PE NUMBER: 0602203F
PE TITLE: Aerospace Propulsion

Exhibit R-2, RDT&E Budget Item Justification	DATE: February 2008
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

	Cost ($ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	220.143	217.172	218.049	202.638	178.565	178.795	183.615	Continuing	TBD
3012	Advanced Propulsion Technology	29.077	21.844	18.055	17.057	22.924	19.949	20.446	Continuing	TBD
3048	Fuels and Lubrication	24.022	30.752	25.497	24.963	19.197	19.981	20.697	Continuing	TBD
3066	Turbine Engine Technology	48.345	56.247	87.771	71.314	49.947	47.101	49.024	Continuing	TBD
3145	Aerospace Power Technology	43.560	44.201	29.280	29.588	29.798	31.534	31.889	Continuing	TBD
33SP	Space Rocket Component Tech	56.623	53.477	48.258	49.014	49.188	48.468	49.486	0.000	0.000
4847	Rocket Propulsion Technology	18.516	10.651	9.188	10.702	7.511	11.762	12.073	Continuing	TBD

Note: In FY 2007, Project 33SP, Space Rocket Component Technology was transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Technology, and Project 5027, High Speed Airbreathing Propulsion Technology, in order to more effectively manage and provide oversight of the efforts. In FY 2007, Project 3012, Advanced Propulsion Technology, combined efforts with a thrust from Project 33SP, Space Rocket Component Technology, in order to more effectively manage cooperative Combined Cycle Engine (CCE) developments. Funds for the FY 2007 Congressionally-directed High Energy Laser for Detection Inspection and Non-Destructive Testing in the amount of $2.7 million were moved to the Defense Advanced Research Projects Agency, from PE 0602203F, Aerospace Propulsion, for execution. Funds for the FY 2007 and 2008 Congressionally-directed Center for Solar Electricity and Hydrogen were moved from PE 0602203F to PE 0602601F, Space Technology, for execution.

(U) A. Mission Description and Budget Item Justification

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has six projects, each focusing on a technology area critical to the Air Force. Advanced Propulsion Technology develops high-speed airbreathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies to enable revolutionary propulsion capability for the Air Force. Fuels and Lubrication evaluates fuels, lubricants, and combustion concepts and technologies for new and existing engines, evaluates alternative fuels and additives, and directly supports the Versatile Affordable Advanced Turbine Engine (VAATE) program. Turbine Engine Technology develops enabling capabilities to enhance performance and affordability of existing weapon systems to include efforts that are part of the VAATE program. Aerospace Power Technology develops electrical power and thermal management technologies for military applications that are part of the High Power Aircraft (HiPAC) program. Space Rocket Component Technology develops advances in rocket propulsion technologies for space access, space maneuver, and missiles. Rocket Propulsion Technology develops advances in rocket technologies for the sustainment of strategic systems and tactical rockets. Finally, Adaptive Cycle Technologies develops component technologies for an adaptive cycle engine architecture to provide optimized performance/fuel efficiency for widely varying mission needs. Note: In FY 2008, Congress added $3.5 million for Active Combustion Control System for Military Aircraft; $0.8 million for Advanced Fuel Cell Based Power Systems for Small UAVs; $1.6 million for an Advanced Vehicle and Propulsion Center; $10.0 million for Alternative Energy Research; $1.6 million for Development and Testing of Advanced Paraffin-Based Hybrid Rockets for Space Applications; $6.0 million for High Energy Superior Lithium Ion Battery Technology; $2.4 million for Hybrid Bearing research; $1.2 million for a Hydrocarbon Boost Technology Demonstrator; $1.6 million for an Integrated Propulsion Analysis Tool; $2.0 million for an Integrated Starter/Generator/IES; $1.0 million for LOX/Methane Cooled Upper Stage Rocket Engine technology; $1.4 million for Modified F-22 Maintenance-Free Nickel Cadmium Aircraft Batteries for the F-16; $3.5 million for THEMA - Thermal and

Exhibit R-2, RDT&E Budget Item Justification	DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion

Energy Management for Aerospace applications; $1.6 million for VDVP for UAV/UCAV Aircraft Engines; and $1.2 million for WASH Oxygen Sensor and Cell Level Battery Controller technologies. 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.

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

		FY 2007	FY 2008	FY 2009
(U)	Previous President's Budget	218.657	179.161	217.394
(U)	Current PBR/President's Budget	220.143	217.172	218.049
(U)	Total Adjustments	1.486	38.011	
(U)	Congressional Program Reductions			
	Congressional Rescissions		-1.389	
	Congressional Increases		37.800	
	Reprogrammings	4.804	1.600	
	SBIR/STTR Transfer	-3.318		

(U) Significant Program Changes:

In FY 2009, 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.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2008

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3012 Advanced Propulsion Technology

Cost ($ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3012 Advanced Propulsion Technology	29.077	21.844	18.055	17.057	22.924	19.949	20.446	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, funding was increased to accelerate efforts to develop technologies to support an Air Force scramjet effort. In FY 2007, Project 3012, Advanced Propulsion Technology, absorbed Combined Cycle Engine (CCE) efforts from Project 33SP, Space Rocket Component Technology, in order to more effectively manage cooperative CCE developments.

(U) A. Mission Description and Budget Item Justification

This project develops combined/advanced cycle airbreathing high-speed (up to Mach 4) and hypersonic (Mach 4 to 8+) propulsion technologies to 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) 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. Note: Component work supporting demo nears completion in FY 2008.	11.649	1.092	3.069

(U) In FY 2007: Developed and demonstrated flight weight engine components and a control system with closed loop controller. Performed trajectory optimization for flight test. Evaluated 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. Verified operation of engine control techniques, based on rapid shock train identification and characterization coupled with fuel control logic, to ensure stable scramjet operation. Completed ground test of a flight weight, fixed geometry inlet scramjet engine with improved operability to reduce flight test risk.

(U) In FY 2008: Continue development and demonstration of scramjet flight weight engine components and advanced engine control logic. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Initiate design and testing of advanced scramjet start techniques. Continue verification of operation of engine control techniques, based on rapid shock train identification and characterization coupled with fuel control logic, to ensure stable scramjet operation.

(U) In FY 2009: Continue development and demonstration of flight weight engine components and advanced engine control logic. Continue performing trajectory optimization for flight test. Continue evaluating options for scramjet start, including gas generator/heat exchanger system, barbotage fuel injection, plasma ignition, and silane injection with a mechanical throat or air throttle. Complete ground testing of advanced scramjet start techniques. Complete

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	development of scramjet engine control logic for flight test engines. Continue verification of operation of engine control techniques, based on rapid shock train identification and characterization coupled with fuel control logic, to ensure stable scramjet operation.			
(U)				
(U)	MAJOR THRUST: Conduct assessments, technology design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies into future missiles and into manned and unmanned air and space vehicle concepts. CCEs require the development and demonstration of components to integrate scramjets with high speed turbines and/or rocket engines for efficient propulsion over a broad range of Mach numbers. Note: In FY 2009, efforts in this thrust were reduced due to higher Air Force priorities.	2.184	1.966	0.181
(U)	In FY 2007: Conducted trade studies to determine military payoff and establish component technology goals. Defined 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. Fabricated and initiated test of advanced inlets for turbine-based CCEs capable of operating from Mach 0 to Mach 8.			
(U)	In FY 2008: Continue trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Continue development of advanced components for turbine-based and rocket-based CCEs. Complete testing of advanced inlets for turbine-based CCEs capable of operating from Mach 0 to Mach 8. Design an advanced nozzle for turbine-based and rocket-based CCEs.			
(U)	In FY 2009: Continue CCE trade studies to determine military payoff and establish component technology goals. Continue defining component and engine performance objectives to enable development of affordable hypersonic flight demonstrators. Continue development of advanced components for turbine-based and rocket-based CCEs.			
(U)				
(U)	MAJOR THRUST: Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future missiles. Note: Starting in FY 2008, efforts shift towards much larger hot section testing and voluminous test data will be required to correlate the combustion scaling phenomena to the original baseline configuration to provide the knowledge to scale the scramjet configuration to larger applications potentially up to space launch. In FY 2009, efforts in this thrust were revamped due to higher Air Force priorities.	10.436	18.786	14.805
(U)	In FY 2007: Developed advanced engine components to improve scramjet operating margin and to establish			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	scramjet scaling laws for reusable applications. Developed variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Completed test of round scramjet combustors for reusable applications with improved structural efficiency. Initiated development of improved durability engine concepts. Developed low internal drag flame stabilization devices and flight test engine components.			
(U)	In FY 2008: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Complete test of scramjet combustors 5 to 10 times baseline size for reusable applications with improved structural efficiency. Initiate development of improved durability engine concepts. Continue development of low internal drag flame stabilization devices and flight test engine components.			
(U)	In FY 2009: Continue development of advanced engine components to improve scramjet operating margin and to establish scramjet scaling laws for reusable applications. Continue development of variable geometry techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Continue development of low internal drag flame stabilization devices and flight test engine components. Conduct assessment of ground test facilities and test techniques to demonstrate large (20 to 100 times) size scramjet engines.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced High Speed Propulsion Development.	0.981	0.000	0.000
(U)	In FY 2007: Enhanced the nation's ability to test and analyze high speed propusion systems such as scramjets and combined cycle engines.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: X-51 Robust Scramjet Flight Research.	3.827	0.000	0.000
(U)	In FY 2007: Investigated the integration of alternative high speed combined cycle engine configurations (such as circular and rectangular scramjets) for potential flight demonstration under X-51 follow-on efforts.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)	Total Cost	29.077	21.844	18.055

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3012 Advanced Propulsion Technology

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

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602201F, Aerospace Flight Dynamics.									
(U) PE 0602500F, Multi-Disciplinary Space Tech.									
(U) PE 0602602F, Conventional Munitions.									
(U) PE 0602702E, Tactical Technology.									
(U) PE 0603211F, Aerospace Structures.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0603601F, Conventional Weapons Technology.									
(U) Program is reported to/coordinated by the Joint Army/Navy/NASA/Air Force (JANNAF) Executive Committee.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY **02 Applied Research**	PE NUMBER AND TITLE **0602203F Aerospace Propulsion**	PROJECT NUMBER AND TITLE **3012 Advanced Propulsion Technology**

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2008

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3048 Fuels and Lubrication

Cost ($ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3048 Fuels and Lubrication	24.022	30.752	25.497	24.963	19.197	19.981	20.697	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: The funding in this project has been increased to provide emphasis on component development in support of adaptive cycle technologies. Funds for the FY 2007 Congressionally-directed High Energy Laser for Detection Inspection and Non-Destructive Testing in the amount of $2.7 million are in the process of being moved to the Defense Advanced Research Projects Agency, from PE 062203F, Aerospace Propulsion, for execution.

(U) A. Mission Description and Budget Item Justification

This project evaluates fuels, lubricants, mechanical systems, and combustion concepts for advanced turbine engines, scramjets, pulse 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, and detonations. Fuels and lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Advanced combustion concepts must be cost-effective, durable, and reduce pollutant emissions. 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop low-cost additive and fuel system approaches to improve fuel properties and to expand the flight envelope for manned and unmanned aircraft. Determine fuel cooling requirements and specifications for an adaptive cycle engine architecture. Design, fabricate, and test of key thermal management technologies. Note: Increased funding in FY 2008 and out due to emphasis on component development in support of adaptive cycle technologies.	2.179	3.102	6.628

(U) In FY 2007: 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. Initiated effort to validate component performance models on aircraft thermal management simulator. Developed approaches to assess and improve additive combustion behavior at low fuel and air temperatures. Tested fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems.

(U) In FY 2008: Continue conducting lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative fuels, and improved materials and coatings. Continue effort to validate component performance models on aircraft thermal management simulator. Complete the development of approaches to assess and improve additive combustion behavior at low fuel and air temperatures. Continue to test fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems and the Highly Efficient Embedded Efficient Turbine Engine (HEETE). Develop a

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	robust mechanical and integrated engine thermal management system (mechanical and fuel systems) for optimum engine performance and durability at sustained supersonic cruise conditions.			
(U)	In FY 2009: Continue conducting lab-scale evaluation of approaches to increase JP-8 temperature capability to 900 degrees Fahrenheit including thermal stability additives, fuel deoxygenation, advanced alternative energy fuels, and improved materials and coatings. Continue effort to validate component performance models on aircraft thermal management simulator. Continue to test fuel candidates in bench scale rigs simulating advanced high Mach propulsion systems and the HEETE. Conduct full-scale component rig testing of mechanical components with experimental lubricants. Conduct simulated high-Mach tests of an integrated thermal management system and mechanical system components.			
(U)				
(U)	MAJOR THRUST: Develop advanced additive approaches to reduce engine emissions and signature (including nano-scale additives), as well as advanced emission diagnostic test protocols.	1.342	1.206	1.785
(U)	In FY 2007: Assessed novel fuel additives including nano-technologies and fuels derived from alternative energy resources to reduce emissions in laboratory scale combustion rigs. Initiated higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion.			
(U)	In FY 2008: Complete assessing novel fuel additives including nano-technologies to reduce emissions in laboratory scale combustion rigs. Initiate improvement of combustion models for kerosene fuels. Continue higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion.			
(U)	In FY 2009: Continue higher-pressure measurements of additive and fuel effects on sub-micron particulate generation during combustion. Initiate study of NOx/soot trade offs in combustor design. Continue improvement of combustion models for kerosene fuels.			
(U)				
(U)	MAJOR THRUST: Study and evaluate low-cost approaches to reduce fuel logistics footprint to simplify logistics and reduce cost (including field and on-board additive injections and improvements to existing fuel additive packages), as well as study fuel logistics vulnerabilities and develop detection and mitigation technologies.	1.341	1.207	1.785
(U)	In FY 2007: Investigated performance of Fischer-Tropsch (F-T) and other alternative fuels for aircraft and other field hardware. Evaluated advanced nano-technology fuel sensors, nano-technology fuel additives, and novel detection and mitigation technologies for biological growth.			
(U)	In FY 2008: Expand investigation of the performance of alternative fuels to include bio-derived fuels. Initiate development of bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Initiate development of knowledge base for certification of Fischer-Tropsch fuels for all Air Force tactical vehicles Continue evaluation of advanced nano-technology fuel sensors, nano-technology fuel additives, and novel detection			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
and mitigation technologies for biological growth.			
(U) In FY 2009: Continue to investigate performance of biomass-derived fuels for aircraft and other field hardware. Initiate extension of knowledge base to other alternative fuels, such as those derived from biomass. Continue development of bioreactors to simulate biological growth in aircraft fuel systems and ground storage facilities. Continue development of knowledge base for certification of Fischer-Tropsch fuels for all Air Force tactical vehicles.			
(U)			
(U) MAJOR THRUST: Investigate hydrocarbon and other high energy density fuels for advanced and combined cycle engines for high-speed aerospace vehicles and low-cost boost applications.	0.670	0.690	0.765
(U) In FY 2007: Assessed advanced hydrocarbon propellant stability under high heat flux conditions. Collected improved fuel property data for hydrocarbon propellant database.			
(U) In FY 2008: Complete study of refined kerosene propellants under high heat flux conditions, while continuing to study synthesized high-energy hydrocarbons. Continue to improve fuel property database and share with industry to improve design tools.			
(U) In FY 2009: Continue study of high-energy hydrocarbon propellant candidates. Complete improved physical property database for kerosene propellants at high pressure. Continue to collect improved physical property for high energy hydrocarbons and improve physical property models.			
(U)			
(U) MAJOR THRUST: Develop, test, and evaluate revolutionary combustor and propulsion concepts for gas turbine, pulsed detonation, and combined cycle engines for missiles, manned and unmanned systems, and reuseable access to space; perform payoff analyses and configuration trade studies for these systems; and evaluate the combustion and emissions characteristics of fuels and fuel additives.	4.526	4.310	5.864
(U) In FY 2007: Evaluated advanced combustion system performance at realistic operating conditions. Investigated inter-turbine burning concepts for large gas turbine engines. Integrated of Pulse Detonation Engine (PDE) into turbine-based hybrid concept. Evaluated and optimized advanced combustor, augmentor, and PDE concepts using modeling and simulation tools.			
(U) In FY 2008: Demonstrate small-scale inter-turbine burner (ITB) concepts in a relevant engine environment. Investigate the scalability of inter-turbine burners for large engines. Assess an integrated pulsed detonation/hybrid turbine concept performance with component fabrication and evaluation. Investigate combustor and augmentor systems for high-altitude low-high mach applications. Evaluate and optimize advanced combustor, augmentor, and PDE concepts using modeling and simulation tools.			
(U) In FY 2009: Evaluate advanced combustion system performance at realistic operating conditions. Demonstrate			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	small-scale ITB concepts in small engine. Identify concept designs of inter-turbine burning concepts for large gas turbine engines. Optimize component efficiency of the integrated pulsed detonation/hybrid turbine. Evaluate and optimize advanced combustor, augmentor, and PDE concepts using modeling and simulation tools covering wider flight conditions and applications.			
(U)				
(U)	MAJOR THRUST: Develop approaches to extend the life of endothermic fuels and fuel system components for sustained supersonic and reusable hypersonic cruise applications.	0.670	0.690	0.765
(U)	In FY 2007: Developed improved surfaces/catalysts to mitigate coking and thus improve fuel heat sink capability. Assessed unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads, including low heat rejection structures.			
(U)	In FY 2008: Evaluate improved coke-mitigating surfaces/catalysts with 2nd generation endothermic fuels in bench-scale heat exchanger rigs. Assess unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads in panel tests. Initiate study of relationship between fuel structure/properties and combustion behavior including blowout.			
(U)	In FY 2009: Continue bench-scale tests to evaluate improved surfaces/catalysts for 2nd generation endothermic fuels. Continue assessment of unconventional approaches to increase fuel heat sink and minimize regenerative cooling heat loads. Continue study of relationship between fuel structure/properties and combustion behavior including blowout.			
(U)				
(U)	MAJOR THRUST: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies.	0.670	0.862	1.020
(U)	In FY 2007: Applied advanced diagnostics in a relevant gas turbine combustion system environment. Applied diagnostics to sensor development and validated sensors in relevant gas turbine engine system. Conducted experiments to obtain benchmark-quality data for improvement of combustion modeling and simulation tools.			
(U)	In FY 2008: Demonstrate high-bandwidth (e.g., MHz-rate) planar laser-induced fluorescence for high-speed digital imaging of key combustion species in fundamental laboratory flames and relevant engine environments. Apply terahertz radiation (T-rays) for combustion temperature sensing and non-destructive inspection/evaluation of turbine engine components. Integrate current and next-generation combustion diagnostics to support RDT&E of augmentor solutions for fighter aircraft.			
(U)	In FY 2009: Develop high-speed techniques for measuring carbon monoxide (CO) to evaluate CO oxidiation and combustion efficiency in near constant volume combust on turbine environments. Exploit ultrafast (e.g., femtosecond), ultraintense (e.g., terawatt) laser systems to generate ultrashort x-ray bursts for soot-mitigation studies			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
and dense fuel spray imaging. Develop multi-pulse femtosecond ballistic imaging to understand and improve fuel sprays in combustor, augmentor, scramjet, and rocket applications.			
(U)			
(U) MAJOR THRUST: Develop, test, and qualify advanced turbine engine lubricants for the Air Force. Establish target requirements and transition opportunities for new oils by working with DoD agencies, industry, and users. Generate and maintain military specifications for aviation engine lubricants, as well as continued field support activities for aviation lubrication technologies and DoD operational units.	2.514	2.413	3.315
(U) In FY 2007: Began technology insertion of advanced bearing and lubrication system concepts, components, and materials for improved engine performance, affordability, and engine health monitoring into demonstrator cores and engines. Conducted testing to focus and develop lubricants and mechanical systems for man-rated, expendable, and UAV turbine engines. Initiated 7cSt ester lubricant development for high Mach/high temperature military and commercial turbine engines. Coordinated and supported demonstration of Joint Oil Program lubricants in new fighter asset engines. Delivered military specifications and test methods for DoD lubricants to support new fighter engines.			
(U) In FY 2008: Complete qualification testing of the enhanced 5cSt ester candidate(s), transition to demo engine program and draft new oil specification. Ramp up qualification testing of hi-mach 7cSt ester in preparation of FY 2011 engine demo. Develop an integrated and effective bearing/oil health monitoring system with prognostics capability to address critical DoD safety, readiness, and life-cycle cost concerns. Conduct technology assessment of long-term, low-temperature (high-altitude) performance of engine lubricants and develop concepts for efficient mechanical system for highly efficient embedded turbine engines.			
(U) In FY 2009: Demonstrate enhanced 5cSt ester lubricant in Joint Strike Fighter thrust growth demo engines. Finalize and begin fielding new enhanced 5cSt oil specification. Conduct qualification testing of new hi-mach 7cSt ester lubricant. Demonstrate an integrated bearing/oil health monitoring/prognostic system in full-scale setting and validate life models. Fabricate and test an efficient mechanical system for highly efficient embedded turbine engine and adaptive versatile turbine engines (ADVENT). Continue development of high-temperature lubricants for Long Range Strike aircraft.			
(U)			
(U) MAJOR THRUST: Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-sized turbine engine applications.	2.850	2.758	3.570
(U) In FY 2007: Conducted airfoil bearing tests in larger shaft diameter sizes to determine load capacity and rotor size limitations of this technology. Developed and tested of affordable rotor support technology for small-, intermediate-, and large-sized turbine engine applications. Validated modeling and simulation tools to advance design, shorten			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	development time, and reduce test requirements for mechanical and electromagnetic rotor support and power generation systems. Improved the modeling of airfoil shaft bearings and initiated evaluation of insertion opportunities for advanced engine rotor support and power generation. Transitioned/transfered airfoil bearing technology to bearing and engine companies. Demonstrated hybrid (metal/ceramic) bearing and JOP lubricants in new fighter demonstrator engines. Initiated programs for hardware needed for optimum thermal protection designs for high mach/high temperature turbine engines and accelerators. Expanded the previous studies of advanced rotor support and power generation for turbine and combined cycle engines.			
(U)	In FY 2008: Demonstrate new fatigue and spall propagation resistant bearing materials in advanced demo engines with enhanced 5cSt oil. Conduct subscale fatigue life and spall propagation studies of bearing materials with hi-mach 7cSt oil candidates. Develop preliminary design of propfan gearbox and conduct trade study of energy efficient mechanical system components (i.e., rolling element versus foil versus magnetic bearing) for HEETE.			
(U)	In FY 2009: Continue complete sub-scale fatigue life and spall propagation studies of bearing materials and validate spall propagation models through with hi-mach 7cSt oil candidates and begin full-scale tests. Fabricate and test propfan gearbox in support of ADVENT. Down select mechanical system components and complete detailed design for highly efficient embedded turbine engines and ADVENT engines.			
(U)				
(U)	CONGRESSIONAL ADD: Ultrafast, Ultraintense Laser Microfabrication and Diagnostics (formerly Intense, Ultrafast Laser Microfabrication and Diagnostics).	0.981	0.000	0.000
(U)	In FY 2007: Established the technical base required to evaluate and develop ultrafast, ultraintense lasers for fabrication, inspection, and repair of components for aerospace propulsion and other weapon systems.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Research Institute for Environmental Studies.	1.962	0.000	0.000
(U)	In FY 2007: Accelerated the development and demonstration of a modular, portable wastewater treatment system that can meet EPA standards and can be deployed to forward bases within 24 hours.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: High Energy Laser for Detection Inspection and Non-Destructive Testing.	2.649	0.000	0.000
(U)	In FY 2007: Developed high-energy laser techniques for use as a non-destructive technique for inspection of gas turbine engine components.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Hybrid Bearings.	1.668	2.385	0.000
(U)	In FY 2007: Developed a suite of advanced hybrid bearing technologies for transition to JSF thrust growth and advanced VAATE turbine engines. Demonstrated hybrid P675 bearing in JSF in accelerated mission engine test (Jul 07). Optimized P675 heat treatment for enhanced spall propagation resistance. Developed bearing spall and crack propagation models. Developed advanced bearing cages for improved bearing performance.			
(U)	In FY 2008: Demonstrate optimized P675 bearing steel in sub-scale bearings. Continue manufacture of full-scale P675 bearings. Demonstrate nondestructive evaluation (NDE) equipment for silicon nitride rolling elements. Continue developing high performance bearing cage.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Alternative Energy Research	0.000	9.937	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Perform research on alternative energy, focusing on alternative hydrocarbon fuels made from coal, biomass, oil shale. Research includes fuel property evaluation and enhancement, as well as component and engine testing of alternative fuels.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: WASH Oxygen Sensor and Cell Level Battery Controller	0.000	1.192	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Conduct research for the development of oxygen sensors for aircraft wing tanks with specific emphasis on evaluating performance and durability in realistic operating environments. Develop a cell level battery controller.			
(U)	In FY 2009: Not Applicable.			
(U)	Total Cost	24.022	30.752	25.497

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

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research									

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3048 Fuels and Lubrication

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

Sciences.

(U) PE 0602805F, Dual Use Science and Technology.

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2008

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3066 Turbine Engine Technology

Cost ($ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3066 Turbine Engine Technology	48.345	56.247	87.771	71.314	49.947	47.101	49.024	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

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

(U) A. Mission Description and Budget Item Justification

This project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, augmentor and exhaust systems, integrated power and thermal management systems, engine inlet integration, mechanical systems, and structural design. This project supports the Integrated Versatile Affordable Advanced Turbine Engine (VAATE) program and industry efforts 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 warfighting, 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. A portion of the project supports the Energy Conservation-Assured Fuels Initiative. This effort identifies, and evaluates technologies that enable the use of domestic fuel sources for military energy needs.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and high-pressure turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports. Identify, and evaluate technologies that enable the use of domestic fuel sources for military energy needs. Develop advanced concepts, designs, design rules, and computational tools to support component research and rig testing of components for an adaptive cycle engine. Develop advanced concepts, designs, design rules, and computational tools to support research and rig testing of component technologies to substantially improve specific fuel consumption by increasing overall pressure ratio and turbine rotor inlet temperature; by improving component efficiencies; and by reducing cooling air and pressure losses. Note: Increased funding in FY 2008 and out due to emphasis on increased fuel efficiency, adaptive cycle technologies, and highly efficient embedded turbine engines.	20.839	33.267	65.828

(U) In FY 2007: Developed and applied advanced modeling and simulation rules and tools for advanced components. Incorporated advanced materials into innovative designs and analyzed Ceramic Matrix Composite (CMC) turbine blades, turbine vanes, and turbine rear frame. Designed and analyzed tiled turbine airfoil technology to reduce cooling flow and increase life. Designed and demonstrated a very short, high efficiency afterburner concept. Conducted rig tests and design optimization of effective, durable, radiation barrier coatings to reduce the radiant heat loads on hot section components. Designed, fabricated, and rig tested fan/radial compressor internal aerodynamics, large radius rotating air seals, a low profile annular combustor, and a large-scale casting of fan/radial compressor.

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3066 Turbine Engine Technology

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) In FY 2008: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Develop and optimize novel dual fuel burner. Determine suitability of latest Titanium Aluminide materials for Mach 4 compressor application. Develop and apply advanced modeling and simulation rules and tools to significantly improve component efficiencies, enabling reduced fuel consumption in emerging and future gas turbine propulsion systems. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of lightweight, simple, adaptive cycle features. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of an efficient, wide-flow range compressor. Initiate 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. Develop and apply advanced modeling and simulation rules and tools to initiate definition and design of an efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine Specific Fuel Consumption (SFC).			
(U) In FY 2009: Continue to develop and apply advanced modeling and simulation rules and tools for advanced components. Conduct rig testing of advanced high pressure turbine vane and blade nano-laminate thermal barrier coating (TBC) applied. Begin to develop computational fluid dynamics methodology for analyzing turbine flows. Begin to develop CMC lifing models. Conduct bench and rig tests for validation of components with significantly improved efficiency. Continue rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work, and an efficient, lightweight, LO-compatible exhaust system. Fabricate and rig test an efficient, very high pressure ratio compressor and associated thermal management features that will offer a step change improvement in engine SFC.			
(U)			
(U) MAJOR THRUST: Develop turbofan/turbojet engine components (i.e., fans, low pressure turbines, engine controls, exhaust nozzles, and integration technologies) for turbofan/turbojet engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports.	12.975	12.283	15.799
(U) In FY 2007: Identified and quantified sources of variability and uncertainty affecting turbine blade durability performance (oxidation, creep, thermal material fatigue, high cycle fatigue, etc.). Applied advanced materials systems to innovative designs to determine wear reduction, improve load capacity, and increase temperature capability of five centi-stokes oil and to assess aerodynamics, operability, aeromechanics, and acoustic characteristics of a counter-rotating fan-on-blade (FLADE) concept. Conducted design optimization for turbine blade microcircuit cooling. Tested pilot and fuel injection concepts in a single-flameholder rig to evaluate fundamental capabilities.			
(U) In FY 2008: Continue to develop and apply advanced modeling and simulation rules and tools for advanced			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3066 Turbine Engine Technology

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
components. Conduct risk reduction testing of variable bypass ratio fan concept. Develop and rig test reheat augmentor technology to significantly decrease burning length. Design and fabricate an advanced lightweight, variable area exhaust nozzle.			
(U) In FY 2009: Continue to 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.			
(U)			
(U) MAJOR THRUST: Develop limited life engine components for missile and unmanned air vehicle applications, including long-range supersonic and hypersonic vehicles. These efforts enable engines with reduced cost, reduced fuel consumption, and increased specific thrust, thereby greatly expanding the operating envelopes of missiles and unmanned vehicles.	3.932	4.094	5.266
(U) In FY 2007: Rig tested a slinger-fed, dual-fuel CRC. Developed and applied advanced modeling and simulation rules and tools for advanced components (i.e., high cycle fatigue, computational fluid dynamics, cycle analyses, propulsion system models, component life models, probabilistic models, etc.). Rig tested a fuel-cooled turbine. Designed and analyzed a five-stage forward swept compressor.			
(U) In FY 2008: Utilize data from high speed turbine engine testing of a wide-range, lightweight carbon-carbon variable area exhaust nozzle and a compact, carbon-carbon ramburner to update and validate advanced modeling and simulation rules and tools.			
(U) In FY 2009: Utilize data from high speed turbine engine testing of a fuel cooled turbine and a slinger-fed, dual-fuel CRC to update and validate advanced modeling and simulation rules and tools.			
(U)			
(U) MAJOR THRUST: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports.	1.573	1.535	0.878
(U) In FY 2007: Developed and applied advanced modeling and simulation rules and tools for advanced components. Applied advanced materials systems to innovative designs and analyze a nano-laminate thermal barrier coating. Developed new and innovative design concepts and conducted bench and rig tests for validation of a high heat release combustor design and an advanced forward swept, centrifugal compressor design.			
(U) In FY 2008: Develop new and innovative design concepts and conduct bench and rig tests for validation of a mixed flow turbine design.			
(U) In FY 2009: Utilize data from efficient small scale engine testing of an advanced forward swept, centrifugal compressor, and a silicon nitride mixed flow turbine to update and validate advanced modeling and simulation rules and tools.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3066 Turbine Engine Technology

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U)			
(U) CONGRESSIONAL ADD: VAATE TMC FLADE Technology Demonstration (formerly VAATE-Titanium Matrix Composites).	1.079	0.000	0.000
(U) In FY 2007: Developed Titanium Matrix Composites for advanced turbine engine components.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Active Combustion Control System for Military Aircraft.	1.766	0.000	0.000
(U) In FY 2007: Developed advanced Active Combustion Control System (ACCS) components for use in ongoing and future engine development programs.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Advanced Affordability Assurance Tools for the Versatile Affordable Advanced Turbine Engine (VAATE) Initiative.	0.981	0.000	0.000
(U) In FY 2007: Developed state-of-the-art computer software tools that will estimate development, production, and maintenace costs for advanced technology turbine engines.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Intelligent Engine Technology Development for UAVs.	1.374	0.000	0.000
(U) In FY 2007: Developed turbine engine life management software to reduce overall engine maintenance costs.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Active Combustion Control Systems for Military Aircraft.	3.826	3.478	0.000
(U) In FY 2007: Developed advanced active combustion control system components for use in ongoing and future engine development programs.			
(U) In FY 2008: Continue to develop Active Combustion Control Systems for military aircraft.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: VDVP for UAV/UCAV Aircraft Engines	0.000	1.590	

Exhibit R-2a, RDT&E Project Justification		DATE: February 2008
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE: 3066 Turbine Engine Technology

(U) B. Accomplishments/Planned Program ($ in Millions)

	FY 2007	FY 2008	FY 2009
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Conduct research and development on variable displacement vane pumps for UAV and UCAV engines.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	48.345	56.247	87.771

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

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Materials:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602102F, Materials.									
(U) PE 0603216F, Aerospace Propulsion and Power Technology.									
(U) PE 0602122N, Aircraft Technology.									
(U) PE 0603210N, Aircraft Propulsion.									
(U) PE 0603003A, Aviation Advanced Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2008

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 3145 Aerospace Power Technology

Cost ($ in Millions)		FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
3145	Aerospace Power Technology	43.560	44.201	29.280	29.588	29.798	31.534	31.889	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop electrical power and thermal management component and subsystem technologies for manned and unmanned aircraft systems. These technologies improve aircraft range, self-sufficiency, reliability, maintainability, and supportability, while reducing life cycle costs and enabling new capabilities. Develop hybrid electrical power and thermal management, including energy conversion/storage, components and subsystem technologies for special purpose applications enabling long endurance missions. Note: Funding increasing in FY 2008 and on due to Air Force emphasis on developing technologies to address thermal management issues of current and emerging aircraft and UAVs.	11.185	16.518	23.717
(U) In FY 2007: Fabricated and characterized next generation solid state lithium-based thin film cells. Completed testing of an advanced switched reluctance machine controller. Completed preliminary aircraft thermal management studies and identified high efficiency design candidates.			
(U) In FY 2008: Develop and design high efficiency, high power, high temperature power electrical components. Develop and test air vehicle electromagnetic and radio frequency effects immune components. Design and fabricate thermal management components and subsystems. Initiate studies, modeling and simulation, and develop preliminary designs for energy harvesting and energy dense, long endurance battery, and fuel cell components and subsystems. Develop and test rechargeable/refuelable, lightweight, energy dense, high power hybrid battery, fuel cell and power management components and subsystems.			
(U) In FY 2009: Fabricate, integrate, and test high efficiency, high power, wide temperature range power electrical components. Initiate integration and test air vehicle electromagnetic and radio frequency effects immune components. Integrate and test thermal management components and subsystems.			
(U)			
(U) MAJOR THRUST: Develop electrical power and thermal management, energy conversion/storage and power conditioning components, and subsystem technologies for aerospace applications. Note: In FY 2007, this activity	4.120	0.000	0.000

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
will be completed.			
(U) In FY 2007: Completed scale-up, modeling efforts and flight tests of ten kW spray cooling technology.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) MAJOR THRUST: Develop lightweight electrical power and thermal management component and subsystem technologies with low volume displacement to enable delivery of high power for operation of directed energy weapons. Note: In FY 2009, this thrust is reduced due to higher AF priorities.	14.127	14.070	1.171
(U) In FY 2007: Designed high rate lithium-ion (liquid) battery system for directed energy applications. Completed fabrication and begin testing proof-of-concept superconducting generator.			
(U) In FY 2008: Develop and initiate design of a flight-weight superconducting generator, high rate charge/discharge energy storage and high voltage/current components and subsystems. Develop concept designs for superconducting multimegawatt generator.			
(U) In FY 2009: Investigate high-rate thermal energy storage for directed energy applications.			
(U)			
(U) MAJOR THRUST: Develop hybrid electrical power and thermal management, including energy conversion/storage, components and subsystem technologies for special purpose applications enabling long endurance missions. Note: In FY 2009, efforts in this thrust are broken out from previous thrust to better address future increased emphasis on component development in support of electric hybrid special programs.	0.000	0.000	4.392
(U) In FY 2007: Not Applicable.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Integrate and test thermal management components and subsystems. Integrate and initiate subsystems test of flight-weight, efficient, energy harvesting, hybrid battery and fuel cell components.			
(U)			
(U) CONGRESSIONAL ADD: High Flux ESC System with TES for Military High Energy Laser.	1.079	0.000	0.000
(U) In FY 2007: Developed evaporative spray cooling techniques for cooling high heat flux tactical lasers.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U)			
(U) CONGRESSIONAL ADD: Affordable Lightweight Power Supply Development.	0.981	0.000	0.000
(U) In FY 2007: Developed alternative high performance electrolytes and low-cost membrane electrode assemblies (MEA's), which are capable of operating at high temperatures, zero or reduced humilities and which enable			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	decreased system complexity and improved utilization of high energy fuels.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: MEPS (Multimegawatt Electric Power System) Thermal Management.	1.275	0.000	0.000
(U)	In FY 2007: Developed a multimegawatt electric power system.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Chemical Hydride Power System (formerly Portable Power Solution Employing Chemical Hydrides).	2.453	0.000	0.000
(U)	In FY 2007: Further developed the technologies necessary to improve the reliability and compactness of chemical hydride replacement cartridges for Airmen portable power systems.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Energy Technology for Munitions - Dominator Program.	1.275	0.000	0.000
(U)	In FY 2007: Developed a compact, flight weight solid oxide fuel cell based power system for the Area Dominator munition.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Military Purpose Electrolyte Supported Fuel Cells.	0.981	0.000	0.000
(U)	In FY 2007: Developed high power dense advanced solid oxide fuel cell stack technology for UAV applications. Specific objectives included stack scale-up, internal reformation development, and system modeling.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Manufacturing of High Energy Superior Lithium Battery Technology.	5.103	5.962	0.000
(U)	In FY 2007: Developed the Superior Lithium Polymer Battery (SLPB) technology for a 5, 28 and 270 VDC advanced military aircraft battery with a goal cycle life equal to 5000 cycles at 80 percent Depth of Discharge.			
(U)	In FY 2008: Develop and design equipment and processes for domestic production of SLPB batteries and develop			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	appropriate anode, cathode and electrolyte materials for prototype production of cells and batteries.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Integrated Electrical Starter/Generator.	0.981	1.988	0.000
(U)	In FY 2007: Developed technologies necessary to raise the technology readiness level of integral starter/generators. Efforts included a detailed design of a production-configuration Inverter-Converter Controllers (ICCs).			
(U)	In FY 2008: Continue detailed design and development to increase the technology readiness level (TRL) of lightweight, compact, high temperature starter generator and Inverter-Converter Controllers (ICCs).			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Fuel Cell Based Power System for Small UAVs	0.000	0.795	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Develop power systems for small/micro UAV systems. Examine mirco UAV systems requirements to determine the size, weight and power requirements needed to power these small aircraft. Perform feasibility studies and initial design of fuel cell systems to meet specifications resulting from the requirements study			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Modified F-22 Maintneance-Free Nickel Cadmium Aircraft Batteries for the F-16	0.000	1.391	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Develop modifications of the cell designs, materials and electronics in the F-22 sealed Nickel-Cadmium battery for application in the F-16 aircraft.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: THEMA- Thermal and Energy Management for Aerospace	0.000	3.477	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Conduct research to advance the state of the art of thermal and energy management technologies for aerospace applications.			
(U)	In FY 2009: Not Applicable.			
(U)	Total Cost	43.560	44.201	29.280

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 3145 Aerospace Power Technology

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

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 0601102F, Defense Research Sciences.

(U) PE 0602102F, Aerospace Flight Dynamics.

(U) PE 0602605F, Directed Energy Technology.

(U) PE 0602805F, Dual Use Science and Technology.

(U) PE 0603605F, Advanced Weapon Technology.

(U) PE 0603216F, Aerospace Propulsion and Power Technology.

(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2008

BUDGET ACTIVITY: 02 Applied Research

PE NUMBER AND TITLE: 0602203F Aerospace Propulsion

PROJECT NUMBER AND TITLE: 33SP Space Rocket Component Tech

Cost ($ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
33SP Space Rocket Component Tech	56.623	53.477	48.258	49.014	49.188	48.468	49.486	0.000	0.000
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

Note: In FY 2007, efforts were transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Tech, and Project 5027, High Speed Airbreathing Propulsion Technologies, to this Project in order to more effectively manage and provide oversight of the efforts. In FY 2007, Project 3012, Advanced Propulsion Technology, absorbed the efforts of a thrust from Project 33SP, Space Rocket Component Technology, in order to more effectively manage cooperative Combined Cycle Engine (CCE) developments.

(U) 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.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellant ingredients, and reduced-toxicity monopropellants to increase space launch payload capability and refine new propellants synthesis methods. Efforts include evaluation and development of reduced-toxicity ionic salt, high-energy-density oxidizers, nano-materials, catalyst, and polymeric binders; development of supporting computational tools; determining optimized paths for incorporating these materials into propellants; and for selected propellants perform laboratory and demonstrator engine evaluations. Efforts seek monopropellants with performance equivalent to bipropellants that reduce the cost of space access and space operations. Phases are referring to the IHPRPT program phases.	3.346	4.186	4.826
(U) In FY 2007: Downselected and scaled-up promising high energy-density materials candidates. Evaluated scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Completed scale-up of candidate ionic liquids. Explored and developed ionic liquids. Advanced concepts work moved to another thrust.			
(U) In FY 2008: Initiate evaluation and development of potential hydrocarbon fuel additives to improve performance of kerosene. Continue downselect process and continue scaling-up promising high energy-density materials candidates. Develop new high engergy-density, high nitrogen ingredients. Develop proof of concept for new computational code			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
to predict molecular properties of propellant ingredients. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Continue exploration and development of ionic liquids.			
(U) In FY 2009: Continue evaluation and development of potential hydrocarbon fuel additives to improve performance of kerosene. Continue downselect process and continue scaling-up promising high energy-density materials candidates. Continue development and characterization of high nitrogen ingredients. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Continue exploration and development of ionic liquids meeting Phase III goals. Initiate scale up of promising ionic liquids for further characterization. Continue proof of concept for new computational code to predict molecular properties.			
(U)			
(U) MAJOR THRUST: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. Efforts include modeling and analyzing advanced propulsion concepts with enhanced performance and reliability such as aerovehicles and potential launch systems.	7.647	7.909	7.239
(U) In FY 2007: Characterized, studied, and evaluated shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Developed, analyzed, and transitioned advanced combustion device technology, including injectors and chambers suitable for advanced synthetic hydrocarbon fuels capable of meeting or exceeding 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. Developed, scaled-up, and transitioned new energetic advanced hydrocarbon fuels and additives for rocket propulsion, including space storable high energy, non-toxic fuels. Continued validation and verification of advanced multi-phase modeling and simulation (M&S) capabilities. Conducted proof-of-concept measurements of promising advanced propulsion concepts. developed more complex and realistic computational models of these concepts, and continued system trade studies to evaluate potential return on investment.			
(U) In FY 2008: Characterize, study, and evaluate shear coaxial injector performance to ensure chamber/injector compatibility and prevent damage to upper stage engines. Develop, analyze, and transition advanced combustion device technology, including injectors and chambers suitable for advanced synthetic hydrocarbon fuels capable of meeting or exceeding the 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			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Complete scale-up and transition new energetic advanced hydrocarbon fuels and additives for rocket propulsion, including space storable high energy, non-toxic fuels. Conduct validation and verification of advanced multi-phase M&S capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Continue and refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Continue system trade studies with improved performance models to evaluate potential return on investment.			
(U) In FY 2009: Characterize, study, and evaluate shear injector performance to ensure chamber/injector compatibility and prevent damage to engines. Develop, analyze, and transition advanced combustion device technology, including injectors and chambers. Develop improved understanding of fundamental combustion and fluid flow/heat transfer processes leading to new methodologies for thermal management, scaling, and combustion instabilities in hydrocarbon fueled liquid rocket engines, reducing the need for conducting large numbers of costly full-scale component and engine tests. Evaluate novel nozzle cooling channels for use with hydrocarbon fuels in the high heat flux test rig. Conduct validation and verification of advanced M&S capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Continue and refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Continue system trade studies with improved performance models to evaluate potential return on investment.			
(U)			
(U) MAJOR THRUST: Develop advanced material applications for lightweight components and material property enhancements for use in advanced combustion devices and propulsion systems for current and future rocket propulsion systems.	5.257	6.048	6.756
(U) In FY 2007: 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.			
(U) In FY 2008: Continue developing 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. Continue developing 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. Evaluate new class of hydrophobic and oleophobic materials.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U)	In FY 2009: Continue developing 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. Continue developing 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. Continue to characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials.			
(U)				
(U)	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.	24.374	22.331	23.646
(U)	In FY 2007: Conducted advance modeling and simulation tool development for advanced cryogenic liquid rocket upper stage technologies. Developed advanced cryogenic upper stage technologies-turbopumps and thrust chambers. Evaluated third set of potential hydrocarbon fuels and adjust/modify/develop fuel characterization test rig. Completed development of second concept for lightweight nozzles for liquid rocket engines. Started hydrocarbon boost technology development for future spacelift concepts including materials scale-up efforts to improve life and weight of the liquid engine components.			
(U)	In FY 2008: Complete advance modeling and simulation tool development for advanced cryogenic liquid rocket upper stage technologies. Continue enabling hydrocarbon boost technology development for future spacelift concepts. Initiate engine health monitoring effort supporting the hydrocarbon boost technology development effort. Also initiate efforts developing hydrocarbon engine technologies using fuels other than kerosene.			
(U)	In FY 2009: Continue enabling hydrocarbon boost technology development for future spacelift concepts. Develop engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene.			
(U)				
(U)	MAJOR THRUST: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for stationkeeping, repositioning, and orbit transfer for large communication satellites, microsatellites, and satellite constellations. Phases are referring to the IHPRPT program phases.	6.691	6.048	5.791
(U)	In FY 2007: Conducted Hall thruster development efforts. Evaluated plasma thrusters for microsatellites propulsion systems. Initiated scale-up testing monopropellants. Initiated assessment of advanced chemical propulsion technology developments for satellite thrusters. Initiated development of advanced multi-mode chemical-electric propulsion concepts for satellites.			
(U)	In FY 2008: Continue Hall thruster development efforts. Continue evaluating plasma thrusters for microsatellites propulsion systems. Continue scale-up testing additional monopropellants. Continue assessment of advanced			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
	chemical propulsion technology developments for satellite thrusters. Continue development of advanced multi-mode chemical-electric propulsion concepts for satellites. Initiate development of alternative propulsion concepts and associated modeling, simulation, and analysis tools to augment or replace Hall Thrusters in the future.			
(U)	In FY 2009: Continue Hall thruster development efforts. Continue evaluating plasma thrusters for microsatellites propulsion systems. Continue scale-up testing additional monopropellants, evaluate advanced ignition schemes and chamber concepts. Continue assessment of advanced chemical propulsion technology developments for satellite thrusters, begin component developments. Continue development of advanced multi-mode chemical-electric propulsion concepts for satellites, down-select to single design concept, and begin component developments.			
(U)				
(U)	MAJOR THRUST: Conduct assessments, design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies in support of the development of affordable, on-demand access to space vehicles to meet future warfighter needs. Note: In FY 2008, this effort transferred within this PE to Project 623012, Advanced Propulsion Technologies, to consolidate and better manage this cooperative CCE effort.	0.478	0.000	0.000
(U)	In FY 2007: Conducted assessments, system design trades, and simulations to integrate combined cycle engines (CCEs) and advanced cycle airbreathing hypersonic propulsion technologies in support of the development of affordable, on-demand access to space vehicles to meet future warfighter needs.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Liquid Rocket Booster Technology.	1.374	0.000	0.000
(U)	In FY 2007: Developed hydrocarbon boost rocket engine technologies for the Air Force.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Engineering Tool Improvement Program (ETIP). Note: In FY 2007, this add was titled Engineering Tool Improvement Program (ETIP) and transferred from PE 0602500F, Multi-Disciplinary Space Technology, Project 5026, Rocket Propulsion Component Technology to better manage development efforts.	2.747	0.000	0.000
(U)	In FY 2007: Developed advanced rocket engine modeling, simulation, and analysis tools for propulsion and integrated them into seamless suite of tools for scientists and engineers to use in developing advanced propulsion technologies.			
(U)	In FY 2008: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 33SP Space Rocket Component Tech

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Methane Second Stage Rocket Engine.	1.570	0.995	0.000
(U)	In FY 2007: Developed liquid oxygen, liquid methane pressure fed second stage rocket engine technologies for the Air Force.			
(U)	In FY 2008: Scale-up liquid oxygen, liquid methane pressure fed second stage rocket engine technologies for the Air Force.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Vehicle and Propulsion Center.	3.139	1.589	0.000
(U)	In FY 2007: Performed technical support and analysis for the Prompt Global Strike Analysis of Alternatives (AoA). Conducted facility upgrades to support upcoming testing which support planning efforts for Land-based Strategic Deterrent and Operationally Responsive Spacelift activities.			
(U)	In FY 2008: Refine analytical tools to help assess feasibility and cost benefit of using common boosters/engines across multiple launch platforms. Continue model developments that will support Prompt Global Strike and future ballistic missile development efforts.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Hydrocarbon Boost Technology Demonstrator.	0.000	1.193	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Funds will be used to accelerate development of technologies for highly operable and reusable spacelift.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Integrated Propulsion Analysis Tool (IPAT).	0.000	1.589	0.000
(U)	In FY 2007: Not Applicable.			
(U)	In FY 2008: Increase fidelity of rocket engine analysis and assessment tools and broaden application to advanced concepts being considered by the Air Force.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Development and Testing of Advanced Paraffin-Based Hybrid Rockets for Space Applications.	0.000	1.589	0.000
(U)	In FY 2007: Not Applicable.			

Exhibit R-2a, RDT&E Project Justification		DATE: February 2008
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE: 33SP Space Rocket Component Tech

(U) B. Accomplishments/Planned Program ($ in Millions)

		FY 2007	FY 2008	FY 2009
(U)	In FY 2008: Scale-up of hybrid rocket technologies and characterize for potential application to space applications.			
(U)	In FY 2009: Not Applicable.			
(U)	Total Cost	56.623	53.477	48.258

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

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Not Applicable.									

(U) D. Acquisition Strategy

Not Applicable

Exhibit R-2a, RDT&E Project Justification			DATE: February 2008
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE: 4847 Rocket Propulsion Technology	

Cost ($ in Millions)	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total
4847 Rocket Propulsion Technology	18.516	10.651	9.188	10.702	7.511	11.762	12.073	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops technologies for the sustainment of strategic systems (including solid boost/missile propulsion, post boost control, aging and surveillance efforts). Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Technologies are being accomplished in two phases and are developed to reduce the weight by 15 percent (Phase I)/20 percent (Phase II) and cost of components 25 percent (Phase I)/35 percent (Phase II) through the use of new materials and improving designs and manufacturing techniques. Aging and surveillance efforts could reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause. All efforts in this project are part of the Technology for the Sustainment of Strategic Systems program and support the Integrated High Payoff Rocket Propulsion Technology program.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) MAJOR THRUST: Develop missile propulsion and boost technologies for tactical and ballistic missile systems. Efforts support the Technology for the Sustainment of Strategic Systems program. Note: Decreased funding in FY 2008 and out due to post boost control system component technology maturation and effort completions.	11.611	8.201	4.962

(U) In FY 2007: Initiated component development and risk reduction efforts for the 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. Formulated and characterized new propellant formulations using new fuels and oxidizers developed over the last couple of years for the next phase of advanced solid propulsion. Conducted sub-scale tests to characterize and validate physics in rocket motor environments and incorporate into modeling and simulation tool developments for solid rocket motors to be used in developing components for the Missile Propulsion Demonstration.

(U) In FY 2008: Continue component development and risk reduction efforts for the Missile Propulsion demonstration. Conduct sub-scale testing of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Complete modeling, simulation, and analysis tool development efforts. Continue development of advanced tactical propulsion technologies.

(U) In FY 2009: Continue component development and risk reduction efforts for the 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 Missile Propulsion demonstration. Complete verification

Exhibit R-2a, RDT&E Project Justification		DATE February 2008
BUDGET ACTIVITY 02 Applied Research	PE NUMBER AND TITLE 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE 4847 Rocket Propulsion Technology

	B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U)	development of rapid densification nozzle technology using improved strategic propellants for future ballistic missiles to enhance performance and weight. Continue demonstrating low-cost, high temperature, non-erosive, lightweight coated carbon-carbon, ceramic and hybrid polymer components for solid rocket motors. Continue development of advanced tactical propulsion technologies.			
(U)				
(U)	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.	3.275	2.450	4.226
(U)	In FY 2007: Conducted advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite.			
(U)	In FY 2008: Continue advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite.			
(U)	In FY 2009: Complete advanced service life prediction technology program developing and applying existing and advanced sensors that can be embedded or attached to solid rocket motors and the aging and surveillance models and tools that can translate and integrate the sensor data into existing aging and surveillance tool suite. Begin efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior.			
(U)				
(U)	CONGRESSIONAL ADD: Aerospace Lab Equipment Upgrade.	0.981	0.000	0.000
(U)	In FY 2007: Upgraded/augmented existing university facilities/capabilities to train future aerospace engineers.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				
(U)	CONGRESSIONAL ADD: Advanced Vortex Hybrid Propulsion System.	1.668	0.000	0.000
(U)	In FY 2007: Developed small launch vehicle size engines that utilize vortex combustion processes to generate improved performance and/or operability. Tasks included developments in propellant storage tanks as well as the engine designs. Engine concepts examined included LOx/Propane vortex cold-wall chamber as well as vortex hybrid designs.			
(U)	In FY 2008: Not Applicable.			
(U)	In FY 2009: Not Applicable.			
(U)				

Exhibit R-2a, RDT&E Project Justification		DATE: February 2008
BUDGET ACTIVITY: 02 Applied Research	PE NUMBER AND TITLE: 0602203F Aerospace Propulsion	PROJECT NUMBER AND TITLE: 4847 Rocket Propulsion Technology

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2007	FY 2008	FY 2009
(U) CONGRESSIONAL ADD: Solid Boost Propulsion Technology for the Sustainment of Strategic Systems.	0.981	0.000	0.000
(U) In FY 2007: Developed technologies that aid in the sustainment of strategic solid rocket motors.			
(U) In FY 2008: Not Applicable.			
(U) In FY 2009: Not Applicable.			
(U) Total Cost	18.516	10.651	9.188

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

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Total Cost
(U) Related Activities:									
(U) PE 0601102F, Defense Research Sciences.									
(U) PE 0602114N, Power Projection Applied Research.									
(U) PE 0602303A, Missile Technology.									
(U) PE 0602500F, Multi-Disciplinary Space Tech.									
(U) PE 0603311F, Ballistic Missile Technology.									
(U) PE 0603401F, Advanced Spacecraft Technology.									
(U) This project has been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication.									

(U) D. Acquisition Strategy

Not Applicable.