular properties. In FY 2010: Not Applicable.					
MAJOR THRUST: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. Efforts include modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as aero-vehicles and potential launch systems. In FY 2008: Characterized, studied, and evaluated shear coaxial injector performance to ensure chamber/ injector compatibility and prevent damage to upper stage engines. Developed, analyzed, and transitioned advanced combustion device technology, including injectors and chambers suitable for advanced synthetic hydrocarbon fuels capable of meeting or exceeding the Phase III goals. Developed improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Completed scale-up and transition new energetic advanced hydrocarbon fuels and additives for rocket propulsion, including space storable high energy, non-toxic fuels. Conducted validation and verification of advanced multi-phase M&S capabilities. Performed pre-selection of most promising advanced propulsion concepts; apply realistic		8.285	8.501	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 6233SP	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
computational models to optimize performance. Continued and refined experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Continued system trade studies with improved performance models to evaluate potential return on investment. In FY 2009: Characterize, study, and evaluate shear injector performance to ensure chamber/injector compatibility and prevent damage to engines. Develop, analyze, and transition advanced combustion device technology, including injectors and chambers capable of meeting or exceeding the IHPRPT Phase III goals. Develop improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Evaluate novel nozzle cooling channels for use with hydrocarbon fuels in the high heat flux test rig. Conduct validation and verification of advanced M&S capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Conduct system trade studies with improved performance models to evaluate potential return on investment. In FY 2010: Not Applicable.					
MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in advanced combustion devices and propulsion systems for current and future rocket propulsion systems. In FY 2008: Continued developing new advanced ablative components using hybrid polymers. Continued to characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Continued developing new advanced materials for use with high-energy propellants. Continued to explore using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Evaluated new class of hydrophobic and oleophobic materials.		5.903	6.507	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 6233SP	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2009: Develop new advanced ablative components using hybrid polymers. Characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Develop new advanced materials for use with high-energy propellants. Explore using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials. In FY 2010: Not Applicable.					
MAJOR THRUST: Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles. In FY 2008: Completed advanced modeling and simulation tool development for advanced cryogenic liquid rocket upper stage technologies. Continued enabling hydrocarbon boost technology development for future spacelift concepts. Initiated engine health monitoring effort supporting the hydrocarbon boost technology development effort. Also initiated Phase III efforts developing hydrocarbon engine technologies using fuels other than kerosene. In FY 2009: Continue enabling hydrocarbon boost technology development for future spacelift concepts. Develop engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene that address IHPRPT Phase III goals. In FY 2010: Not Applicable.		21.843	22.947	0.000	
MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for large communication satellites, micro-satellites, and satellite constellations.		5.061	5.731	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 6233SP	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2008: Continued Hall thruster Phase III development efforts. Continued evaluating Phase III plasma thrusters for microsatellites propulsion systems. Continued scale-up testing Phase II and III monopropellants. Continued assessment of advanced chemical propulsion technology developments for satellite thrusters. Continued development of advanced multi-mode chemical-electric propulsion concepts for satellites. Initiated development of alternative propulsion concepts and associated modeling, simulation, and analysis tools to augment or replace Hall Thrusters in the future. In FY 2009: Conduct Hall thruster IHPRPT Phase III development efforts. Evaluate IHPRPT Phase III plasma thrusters for microsatellites propulsion systems. Scale-up testing IHPRPT Phase II and III monopropellants, evaluate advanced ignition schemes and chamber concepts. Assess advanced chemical propulsion technology developments for satellite thrusters, begin component developments. Develop advanced multi-mode chemical-electric propulsion concepts for satellites, down-select to single design concept and begin component developments. In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: Advanced Vehicle and Propulsion Center. In FY 2008: Refined analytical tools to help assess feasibility and cost benefit of using "common" boosters/ engines across multiple launch platforms. Conducted model developments that will support Prompt Global Strike, future ballistic missile development efforts, and other missile/boost concepts. In FY 2009: Refinement of analytical tools helping assess feasibility and cost benefit of using "common" boosters/engines across multiple launch platforms. Continue model developments that will support Prompt Global Strike, future ballistic missile development efforts, and other missile/boost concepts. In FY 2010: Not Applicable.		1.564	1.197	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 6233SP	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
CONGRESSIONAL ADD: Hydrocarbon Boost Technology Demonstrator. In FY 2008: Accelerated development of technologies for highly operable and reusable spacelift. In FY 2009: Conduct additional modeling, simulation, and analysis work for liquid rocket engines which will make them more affordable, operable, and reliable. In FY 2010: Not Applicable.		1.174	1.396	0.000	
CONGRESSIONAL ADD: Development & Testing of Advanced Paraffin Based Hybrid Rockets for Space Applications. In FY 2008: Scaled up hybrid rocket technologies and characterized for potential use in space applications. In FY 2009: Continue to scale-up motors. Design, build and initiate testing of 24 inch diameter, 30,000 pound thrust-class motors. In FY 2010: Not Applicable.		1.564	2.792	0.000	
CONGRESSIONAL ADD: Integrated Propulsion Analysis Tool (IPAT) In FY 2008: Increased fidelity of rocket engine analysis and assessment tools and broaden application to advanced concepts being considered by the Air Force. In FY 2009: Increase fidelity of rocket engine analysis and assessment tools and broaden application to advanced concepts being considered by the Air Force.		1.564	1.995	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 6233SP	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Not Applicable.					
CONGRESSIONAL ADD: LOX/Methane Cooled Upper Stage Rocket Engine. In FY 2008: Scaled-up liquid oxygen, liquid methane pressure fed second stage rocket engine technologies for the Air Force. In FY 2009: Not Applicable. In FY 2010: Not Applicable.		0.980	0.000	0.000	
CONGRESSIONAL ADD: Multi-Mode Space Propulsion In FY 2008: Not Applicable. In FY 2009: Provide added risk reduction efforts to existing scope of work developing multi-mode propulsion technology. In FY 2010: Not Applicable.		0.000	0.798	0.000	
CONGRESSIONAL ADD: Vortex Low Cost Rocket Engine In FY 2008: Not Applicable.		0.000	2.393	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 6233SP

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2009: Develop small launch vehicle that utilizes vortex combustion processes to generate improved performance and/or operability. In FY 2010: Not Applicable.				

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.

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 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					PROJECT NUMBER 624847	
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**
624847: Rocket Propulsion Technology	10.362	9.961	59.101						Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops rocket propulsion technologies for space access, space maneuver, missiles, the sustainment of strategic systems (including solid boost/ missile propulsion, post boost control, aging and surveillance efforts), and tactical missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, Technology for Sustainment of Strategic Systems (TSSS), and novel space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Technologies are developed to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the Technology for the Sustainment of Strategic Systems (TSSS) program and the Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, a joint Department of Defense, NASA, and industry effort to focus rocket propulsion technology on national needs. Technologies developed under this program enable capabilities of interest to both the Department of Defense and the NASA. Efforts include modeling and simulation, proof of concept tests of critical components, advanced component development, and ground-based tests. Aging and surveillance efforts could reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. Note: In FY 2010, funds from Project 33SP have been moved to Project 4847 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, characterize, and test advanced hydrocarbons, energetics, solid propellant ingredients, and reduced-toxicity monopropellants to increase space launch payload capability and refine new propellants synthesis methods. Efforts include evaluation and development of reduced-toxicity ionic salt, high-energy-density oxidizers, nano-materials, catalyst, and polymeric binders; development of supporting computational tools; determining optimized paths for incorporating these materials into propellants; and for selected propellants perform laboratory and demonstrator engine evaluations. Efforts seek monopropellants with performance equivalent to bipropellants that reduce the cost of space access and space operations. Note: In FY 2008 and FY 2009 this work was conducted under project 33SP. In FY 2008: Not Applicable. In FY 2009: Not Applicable.	0.000	0.000	4.689	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 624847

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Evaluate and develop potential hydrocarbon fuel additives to improve performance of kerosene. Proceed with downselect and scale-up promising high energy-density materials candidates. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Explore and develop ionic liquids meeting IHPRPT Phase III goals. Initiate scale up of promising ionic liquids for further characterization. Conduct proof of concept for new computational code to predict molecular properties of promising propellant ingredients.				
MAJOR THRUST: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. Efforts include modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as aero-vehicles and potential launch systems. Note: In FY 2008 and FY 2009 this work was conducted under project 33SP. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Characterize, study, and evaluate shear injector performance to ensure chamber/injector compatibility and prevent damage to engines. Development, analysis, and transition of advanced combustion device technology, including injectors and chambers capable of meeting or exceeding the IHPRPT Phase III goals. Develop improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Evaluate novel nozzle cooling channels for use with hydrocarbon fuels in the high heat flux test rig. Conduct validation and verification of advanced M&S capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Conduct system trade studies with improved performance models to evaluate potential return on investment.	0.000	0.000	8.401	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 624847	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in advanced combustion devices and propulsion systems for current and future rocket propulsion systems. Note: In FY 2008 and FY 2009 this work was conducted under project 33SP. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Develop new advanced ablative components using hybrid polymers. Characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Develop new advanced materials for use with high-energy propellants. Explore using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials exploring various transition opportunities.		0.000	0.000	6.698	
MAJOR THRUST: Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles. Note: In FY 2008 and FY 2009 this work was conducted under project 33SP. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Update advanced modeling, simulation, and analysis tools with results from full-scale component testing. Develop enabling hydrocarbon boost technology for future spacelift concepts. Develop engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene that address IHPRPT Phase III goals.		0.000	0.000	21.884	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 624847

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for large communication satellites, micro-satellites, and satellite constellations. Note: In FY 2008 and FY 2009 this work was conducted under project 33SP. In FY 2008: Not Applicable. In FY 2009: Not Applicable. In FY 2010: Conduct Hall thruster IHPRPT Phase III development efforts. Evaluate IHPRPT Phase III plasma thrusters for microsatellites propulsion systems. Scale-up testing IHPRPT Phase II and III monopropellants, evaluate advanced ignition schemes and chamber concepts. Assess advanced chemical propulsion technology developments for satellite thrusters, continue component developments. Develop advanced multi-mode chemical-electric propulsion concepts for satellites, continue component developments. Development of next generation high power spacecraft propulsion.	0.000	0.000	6.976	
MAJOR THRUST: Develop missile propulsion and boost technologies. Efforts support the Technology for the Sustainment of Strategic Systems (TSSS) program. In FY 2008: Conducted component development and risk reduction efforts for TSSS Phase II Missile Propulsion demonstration. Conducted sub-scale testing of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Demonstrated low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Completed modeling, simulation, and analysis tool development efforts. Continued development of advanced tactical propulsion technologies. In FY 2009: Conduct component development and risk reduction efforts for TSSS Phase II Missile Propulsion demonstration. Use physics based modeling, simulation, and analysis tools to design and analyze sub-scale components to help verify suitability of those technologies for use in TSSS Phase II Missile Propulsion	8.245	6.050	7.102	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 624847	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
demonstration. Verify development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Development of advanced tactical propulsion technologies. In FY 2010: Conduct component development and risk reduction efforts for TSSS Phase II Missile Propulsion demonstration. Use physics based modeling, simulation, and analysis tools to design and analyze sub-scale components to help verify suitability of those technologies for use in TSSS Phase II Missile Propulsion demonstration. Complete verification development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic, and hybrid polymer components for solid rocket motors. Development of advanced tactical propulsion technologies. Evaluate next generation of updated, physics-based modeling, simulation, and analysis tools for missile propulsion components and applications.					
MAJOR THRUST: Develop missile propulsion technologies and aging and surveillance technologies for ballistic missiles. Efforts support the Technology for the Sustainment of Strategic Systems (TSSS) program. In FY 2008: Continued advanced service life prediction technology program. Developed and applied existing and advanced sensors to be attached to solid rocket motors, and tools that can integrate sensor data into existing aging and surveillance tool suite. In FY 2009: Conduct advanced service life prediction technology program. Develop and apply existing and advanced sensors to be attached to solid rocket motors, and tools that can integrate sensor data into existing aging and surveillance tool suite. Begin efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Assess next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, non-destructive analysis tools.		2.117	3.113	3.351	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 624847

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
In FY 2010: Conduct advanced service life prediction technology program. Develop and apply existing and advanced sensors to be attached to solid rocket motors, and tools that can integrate sensor data into existing aging and surveillance tool suite. Assess integrating advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Develop next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, non-destructive analysis tools.				
CONGRESSIONAL ADD: Aerospace Lab Equipment Upgrade In FY 2008: Not Applicable. In FY 2009: Purchase equipment for university use in classroom instruction and research efforts. In FY 2010: Not Applicable.	0.000	0.798	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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 624847

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 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602114N/ Power Projection Applied Research.	0.000	0.000							Continuing	Continuing
PE 0602303A/ Missile Technology.	0.000	0.000							Continuing	Continuing
PE 0602500F/ Multi-Disciplinary Space Tech.	0.000	0.000							Continuing	Continuing
PE 0603311F/ Ballistic Missile Technology.	0.000	0.000							Continuing	Continuing
PE 0603401F/ Advanced Spacecraft 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 2 - Applied Research				R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion					PROJECT NUMBER 625330	
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**
625330: Aerospace Fuel Technology	0.000	0.000	5.598						Continuing	Continuing

Note

Note: The funding in this project will be transferred in from 62203F Project 3048 starting in FY 2010 to more accurately align efforts with organizational structure.

A. Mission Description and Budget Item Justification

This project evaluates hydrocarbon-based fuels for legacy and advanced turbine engines, scramjets, pulse detonation and combined cycle engines. This project also considers fuel related concepts that can increase turbine engine operational reliability, durability, mission flexibility, energy efficiency, and performance while reducing weight, fuel consumption, and cost of ownership. Applications include missiles, aircraft, sustained high-speed vehicles, and responsive space launch. Analytical and experimental areas of emphasis include evaluations of fuel properties and characteristics of alternative fuels developed from unconventional sources (such as coal, natural gas, biomass, and combinations thereof), fuels and components used in integrated thermal and energy management systems including high heat sink fuel capability, fuels logistics and associated vulnerabilities, and combustion diagnostics and engine emissions measurements.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
MAJOR THRUST: Conduct research and perform technical assessments of alternative hydrocarbon fuels for use in legacy and advanced aerospace systems. Alternative fuels include those derived from coal, natural gas, biomass and combinations thereof. Efforts include investigation of the chemical composition, evaluation of fuel properties, and fuel "fit-for-purpose" assessments of potential alternative aviation fuels. Develop an understanding of alternative aviation fuel lifecycle green house gas emissions relative to conventional petroleum and evaluate potential mitigation approaches. Note: Funding in FY 2010 will be transfered from Project 3048. In FY 2008: Not Applicable. In FY 2009: Not Applicable In FY 2010: Complete component evaluations of 50% synthetic paraffinic kerosene (SPK) produced by Fischer-Tropsch synthesis blended with 50% conventional aviation fuel. Conduct component "fit-for-purpose"	0.000	0.000	2.915	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 625330	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
evaluations of up to 100% SPK. Conduct initial evaluations of biomass derived aviation fuels, both blended with conventional aviation fuel and used 100%. Assess analytical tools being developed to assess CO2 footprint of coal and biomass derived alternative fuels.					
MAJOR THRUST: Develop and demonstrate advanced components and conduct performance assessments of advanced aircraft integrated thermal and energy management systems for advanced engines, aircraft, and combined cycle systems. Develop analytical tools necessary to conduct performance assessments. Develop understanding of and investigate methods to improve the properties and characteristics of current and future aerospace fuels used in integrated thermal and energy management systems. Note: Funding in FY 2010 will be transfered from Project 3048. In FY 2008: Not Applicable. In FY 2009: Not Applicable In FY 2010: Assess advanced aircraft thermal management designs. Develop and assess techniques to improve the thermal characteristics of aviation fuels used in integrated thermal and energy management systems. Develop advanced hydrocarbon based endothermic fuel technologies applicable to combined cycle engines.		0.000	0.000	0.800	
MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to simplify logistics and reduce cost (including field and on-board additive injections and improvements to existing fuel additive packages). Assess fuel logistics vulnerabilities (biological and chemical) and develop detection and mitigation technologies. Note: Funding in FY 2010 will be transfered from Project 3048. In FY 2008: Not Applicable. In FY 2009: Not Applicable.		0.000	0.000	1.000	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion			PROJECT NUMBER 625330	
B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
In FY 2010: Assess aberrant logistical fuels to support field operations and recommend possible corrective actions. Evaluate low cost fuel additives and assess the impact on biological growth in fuel. Complete the development of experimental systems to simulate biological contamination in aircraft fuel systems and ground storage facilities and investigate possible mitigation actions.					
MAJOR THRUST: Develop and test advanced emissions diagnostic techniques for legacy and advanced airbreathing propulsion systems. Conduct evaluations of the combustion and emissions characteristics of current aviation fuels, alternative aerospace fuels, fuel additives, and combinations thereof in representative combustion systems. Note: Funding in FY 2010 will be transfered from Project 3048. In FY 2008: Not Applicable In FY 2009: Not Applicable. In FY 2010: Complete combustion emissions evaluations of high pressure combustor sectors operating on 100% pure and blends of synthetic paraffinic kerosene with conventional aviation fuel and compare to analytical predictions. Develop diagnostic protocols for aircraft ground emissions measurements and perform emissions evaluations on fielded engines to investigate particulate formation and composition. Initiate development of emissions diagnostics applicable to advanced high pressure combustor systems. Conduct preliminary assessment of combustion emissions from biomass derived aviation fuels.		0.000	0.000	0.883	

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 2 - Applied Research	R-1 ITEM NOMENCLATURE PE 0602203F Aerospace Propulsion	PROJECT NUMBER 625330

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
PE 0601102F/ Defense Research Sciences.	0.000	0.000							Continuing	Continuing
PE 0602805F/ Dual Use Science and Technology.	0.000	0.000							Continuing	Continuing
PE 0603216F/ Aerospace Propulsion and Power 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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