Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Air Force										DATE: February 2010	
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 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base Estimate**	**FY 2011 OCO Estimate**	**FY 2011 Total Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	244.890	221.503	207.049	0.000	207.049	209.957	208.178	193.981	192.019	Continuing	Continuing
623012: *Advanced Propulsion Technology*	17.276	17.494	22.859	0.000	22.859	20.455	23.235	20.850	21.336	Continuing	Continuing
623048: *Combustion and Mechanical Systems*	27.086	19.638	18.679	0.000	18.679	20.087	18.995	16.640	15.778	Continuing	Continuing
623066: *Turbine Engine Technology*	85.675	60.655	67.274	0.000	67.274	69.169	65.198	55.689	52.170	Continuing	Continuing
623145: *Aerospace Power Technology*	48.865	41.254	32.604	0.000	32.604	32.781	33.037	31.897	32.657	Continuing	Continuing
6233SP: *Space Rocket Component Tech*	56.539	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
624847: *Rocket Propulsion Technology*	9.449	75.582	58.954	0.000	58.954	61.231	61.141	62.337	63.534	Continuing	Continuing
625330: *Aerospace Fuel Technology*	0.000	6.880	6.679	0.000	6.679	6.234	6.572	6.568	6.544	0.000	0.000

Note

Note: In FY 2010, funds from Project 33SP have been moved to Project 4847 within this program element and from Project 3048 to Project 5330 within this program element to better align efforts.

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 project 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 Combustion and Mechnical Systems project evaluates 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. This project also develops component technologies for adaptive cycle engine architecture to provide optimized performance/fuel efficiency for widely varying mission needs. The Aerospace Power Technology project develops electrical power and thermal management technologies for military applications that are part of the Integrated Vehicle Energy Technology (INVENT) 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. The Aerospace Fuel Technology project evaluates hydrocarbon-based fuels for legacy and advanced turbine engines, scramjets, pulse detonation, and combined-cycle engines. 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.

B. Program Change Summary ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	252.024	196.529	0.000	0.000	0.000
Current President's Budget	244.890	221.503	207.049	0.000	207.049
Total Adjustments	-7.134	24.974	207.049	0.000	207.049
• Congressional General Reductions		-5.000			
• Congressional Directed Reductions		0.000			
• Congressional Rescissions	0.000	-0.938			
• Congressional Adds		30.912			
• Congressional Directed Transfers		0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	0.000	0.000			
• Other Adjustments	-7.134	0.000	207.049	0.000	207.049

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2009	FY 2010
Project: 623048: *Combustion and Mechanical Systems*		
Congressional Add: *National Test Facility for Aerospace Fuels and Propulsion.*	1.356	0.000
Congressional Add: *Hybrid Bearings.*	1.596	0.797
Congressional Add Subtotals for Project: 623048	2.952	0.797
Project: 623066: *Turbine Engine Technology*		
Congressional Add: *Split Discharge Variable Delivery Pump for Military Aircraft.*	0.000	1.593

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Air Force	DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	**R-1 ITEM NOMENCLATURE** PE 0602203F: *Aerospace Propulsion*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2009	FY 2010
Congressional Add Subtotals for Project: 623066	0.000	1.593
Project: 623145: *Aerospace Power Technology*		
Congressional Add: *Advanced Fuel Cell Based Power System for Small UAVs.*	1.197	0.000
Congressional Add: *Affordable Lightweight Power Supply Development.*	0.997	0.000
Congressional Add: *Electronics Liquid Cooling For Advanced Military Ground and Aerospace Vehicle Projects.*	0.997	0.000
Congressional Add: *Integrated Aircraft Energy Management.*	1.995	0.000
Congressional Add: *Integrated Power for Aircraft Technologies (INPACT II).*	3.491	0.000
Congressional Add: *Lithium Ion Domestic Materials Development.*	1.596	0.000
Congressional Add: *Advanced Lithium Battery Scale-Up and Manufacturing.*	1.596	1.593
Congressional Add: *Energy Superior Lithium Battery Technology for Defense Applications.*	5.983	1.593
Congressional Add: *Integrated Engine Starter/Generator.*	1.596	1.593
Congressional Add: *Wavelength Agile Spectral Harmonic Oxygen Sensor and Cell-Level Battery Controller.*	0.798	1.195
Congressional Add: *High-Energy Li-Ion Technology for Aviation Batteries.*	0.000	1.195
Congressional Add: *Thermal and Energy Management for Aerospace.*	0.000	3.187
Congressional Add Subtotals for Project: 623145	20.246	10.356
Project: 6233SP: *Space Rocket Component Tech*		
Congressional Add: *Advanced Vehicle and Propulsion Center.*	1.197	0.000
Congressional Add: *Hydrocarbon Boost Technology Demonstrator.*	1.396	0.000
Congressional Add: *Development and Testing of Advanced Paraffin Based Hybrid Rockets for Space Applications.*	2.792	0.000
Congressional Add: *Integrated Propulsion Analysis Tool (IPAT).*	1.995	0.000
Congressional Add: *Multi-Mode Space Propulsion.*	0.798	0.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Air Force	DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	**R-1 ITEM NOMENCLATURE** PE 0602203F: *Aerospace Propulsion*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2009	FY 2010
Congressional Add: *Vortex Low Cost Rocket Engine.*	2.393	0.000
Congressional Add Subtotals for Project: 6233SP	10.571	0.000
Project: 624847: *Rocket Propulsion Technology*		
Congressional Add: *Aerospace Lab Equipment Upgrade.*	0.798	1.195
Congressional Add: *Advanced Vehicle Propulsion Center.*	0.000	2.390
Congressional Add: *AFRL Edwards Rocket Test Stand 2-A Technical Improvements.*	0.000	3.187
Congressional Add: *Development and Testing of Advanced Hybrid Rockets for Space Applications.*	0.000	2.788
Congressional Add: *Integrated Propulsion Analysis and Spacecraft Engineering Tools (IPAT/ISET).*	0.000	4.780
Congressional Add: *Multi-Mode Propulsion Phase IIA: High Performance Green Propellant.*	0.000	1.593
Congressional Add: *Next Generation Solar Electric In-Space Propulsion.*	0.000	0.797
Congressional Add Subtotals for Project: 624847	0.798	16.730
Project: 625330: *Aerospace Fuel Technology*		
Congressional Add: *National Test Facility for Aerospace Fuels Propulsion.*	0.000	1.306
Congressional Add Subtotals for Project: 625330	0.000	1.306
Congressional Add Totals for all Projects	34.567	30.782

Change Summary Explanation

In FY 2009 and 2010, the 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. Starting in FY 2010, Funds from Project 33SP have been moved to Project 4847 within this Program Element to more accurately align efforts.

The FY 2010 President's Budget submittal did not reflect FY 2011 through FY 2015 funding. A detailed explanation of changes between the two budget positions is not provided because it cannot be made in a relevant manner.

Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Air Force	DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	**R-1 ITEM NOMENCLATURE** PE 0602203F: *Aerospace Propulsion*

In FY 2010, Congress added $1.6 million for Advanced Lithium Battery Scale-up and Manufacturing, $2.4 million for Advanced Vehicle Propulsion Center, $1.2 million for Aerospace Lab Equipment Upgrade, $3.2 million for AFRL Edwards Rocket Test Stand 2-A Technical Improvements, $2.8 million for Development and Testing of Advanced Hybrid Rockets for Space Applications, $1.6 million for Energy Superior Lithium Battery Technology for Defense Applications, $1.2 million for High-Energy Li-Ion Technology for Aviation Batteries, $0.8 million for Hybrid Bearings, $1.6 million for Integrated Engine Starter/Generator, $4.8 million for Integrated Propulsion Analysis and Spacecraft Engineering Tools (IPAT/ISET), $1.6 million for Multi-Mode Propulsion Phase IIA: High Performance Green Propellant, $1.312 million for National Test Facility for Aerospace Fuels Propulsion, $0.8 million for Next Generation Solar Electric In-Space Propulsion, $1.6 million for Split Discharge Variable Delivery Pump for Military Aircraft, $3.2 million for Thermal and Energy Management for Aerospace, and $1.2 million for Wavelength Agile Spectral Harmonic Oxygen Sensor and Cell-Level Battery Controller.

C. Performance Metrics
(U) Under Development.

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
623012: *Advanced Propulsion Technology*	17.276	17.494	22.859	0.000	22.859	20.455	23.235	20.850	21.336	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 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop advanced fuel-cooled scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future warfighter needs.	3.200	1.650	1.150	0.000	1.150
FY 2009 Accomplishments: In FY 2009: 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. Conducted design of ground test hardware of advanced scramjet start techniques. Completed development of scramjet engine control logic for flight test engines. 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.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: 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. *FY 2011 Base Plans:* In FY 2011: Develop and demonstrate flight weight engine components and advanced engine control logic. Perform trajectory optimization for flight test. Participate in international flight test to demonstrate ramjet to scramjet transition. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Conduct assessments, technology design trades, and simulations to integrate combined cycle engines (CCEs) and air breathing hypersonic propulsion technologies into future systems. *FY 2009 Accomplishments:* In FY 2009: 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. Developed advanced components for turbine-based and rocket-based CCEs. *FY 2010 Plans:* 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.	0.165	0.165	0.165	0.000	0.165

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: In FY 2011: 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, including test facility requirements, for advanced components for turbine-based and rocket-based CCEs. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future platforms. *FY 2009 Accomplishments:* In FY 2009: 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. Continued development of low internal drag flame stabilization devices and flight test engine components. Conducted assessment of ground test facilities and test techniques to demonstrate large (20 to 100 times) size scramjet engines. *FY 2010 Plans:* 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.	13.911	15.679	21.544	0.000	21.544

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: In FY 2011: 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. Ground test subscale components/combustors to represent medium scale (5 to 20 times) scramjet engines. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	17.276	17.494	22.859	0.000	22.859

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0601102F: *Defense Research Sciences.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602201F: *Aerospace Flight Dynamics.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602500F: *Multi-Disciplinary Space Tech.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602602F: *Conventional Munitions.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602702E: *Tactical Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603211F: *Aerospace Structures.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0603216F: *Aerospace Propulsion and Power Technology.*											
• PE 0603601F: *Conventional Weapons Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE Not Provided (5580): *Program is reported to/coordinated by the Joint Army/Navy/NASA/ Air Force (JANNAF) Executive Committe*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
623048: *Combustion and Mechanical Systems*	27.086	19.638	18.679	0.000	18.679	20.087	18.995	16.640	15.778	Continuing	Continuing

Note

Note: In FY 2010, the fuels portion of this Project was moved to PE 0602203F Project 5330 within this Program Element 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.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop low-cost additive and fuel system approaches to improve fuel properties. Determine fuel cooling requirements and specifications for adaptive cycle engine architecture.	3.000	0.000	0.000	0.000	0.000
FY 2009 Accomplishments: In FY 2009: Conducted 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. Continued efforts to validate component performance models on aircraft thermal management simulator. Tested fuel candidates in bench scale					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
rigs simulating advanced high Mach propulsion systems and ultra efficient turbine engine components. Conducted full-scale component rig testing of mechanical components with prototype lubricants. Conducted simulated high-Mach tests of an integrated thermal management system and mechanical system components. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature (including nano-scale additives), as well as advanced emission diagnostic test protocols. *FY 2009 Accomplishments:* In FY 2009: Continued higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion. Initiated study of NOx/soot tradeoffs in combustor design. Improved combustion models for kerosene fuels. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	1.000	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to reduce cost. Study fuel logistics vulnerabilities and develop detection and mitigation technologies. *FY 2009 Accomplishments:* In FY 2009: Expanded investigation of performance of biomass-derived fuels for aircraft and other field hardware. Extended knowledge base to other alternative fuels, such as those derived from biomass. Developed bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Expanded knowledge base for certification of Fischer-Tropsch fuels for all AF tactical vehicles. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	1.000	0.000	0.000	0.000	0.000
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. *FY 2009 Accomplishments:* In FY 2009: Expanded study of high-energy hydrocarbon propellant candidates. Completed improved physical property database for kerosene propellants at high pressure. Collected improved physical property for high energy hydrocarbons and improved physical property models. *FY 2010 Plans:* In FY 2010: Not Applicable.	0.500	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
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. *FY 2009 Accomplishments:* In FY 2009: Evaluated advanced combustion system performance at realistic operating conditions. Demonstrated small-scale inter-turbine burning concepts in small engines. Identified concept designs of inter-turbine burning concepts for large gas turbine engines. Optimized component efficiency of the integrated pulsed detonation/hybrid turbine. Evaluated and optimized advanced combustor, augmentor, and pulse detonation engine concepts using modeling and simulation tools covering wider flight conditions and applications. *FY 2010 Plans:* In FY 2010: Test concept designs for larger-scale inter-turbine burners at relevant gas turbine engine conditions. Evaluate performance characteristics in small internal combustion engines burning military fuels. Identify potential performance improvements for small engines. Investigate novel combustor, augmentor, continuous detonation, 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 pulse detonation engines. *FY 2011 Base Plans:* In FY 2011: Test full-scale inter-turbine burner concepts at relevant engine conditions. Investigate novel valving concepts for pulse detonation engines. Study pulse detonation engine-turbine	7.061	7.100	8.128	0.000	8.128

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
interactions. Explore the use of regenerative fuel cooling with pulse detonation engines and other combustion systems. Demonstrate novel small internal combustion engine concepts that improve system performance. Use advanced modeling and simulation tools to understand combustion processes and to guide combustion system design. Employ new chemistry models for alternative fuels. Test concept designs for adaptive combustors for ultra efficient turbine engine components which reduce harmful emissions. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop approaches to extend the life of endothermic fuels and fuel system components for sustained supersonic and reusable hypersonic cruise applications. *FY 2009 Accomplishments:* In FY 2009: Conducted bench-scale tests to evaluate improved surfaces/catalysts for 2nd generation endothermic fuels. Assessed unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads. Studied relationship between fuel structure/properties and combustion behavior including blowout. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* FY 2011 OCO: N/A.	0.500	0.000	0.000	0.000	0.000
MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies.	1.000	1.000	1.212	0.000	1.212

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2009 Accomplishments: In FY 2009: Developed high-speed techniques for measuring carbon monoxide (CO) to evaluate CO oxidiation/combustion efficiency in near constant volume combustion turbine environments. Exploited 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. Developed multi-pulse femtosecond ballistic imaging to understand and improve fuel sprays in combustor, augmentor, scramjet, and rocket applications. Developed ultrafast (picosecond, femtosecond) coherent anti-Stokes Raman scattering (CARS) for measuring temperature and critical species in combustion devices. Applied advanced optical diagnostics suites to characterization and improvement of engine combustors and afterburners. *FY 2010 Plans:* 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 FY 2009 to practical combustion devices and engine systems. Apply advanced optical diagnostics suites to characterize and improve engine combustors and afterburners. *FY 2011 Base Plans:* In FY 2011: Use two-color planar laser induced fluorescence techniques to measure temperature in relevant-environment combustion systems. Develop robust line-of-sight measurement techniques for temperature and species and apply to engine systems. Develop simultaneous high-speed planar laser-induced fluorescence and particle-image velocimetry for measurements of species and velocity fields in practical combustion devices. Expand line-of-sight measurement techniques for temperature and species to include many simultaneous lines of sight and tomographic reconstruction of complex reacting flowfields characteristic of real-world hardware. Apply advanced optical diagnostics suites for characterization and improvement of engine combustors and afterburners.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 OCO Plans: In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop, test, and qualify advanced turbine engine lubricants. Generate and maintain military specifications for aviation engine lubricants. *FY 2009 Accomplishments:* In FY 2009: Demonstrated enhanced 5cSt ester lubricant in JSF thrust growth demo engines. Finalized new enhanced 5cSt oil specification. Began initial testing of new high-mach 7cSt ester lubricant. Demonstrated an integrated bearing/oil health monitoring/prognostic system in full-scale setting and validate life models. Fabricated and tested an efficient mechanical system for ultra efficient turbine engine components and adaptive components for high efficiency. Continued development of high-temperature lubricants for Long Range Strike aircraft. *FY 2010 Plans:* In FY 2010: Complete testing of Joint Enhanced Ester oils in technology readiness level 5 full-scale bearing endurance rigs and in XTE68/LF1 and XTE78/LF1 VAATE-I technology demonstrator engines. Finalize elastomer and load capacity limits jointly with US Navy, Draft Joint USAF-Navy enhanced ester oil specification and support initial transition activities to F-35, C-17, F-16 aircraft. Conduct TRL 2-3 component level testing of high-Mach ester lubricant for future High-Mach Turbine Engine (HMTE) aircraft. Investigate anti-coke lube system surface modifiers using vapor phase coke (VPC) test rig for sustained supersonic engine oil system. Develop intelligent prognostics for lubrication system health monitoring. *FY 2011 Base Plans:* In FY 2011: Support full transition of Joint Enhanced Ester to F-35 and operational fleet by coordinating with engine manufacturers and users. Conduct adaptive components for high efficiency risk mitigation bearing and gear rig tests with Joint Enhanced Ester in preparation for 2012 demo engine test. Conduct TRL 3-4 component level testing of hi-Mach ester lubricant for HMTE.	5.004	5.241	4.620	0.000	4.620

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Demonstrate anti-coke surface modifiers on sub-scale supersonic lube system components. Expand development of intelligent prognostics for lubrication system health monitoring. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-sized turbine engine applications. *FY 2009 Accomplishments:* In FY 2009: Continued sub-scale fatigue life and spall propagation studies of bearing materials and validated spall propagation models with oil candidates and begin full-scale tests. Conducted full-scale bearing evaluation to map out and transfer thermal models in support of adaptive components for high efficiency. *FY 2010 Plans:* In FY 2010: Investigate spall propagation of nitrided bearings. Continue experimental validation of bearing heat generation models. Initiate fabrication of adaptive components for high efficiency and ultra efficient turbine engine mechanical systems components and initiate risk mitigation tests. Test bearing concepts, such as foil bearings for high Mach missile and other future applications. Continue developing in-house rotor dynamic modeling expertise in support of adaptive components for high efficiency, ultra efficient turbine engine components, and future advanced turbine engine efforts. *FY 2011 Base Plans:* In FY 2011: Investigate fatigue life and spall propagation of VIM VAR 52100 bearings. Complete mechanical systems risk mitigation test activities for adaptive components for high efficiency. Develop coupled bearing & rotor dynamic models for virtual simulation of mechanical systems for advanced engines. Continue developing reliable bearing technologies for sustained hi-mach reusable and limited-life engines. Note: In FY 2011, the efforts in this thrust are reduced due to higher AF priorities.	5.069	5.500	4.719	0.000	4.719

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 OCO Plans: In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	24.134	18.841	18.679	0.000	18.679

	FY 2009	FY 2010
Congressional Add: National Test Facility for Aerospace Fuels and Propulsion. *FY 2009 Accomplishments:* In FY 2009: Developed test capability for aerospace fuels and propulsion, focusing on alternative fuel/ combustion testing. *FY 2010 Plans:* In FY 2010: Not Applicable.	1.356	0.000
Congressional Add: Hybrid Bearings. *FY 2009 Accomplishments:* In FY 2009: Completed crack propagation modeling of C-crack flaws in Si3N4 rolling elements for hybrid bearings. Completed full-scale bearing rig tests of light-weight carbon-carbon composite bearing cages and CSS42L cages. Completed heat treat optimization of 2nd generation P675 bearing steel and fabrication of full-scale hybrid bearing hardware is underway. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Hybrid Bearings.	1.596	0.797
Congressional Adds Subtotals	2.952	0.797

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0601102F: *Defense Research Sciences.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602805F: *Dual Use Science and Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603216F: *Aerospace Propulsion and Power Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
623066: *Turbine Engine Technology*	85.675	60.655	67.274	0.000	67.274	69.169	65.198	55.689	52.170	Continuing	Continuing

Note

Note: The funding in this project was increased in FY 2009 to provide emphasis on adaptive cycle technologies, increased fuel efficiency, and ultra efficient turbine engine components.

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 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports.	63.346	42.506	41.097	0.000	41.097
FY 2009 Accomplishments: In FY 2009: Developed and applied advanced modeling and simulation rules and tools for advanced components. Conducted rig testing of advanced high pressure turbine vane and applied blade nano-laminate thermal barrier coating. Began developing computational fluid dynamics methodology for analyzing turbine flows. Began developing ceramic matrix composites lifing models. Conducted bench					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
and rig tests for validation of components with significantly improved efficiency. Performed 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, low observable-compatible exhaust system. Fabricated an efficient, very high pressure ratio compressor and associated thermal management features that offer a step change improvement in engine specific fuel consumption. *FY 2010 Plans:* 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.) *FY 2011 Base Plans:* In FY 2011: Develop and apply advanced modeling and simulation rules and tools for advanced components. Develop computational fluid dynamics methodology for analyzing turbine flows. Develop ceramic matrix composite lifing models. Conduct bench and rig tests for validation of components with significantly improved efficiency. Perform 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, low observable-compatible exhaust system. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of efficient, very high pressure ratio core component technologies that will offer a step change improvement in engine specific fuel consumption. Note: In FY 2011, the efforts in this thrust are reduced due to higher AF priorities.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 OCO Plans: In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop turbofan/turbojet engine components (i.e. fans, nozzles, etc.) for engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports. *FY 2009 Accomplishments:* In FY 2009: Developed and applied advanced modeling and simulation rules and tools for advanced components. Developed durable damping/erosion coating systems. Conducted rig testing of advanced fan design for application to a variable cycle engine concept. Conducted rig testing of advanced low pressure turbine design for application to a variable cycle engine concept. Designed and rig tested lightweight, simple, LO-compatible inlet and exhaust system. *FY 2010 Plans:* 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. *FY 2011 Base Plans:* In FY 2011: 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. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	15.773	14.485	19.237	0.000	19.237

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. *FY 2009 Accomplishments:* In FY 2009: Utilized 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. *FY 2010 Plans:* 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. Note: In FY 2010, efforts in this thrust are reduced due to higher AF priorities. *FY 2011 Base Plans:* In FY 2011: Develop and apply advanced modeling and simulation rules and tools for advanced limited life components. Design and rig test advanced limited life components. Note: In FY 2011, efforts in this thrust are increased due to increased AF emphasis on propulsion for unmanned air vehicle applications. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	5.246	0.868	5.309	0.000	5.309
MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. *FY 2009 Accomplishments:* In FY 2009: Utilized 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.	1.310	1.203	1.631	0.000	1.631

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: In FY 2010: Develop and apply advanced modeling and simulation rules and tools for advanced limited life components. *FY 2011 Base Plans:* In FY 2011: Develop and apply advanced modeling and simulation rules and tools for advanced limited life components. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	85.675	59.062	67.274	0.000	67.274

	FY 2009	FY 2010
Congressional Add: Split Discharge Variable Delivery Pump for Military Aircraft. *FY 2009 Accomplishments:* In FY 2009: Not applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Split Discharge Variable Delivery Pump for Military Aircraft.	0.000	1.593
Congressional Adds Subtotals	0.000	1.593

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0601102F: *Defense Research Sciences.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602102F: *Materials.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603216F: *Aerospace Propulsion and Power Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602122N: *Aircraft Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603210N: *Aircraft Propulsion.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603003A: *Aviation Advanced Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
623145: *Aerospace Power Technology*	48.865	41.254	32.604	0.000	32.604	32.781	33.037	31.897	32.657	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 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop electrical power and thermal management component and subsystem technologies for manned and unmanned systems. Develop hybrid electrical power for special purpose applications.	23.182	25.620	27.521	0.000	27.521
FY 2009 Accomplishments: In FY 2009: Fabricated, integrated, and tested high efficiency, high power, wide temperature range power electrical components. Initiated integration and test air vehicle electromagnetic and radio frequency effects immune components. Integrated and tested thermal management components and subsystems.					
FY 2010 Plans: In FY 2010: Assess component performance objectives needed to meet systems level, energy optimized performance goals.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: In FY 2011: Perform hardware-in-the-loop simulation tests to validate power and thermal management systems provide continuous thermal balancing of critical systems over a range of mission profiles. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop lightweight electrical power and thermal management component and subsystem technologies with low volume displacement for delivery of high power for directed energy weapons. *FY 2009 Accomplishments:* In FY 2009: Investigated high-rate thermal energy storage for directed energy applications. *FY 2010 Plans:* In FY 2010: Complete investigation of high-rate thermal energy storage for directed energy applications. *FY 2011 Base Plans:* In FY 2011: Assess component technologies for application to directed energy weapon concepts. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	1.398	1.119	1.103	0.000	1.103
MAJOR THRUST: Develop hybrid electrical power and thermal management, including energy conversion/ storage, components and subsystem technologies for special purpose applications.	4.039	4.159	3.980	0.000	3.980

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2009 Accomplishments: In FY 2009: Integrated and tested thermal management components and subsystems. Integrated and initiated subsystems test of flight-weight, efficient, energy harvesting, hybrid battery and fuel cell components. *FY 2010 Plans:* 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. *FY 2011 Base Plans:* In FY 2011: Develop increased fuel flexibility and integrated energy harvesting technologies for expanded special purpose applications for improved power and energy density. Perform integrated flight-weight subsystems flight tests to demonstrate power and energy dense goals. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	28.619	30.898	32.604	0.000	32.604

	FY 2009	FY 2010
Congressional Add: Advanced Fuel Cell Based Power System for Small UAVs.	1.197	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2009 Accomplishments: In FY 2009: Continued development of micro fuel cell technology for Micro Air Vehicle (MAV) applications. Continued improvements to balance of plant, reactor and power electronics to increase power density of the system and integrate into MAV vehicle. *FY 2010 Plans:* In FY 2010: Not Applicable.		
Congressional Add: Affordable Lightweight Power Supply Development. *FY 2009 Accomplishments:* In FY 2009: Developed novel high-performance and low-cost Membrane Electrode Assemblies, which are capable of operating at high temperatures, reduced humidities and which enable decreased system complexity. Demonstrated their ability to provide an improved Proton Exchange Membrane Fuel Cell system for US military/Air Force applications. *FY 2010 Plans:* In FY 2010: Not Applicable.	0.997	0.000
Congressional Add: Electronics Liquid Cooling For Advanced Military Ground and Aerospace Vehicle Projects. *FY 2009 Accomplishments:* In FY 2009: Developed bonding processes required to fabricate aluminum macrolaminate cold plates for thermal management devices. *FY 2010 Plans:* In FY 2010: Not Applicable.	0.997	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
Congressional Add: Integrated Aircraft Energy Management. *FY 2009 Accomplishments:* In FY 2009: Integrated engine specifications, data, and propulsion subsystem-level assessments for use in aircraft system design and modeling to develop an energy optimized aircraft. *FY 2010 Plans:* In FY 2010: Not Applicable.	1.995	0.000
Congressional Add: Integrated Power for Aircraft Technologies (INPACT II). *FY 2009 Accomplishments:* In FY 2009: Conducted research to advance the state of the art of energy, power and thermal technologies for aerospace applications. *FY 2010 Plans:* In FY 2010: Not Applicable.	3.491	0.000
Congressional Add: Lithium Ion Domestic Materials Development. *FY 2009 Accomplishments:* In FY 2009: Synthesized, characterized, and scaled-up domestically fabricated cathode material for lithium ion batteries. First step in establishing a stable, domestic capability to produce high quality cathodes with similar or improved performance characteristics as prior material. *FY 2010 Plans:* In FY 2010: Not Applicable.	1.596	0.000
	1.596	1.593

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
Congressional Add: Advanced Lithium Battery Scale-Up and Manufacturing. *FY 2009 Accomplishments:* In FY 2009: Completed lithium-ion cathode material selection and initial characterization studies. Conducted preliminary battery performance tests and completed evaluation of cell packaging methods. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Advanced Lithium Battery Scale-Up and Manufacturing.		
Congressional Add: Energy Superior Lithium Battery Technology for Defense Applications. *FY 2009 Accomplishments:* In FY 2009: Developed a high energy nano cell design, a high power (HP) cell design for aviation applications, and developed a 270 V aircraft module using the HP cell design. Sample production batteries delivered to the different services for development, test, and evaluation. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Energy Superior Lithium Battery Technology for Defense Applications.	5.983	1.593
Congressional Add: Integrated Engine Starter/Generator. *FY 2009 Accomplishments:* In FY 2009: Fabricated initial prototypes of the lightweight, compact, high temperature starter/generator and Inverter-Converter Controllers to increase the technology readiness level. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Integrated Engine Starter/Generator.	1.596	1.593

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
Congressional Add: Wavelength Agile Spectral Harmonic Oxygen Sensor and Cell-Level Battery Controller. *FY 2009 Accomplishments:* In FY 2009: Continued to develop battery controlling/monitoring technology. Continued to develop an O2 sensor for potential fuel tank applications. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Wavelength Agile Spectral Harmonic Oxygen Sensor and Cell-Level Battery Controller.	0.798	1.195
Congressional Add: High-Energy Li-Ion Technology for Aviation Batteries. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in High-Energy Li-Ion Technology for Aviation Batteries.	0.000	1.195
Congressional Add: Thermal and Energy Management for Aerospace. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Thermal and Energy Management for Aerospace.	0.000	3.187
Congressional Adds Subtotals	20.246	10.356

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0601102F: *Defense Research Sciences.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602102F: *Aerospace Flight Dynamics.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602605F: *Directed Energy Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602805F: *Dual Use Science and Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603605F: *Advanced Weapon Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603216F: *Aerospace Propulsion and Power Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 6233SP: *Space Rocket Component Tech*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
6233SP: *Space Rocket Component Tech*	56.539	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note

Note: In FY 2010, work in this project was moved to Project 4847 within this Program Element 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.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellant ingredients, and reduced-toxicity monopropellants to increase space launch payload capability.	4.241	0.000	0.000	0.000	0.000
FY 2009 Accomplishments: In FY 2009: Continued evaluation and development of potential hydrocarbon fuel additives to improve performance of kerosene. Continued downselect process and continued scaling-up promising high energy-density materials candidates. Continued 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 motor tests. Continued exploration					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 6233SP: *Space Rocket Component Tech*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
and development of ionic liquids meeting Phase III goals. Initiated scale up of promising ionic liquids for further characterization. Continued proof of concept for new computational code to predict molecular properties. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
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. *FY 2009 Accomplishments:* In FY 2009: Characterized, studied, and evaluated shear injector performance to ensure chamber/ injector compatibility and prevent damage to engines. Developed, analyzed, and transitioned advanced combustion device technology, including injectors and chambers capable of meeting or exceeding the IHPRPT 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. Evaluated novel nozzle cooling channels for use with hydrocarbon fuels in the high heat flux test rig. Conducted validation and verification of advanced capabilities. Performed pre-selection of most promising advanced propulsion concepts; applied realistic computational models to optimize performance. Refined experimental demonstrations of proof-of-concepts, continued development of	8.120	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 6233SP: *Space Rocket Component Tech*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
realistic computational models. Conducted system trade studies with improved performance models to evaluate potential return on investment. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in current and future rocket propulsion systems. *FY 2009 Accomplishments:* In FY 2009: Developed new advanced ablative components using hybrid polymers. Characterized and finalized processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Developed new advanced materials for use with high-energy propellants. Explored using nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Characterized the mechanisms behind a new class of hydrophobic and oleophobic materials. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable.	6.215	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 6233SP: *Space Rocket Component Tech*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 OCO Plans: In FY 2011 OCO: N/A.					
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. *FY 2009 Accomplishments:* In FY 2009: Continued enabling hydrocarbon boost technology development for future spacelift concepts. Developed engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Developed advanced hydrocarbon engine technologies using fuels other than kerosene that address IHPRPT Phase III goals. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	21.918	0.000	0.000	0.000	0.000
MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for satellites and satellite constellations. *FY 2009 Accomplishments:* In FY 2009: Conducted Hall thruster IHPRPT Phase III development efforts. Evaluated IHPRPT Phase III plasma thrusters for microsatellites propulsion systems. Performed scale-up testing IHPRPT Phase II and III monopropellants, evaluated advanced ignition schemes and chamber concepts. Assessed advanced chemical propulsion technology developments for satellite thrusters, begin	5.474	0.000	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 6233SP: *Space Rocket Component Tech*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
component developments. Developed advanced multi-mode chemical-electric propulsion concepts for satellites, down-selected to single design concept and began component developments. *FY 2010 Plans:* In FY 2010: Not Applicable. *FY 2011 Base Plans:* In FY 2011: Not Applicable. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	45.968	0.000	0.000	0.000	0.000

	FY 2009	FY 2010
Congressional Add: Advanced Vehicle and Propulsion Center. *FY 2009 Accomplishments:* In FY 2009: Refined analytical tools helping assess feasibility and cost benefit of using "common" boosters/engines across multiple launch platforms. Continued model developments that will support Prompt Global Strike, future ballistic missile development efforts, and other missile/boost concepts. *FY 2010 Plans:* In FY 2010: Not Applicable.	1.197	0.000
Congressional Add: Hydrocarbon Boost Technology Demonstrator.	1.396	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 6233SP: *Space Rocket Component Tech*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2009 Accomplishments: In FY 2009: Conducted additional modeling, simulation, and analysis work for liquid rocket engines which accelerate the development of technologies for highly operable and reusable spacelift. *FY 2010 Plans:* In FY 2010: Not Applicable.		
Congressional Add: Development and Testing of Advanced Paraffin Based Hybrid Rockets for Space Applications. *FY 2009 Accomplishments:* In FY 2009: Continued to scale-up motors. Designed, built, and initiated testing of 24-inch diameter, 30,000 pound thrust-class motors. *FY 2010 Plans:* In FY 2010: Not Applicable.	2.792	0.000
Congressional Add: Integrated Propulsion Analysis Tool (IPAT). *FY 2009 Accomplishments:* In FY 2009: Increased fidelity of rocket engine analysis and assessment tools and broadened application to advanced concepts being considered by the Air Force. *FY 2010 Plans:* In FY 2010: Not Applicable.	1.995	0.000
Congressional Add: Multi-Mode Space Propulsion.	0.798	0.000

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2009 Accomplishments: In FY 2009: Provided added risk reduction efforts to existing scope of work developing multi-mode propulsion technology. *FY 2010 Plans:* In FY 2010: Not Applicable.		
Congressional Add: Vortex Low Cost Rocket Engine. *FY 2009 Accomplishments:* In FY 2009: Developed small launch vehicle that utilizes vortex combustion processes to generate improved performance and/or operability. *FY 2010 Plans:* In FY 2010: Not Applicable.	2.393	0.000
Congressional Adds Subtotals	10.571	0.000

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE Not Provided (7378): *Activity Not Provided*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

D. Acquisition Strategy

Not Applicable

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	**R-1 ITEM NOMENCLATURE** PE 0602203F: *Aerospace Propulsion*	**PROJECT** 6233SP: *Space Rocket Component Tech*

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, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
624847: *Rocket Propulsion Technology*	9.449	75.582	58.954	0.000	58.954	61.231	61.141	62.337	63.534	Continuing	Continuing

Note

Note: Funding increase in FY 2010 and out due to multiple programs scheduled for major hardware scale-up and production in preparation for testing in the following years, and to feed technologies into the Hydrocarbon Boost Demo. These have been planned for and are expected. In FY 2010, funds from PE 0602203F Project 33SP have been moved to this project within this Program Element to more accurately align efforts.

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.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellants, and monopropellants to increase space launch payload capability and refine new synthesis methods.	0.000	4.689	3.838	0.000	3.838
FY 2009 Accomplishments: In FY 2009: Not Applicable.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: In FY 2010: Perform screening analysis of 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. Evaluate suitability for ionic liquid propellants for missile defense interceptor and spacecraft propulsion demonstrations. Initiate technology transfer to industry for production of downselected propellants. Initiate high performance bi-propellant identification program. *FY 2011 Base Plans:* In FY 2011: Conduct experimental and analytical evaluation of potential hydrocarbon fuel additives to improve performance of kerosene. Continue downselect process 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. Exploration and development of ionic liquids meeting IHPRPT Phase III goals. Continue scale up experiments of promising ionic liquids for further characterization. Continue proof of concept for new computational code to predict molecular properties of various promising propellant ingredients. Continue evaluation of suitability for ionic liquid propellants for missile defense interceptor and spacecraft propulsion demonstrations. Continue technology transfer to industry for production of downselected propellants. Continue high performance bi-propellant identification and synthesis program. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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.	0.000	8.401	7.125	0.000	7.125

FY 2009 Accomplishments:
In FY 2009: Not Applicable.

FY 2010 Plans:
In FY 2010: 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 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.

FY 2011 Base Plans:
In FY 2011: Characterize, study, and evaluate shear injector performance to ensure chamber/injector compatibility and prevent damage to engines. Validate study results in more realistic rocket-chamber conditions and begin transition of predictive tools to industry. 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

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
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. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for current and future rocket propulsion systems. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Develop new advanced ablative components using hybrid polymers. Characterize and refine 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. Continue to 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. *FY 2011 Base Plans:* In FY 2011: Develop new advanced ablative components using hybrid polymers. Continue to 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	0.000	6.698	5.492	0.000	5.492

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
high-energy propellants. Continue to explore applications of nanocomposites for liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Continue to characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials exploring various transition opportunities. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
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. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* 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. Initiate risk reduction activities for the development of hydrocarbon boost technologies. 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. Develop and demonstrate in-house, moderate scale liquid rocket component testing capability. Initiate evaluation of high performance compact liquid rocket engine technology. Initiate evaluation of bipropellant liquid rocket engine technologies. *FY 2011 Base Plans:* In FY 2011: Develop enabling hydrocarbon boost technology for future spacelift concepts. Continue risk reduction activities for the development of hydrocarbon boost technologies. Continue development of engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene that	0.000	21.635	26.955	0.000	26.955

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
address IHPRPT Phase III goals. Develop and demonstrate in-house, moderate scale liquid rocket component testing capability. Develop high performance compact liquid rocket engine technologies. Continue development and evaluation of bipropellant technologies. Note: Increase in FY 2011 due to multiple programs scheduled for major hardware scale-up and production. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for satellites and satellite constellations. *FY 2009 Accomplishments:* In FY 2009: Not applicable. *FY 2010 Plans:* In FY 2010: Complete Hall thruster IHPRPT Phase III development efforts. Evaluate IHPRPT Phase III 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. Develop next generation high power spacecraft propulsion. Initiate advanced modeling and simulation tool developments to improve design and analysis tools for a wide range of spacecraft propulsion concepts/technologies. *FY 2011 Base Plans:* In FY 2011: 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	0.000	6.976	5.391	0.000	5.391

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
propulsion concepts for satellites, continue component developments. Develop next generation high power electric spacecraft propulsion. Continue advanced modeling and simulation tool developments to improve design and analysis tools for a wide range of spacecraft propulsion concepts/technologies. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop missile propulsion and boost technologies. Efforts support the Technology for the Sustainment of Strategic Systems (TSSS) program. *FY 2009 Accomplishments:* In FY 2009: Conducted component development and risk reduction efforts for TSSS Phase II Missile Propulsion demonstration. Used 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. Verified development 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. Developed advanced tactical propulsion technologies. *FY 2010 Plans:* In FY 2010: Continue 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. 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. Develop advanced tactical propulsion	5.712	7.102	7.641	0.000	7.641

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
technologies. Evaluate next generation of updated, physics-based modeling, simulation, and analysis tools for missile propulsion components and applications. *FY 2011 Base Plans:* In FY 2011: Continue the component development and risk reduction efforts for TSSS Phase II Missile Propulsion demonstration. Demonstrate low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic, and hybrid polymer components for solid rocket motors. Develop advanced tactical propulsion technologies. Plan for the demonstration of advanced missile propulsion technologies under TSSS Phase II Missile Propulsion demonstration. Continue development and evaluation of next generation of updated, physics-based modeling, simulation, and analysis tools for missile propulsion components and applications. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop missile propulsion technologies and aging and surveillance technologies for ballistic missiles. Efforts support the Technology for the Sustainment of Strategic Systems program. *FY 2009 Accomplishments:* In FY 2009: Conducted 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. Began efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Assessed next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools.	2.939	3.351	2.512	0.000	2.512

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: 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. Continue efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Continue development of next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. *FY 2011 Base Plans:* In FY 2011: 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. Continue efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Continue development of next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	8.651	58.852	58.954	0.000	58.954

	FY 2009	FY 2010
Congressional Add: Aerospace Lab Equipment Upgrade.	0.798	1.195

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2009 Accomplishments: In FY 2009: Upgraded/augmented existing university facilities/capabilities to train future aerospace engineers. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in the Aerospace Lab Equipment Upgrade.		
Congressional Add: Advanced Vehicle Propulsion Center. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort at the Advanced Vehicle Propulsion Center.	0.000	2.390
Congressional Add: AFRL Edwards Rocket Test Stand 2-A Technical Improvements. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort for AFRL Edwards Rocket Test Stand 2-A Technical Improvements.	0.000	3.187
Congressional Add: Development and Testing of Advanced Hybrid Rockets for Space Applications. *FY 2009 Accomplishments:* In FY 2009: Not Applicable.	0.000	2.788

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2010 Plans: In FY 2010: Conduct Congressionally directed effort in Development and Testing of Advanced Hybrid Rockets for Space Applications.		
Congressional Add: Integrated Propulsion Analysis and Spacecraft Engineering Tools (IPAT/ISET). *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Integrated Propulsion Analysis and Spacecraft Engineering Tools (IPAT/ISET).	0.000	4.780
Congressional Add: Multi-Mode Propulsion Phase IIA: High Performance Green Propellant. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort in Multi-Mode Propulsion Phase II-A: High Performance Green Propellant.	0.000	1.593
Congressional Add: Next Generation Solar Electric In-Space Propulsion. *FY 2009 Accomplishments:* In FY 2009: Not Applicable.	0.000	0.797

Exhibit R-2A, RDT&E Project Justification: PB 2011 Air Force		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2010 Plans: In FY 2010: Conduct Congressionally directed effort in Next Generation Solar Electric In-Space Propulsion.		
Congressional Adds Subtotals	0.798	16.730

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0601102F: *Defense Research Sciences.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602114N: *Power Projection Applied Research.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602303A: *Missile Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602500F: *Multi-Disciplinary Space Tech.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603311F: *Ballistic Missile Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603401F: *Advanced Spacecraft Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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, RDT&E Project Justification: PB 2011 Air Force			DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 625330: *Aerospace Fuel Technology*	

COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
625330: *Aerospace Fuel Technology*	0.000	6.880	6.679	0.000	6.679	6.234	6.572	6.568	6.544	0.000	0.000

Note

Note: The funding in this project was moved from PE 0602203F 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 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
MAJOR THRUST: Conduct research and perform technical assessments of alternative hydrocarbon fuels derived from coal, natural gas, and biomass for use in legacy and advanced aerospace systems.	0.000	2.891	3.200	0.000	3.200
FY 2009 Accomplishments: In FY 2009: Not Applicable.					
FY 2010 Plans: In FY 2010: Complete component evaluations of 50 percent synthetic paraffinic kerosene (SPK) produced by Fischer-Tropsch synthesis blended with 50 percent conventional aviation fuel. Conduct component "fit-for-purpose" evaluations of up to 100 percent SPK. Conduct initial evaluations of biomass derived aviation fuels, both blended with conventional aviation fuel and used 100 percent.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Assess analytical tools being developed to assess CO2 footprint of coal and biomass derived alternative fuels. *FY 2011 Base Plans:* In FY 2011: Complete component "fit-for-purpose" evaluations of up to 100 percent SPK and make recommendation as to maximum SPK in blend use. Complete initial evaluations of biomass derived aviation fuels and assessment of associated CO2 footprint. Conduct follow-on component evaluations as available fuel quantities permit. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Develop and demonstrate advanced components and conduct performance assessments of advanced aircraft integrated thermal and energy management systems for engines and aircraft. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* 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. *FY 2011 Base Plans:* In FY 2011: Assess advanced aircraft thermal management designs. Develop and assess techniques to improve the thermal characteristics of aviation fuels used in integrated thermal and energy	0.000	0.800	1.100	0.000	1.100

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
management systems. Develop advanced hydrocarbon based endothermic fuel technologies applicable to combined cycle engines. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to reduce cost. Study fuel logistics vulnerabilities and develop detection and mitigation technologies. *FY 2009 Accomplishments:* In FY 2009: Not Applicable. *FY 2010 Plans:* 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. *FY 2011 Base Plans:* In FY 2011: Assess aberrant logistical fuels to support field operations and investigate impact of novel corrective actions. Evaluate low cost fuel additives and assessment of the impact on biological growth in fuel. Continue the investigation of actions to mitigate the growth of biological agents in fuel. Investigate the development of biological mutations in fuel leading to the development of resistance to chemical biocides and antifungal agents. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.	0.000	1.000	1.000	0.000	1.000
MAJOR THRUST: Develop and test advanced emissions diagnostic techniques for airbreathing propulsion systems. Conduct evaluations of the combustion and emissions characteristics of aviation fuels.	0.000	0.883	1.379	0.000	1.379

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2009 Accomplishments: In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Complete combustion emissions evaluations of high pressure combustor sectors operating on 100 percent 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. *FY 2011 Base Plans:* In FY 2011: Develop diagnostic protocols for aircraft ground emissions measurements and perform emissions evaluations on fielded engines to investigate particulate formation and composition. Develop emissions diagnostics applicable to advanced high pressure combustor systems. Assess combustion emissions from biomass derived aviation fuels. Conduct assessment of combustion emissions from blends of coal/biomass derived aviation fuels. *FY 2011 OCO Plans:* In FY 2011 OCO: N/A.					
Accomplishments/Planned Programs Subtotals	0.000	5.574	6.679	0.000	6.679

	FY 2009	FY 2010
Congressional Add: National Test Facility for Aerospace Fuels Propulsion.	0.000	1.306

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010
FY 2009 Accomplishments: In FY 2009: Not Applicable. *FY 2010 Plans:* In FY 2010: Conduct Congressionally directed effort at the National Test Facility for Aerospace Fuels Propulsion.		
Congressional Adds Subtotals	0.000	1.306

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
• PE 0601102F: *Defense Research Sciences.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0602805F: *Dual Use Science and Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
• PE 0603216F: *Aerospace Propulsion and Power Technology.*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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.