Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Air Force										DATE: February 2012	
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*				R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*							
COST ($ in Millions)	**FY 2011**	**FY 2012**	**FY 2013 Base**	**FY 2013 OCO**	**FY 2013 Total**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**	**Cost To Complete**	**Total Cost**
Total Program Element	198.878	207.406	232.547	-	232.547	200.918	165.900	168.511	177.525	Continuing	Continuing
623012: *Advanced Propulsion Technology*	22.074	20.367	23.637	-	23.637	23.345	22.160	24.276	27.254	Continuing	Continuing
623048: *Combustion and Mechanical Systems*	17.734	20.069	15.874	-	15.874	13.886	12.744	12.829	13.103	Continuing	Continuing
623066: *Turbine Engine Technology*	64.278	67.702	102.188	-	102.188	75.523	42.355	42.628	43.520	Continuing	Continuing
623145: *Aerospace Power Technology*	31.346	32.639	30.061	-	30.061	27.801	28.677	28.739	28.848	Continuing	Continuing
624847: *Rocket Propulsion Technology*	56.966	60.390	55.293	-	55.293	54.888	54.689	54.727	59.374	Continuing	Continuing
625330: *Aerospace Fuel Technology*	6.480	6.239	5.494	-	5.494	5.475	5.275	5.312	5.426	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The program has six projects, each focusing on a technology area critical to the Air Force. The Advanced Propulsion Technology project develops high-speed air breathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies to enable revolutionary propulsion capability for the Air Force. The Combustion and Mechanical Systems project evaluates lubricants and combustion concepts and technologies for new and existing engines. The Turbine Engine Technology project develops enabling capabilities to enhance performance and affordability of existing weapon systems and develops component technologies for ultra high pressure ratio, substantially improved durability, and adaptive cycle engine architecture to provide optimized performance, fuel efficiency, and life for widely varying mission needs. The Aerospace Power Technology project develops electrical power and thermal management technologies for military applications that are part of energy optimized aircraft development. The Rocket Propulsion Technology project develops advances in rocket propulsion technologies for space access, space maneuver, missiles, the sustainment of strategic systems, and tactical rockets. The Aerospace Fuel Technology project evaluates hydrocarbon-based fuels for legacy and advanced turbine engines, scramjets, pulse detonation, and combined-cycle engines. Efforts in this program have been coordinated through the Reliance 21 process to harmonize efforts and eliminate duplication. 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	

B. Program Change Summary ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Previous President's Budget	207.049	207.508	204.967	-	204.967
Current President's Budget	198.878	207.406	232.547	-	232.547
Total Adjustments	-8.171	-0.102	27.580	-	27.580
• Congressional General Reductions	-	-0.102			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.474	-			
• Other Adjustments	-4.697	-	27.580	-	27.580

Change Summary Explanation

FY11: Other Adjustments include -1.697 Congressional General Reductions and -3.000 Congressional Directed Reductions

FY13: Increase due to higher Air Force priorities in Turbine Engine Technology

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force			DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
623012: *Advanced Propulsion Technology*	22.074	20.367	23.637	-	23.637	23.345	22.160	24.276	27.254	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Title: Major Thrust 1.	2.565	1.650	1.650	-	1.650
Description: Develop advanced fuel-cooled scramjet engine technologies to support flight demonstration and enable the broad application of hypersonics to meet future warfighter needs. ***FY 2011 Accomplishments:*** Developed and demonstrated flight weight engine components and advanced engine control logic. Assessed advanced instrumentation with control logic to improve scramjet operability. Performed trajectory optimization for flight test. Conducted ground test of advanced scramjet start technique. Completed fabrication of flight test hardware to demonstrate ramjet to scramjet transition. ***FY 2012 Plans:*** Develop and demonstrate advanced engine control systems and flight weight scramjet engine components. Develop and demonstrate closed loop engine control system with advanced instrumentation to increase scramjet engine operability at low scramjet Mach numbers. Conduct flight test using sounding rocket launch to demonstrate transition from ramjet to scramjet. ***FY 2013 Base Plans:*** Continue development and demonstration of advanced engine control systems and flight weight scramjet engine components. Based on prior ground and flight testing, refine and demonstrate closed loop engine control system with advanced instrumentation to increase scramjet engine operability at low scramjet Mach numbers. Conduct direct connect testing of flight weight scramjet components for cold start systems. ***FY 2013 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
N/A					
Title: Major Thrust 2. ***Description:*** Conduct assessments, technology design trades, and simulations to integrate combined cycle engines (CCEs) and air breathing hypersonic propulsion technologies into future systems. ***FY 2011 Accomplishments:*** Conducted further 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 National Aeronautics and Space Administration (NASA) and Defense Advanced Research Projects Agency (DARPA). Developed technology maturation plan, including test facility requirements, for advanced components for turbine-based and rocket-based CCEs. ***FY 2012 Plans:*** Continue to conduct trade studies to determine military payoff and establish component technology goals. Improve definition of component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Update technology maturation plan, including test facility requirements, for advanced components for turbine-based and rocket-based CCEs. ***FY 2013 Base Plans:*** Continue to conduct trade studies to determine military payoff and establish component technology goals. Improve definition of component and engine performance objectives to enable development of affordable hypersonic flight demonstrators jointly with NASA and DARPA. Update technology maturation plan, including test facility requirements, for advanced components for turbine-based and rocket-based CCEs. Initiate detailed component development roadmapping. ***FY 2013 OCO Plans:*** N/A	0.165	0.165	0.120	-	0.120
Title: Major Thrust 3. ***Description:*** Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future platforms. ***FY 2011 Accomplishments:***	19.344	18.552	21.867	-	21.867

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Developed advanced engine components to improve scramjet operating margin and to refine scramjet scaling laws for reusable applications. Developed techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Developed low internal drag flame stabilization devices and flight test engine components. Ground tested subscale components/combustors to represent medium scale (5 to 20 times) scramjet engines. ***FY 2012 Plans:*** Develop advanced engine components to improve scramjet operating margin and to refine scramjet scaling laws for reusable applications. Develop techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Develop low internal drag flame stabilization devices and flight test engine components. Design and initiate fabrication of heavy weight scramjet combustor in medium scale (5 to 20 times) scramjet engines. ***FY 2013 Base Plans:*** Continue to develop advanced engine components to improve scramjet operating margin and to refine scramjet scaling laws for reusable applications. Continue to develop techniques to decrease scramjet take-over from Mach 4.5 to Mach 3.5 to provide robust options for CCEs. Continue to develop low internal drag flame stabilization devices and flight test engine components. Complete fabrication of heavy weight scramjet combustor in medium scale (5 to 20 times) scramjet engines. Initiate direct connect testing of medium scale (5 to 20 times) scramjet engines operating at Mach 3.5 to Mach 7 conditions. ***FY 2013 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	22.074	20.367	23.637	-	23.637

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• N/A: *N/A*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623012: *Advanced Propulsion Technology*

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force			DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
623048: *Combustion and Mechanical Systems*	17.734	20.069	15.874	-	15.874	13.886	12.744	12.829	13.103	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project evaluates lubricants, mechanical systems, and combustion concepts for advanced turbine engines, pulse detonation engines, and combined cycle engines. This project also develops technologies to increase turbine engine operational reliability, durability, mission flexibility, maintainability, and performance while reducing weight, fuel consumption, and cost of ownership. Applications include missiles, aircraft, and sustained high-speed vehicles. Analytical and experimental areas of emphasis include lubricants, bearings, mechanical systems diagnostics, mechanical systems prognostics, rotordynamics, oil-less engine technology, optical diagnostics, fundamental combustion, detonations, combustors, and afterburners. Lubricants for these engines must be thermally stable, cost-effective, and operate over a broad range of conditions. Advanced combustion concepts must be cost-effective, durable, and reduce pollutant emissions. A portion of this project supports adaptive cycle technologies. This effort develops component technology for an adaptive cycle engine architecture that provides optimized performance/fuel efficiency for widely varying mission needs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Title: Major Thrust 1.	7.541	8.719	6.202	-	6.202
Description: Develop, test, and evaluate revolutionary combustion and propulsion concepts for gas turbine, pulse detonation, and combined cycle engines for missiles, manned and unmanned systems. ***FY 2011 Accomplishments:*** Tested full-scale inter-turbine burner (ITB) concepts at relevant engine conditions. Investigated novel valving concepts for pulse detonation engines. Studied pulse detonation engine-turbine interactions. Explored the use of regenerative fuel cooling with pulse detonation engines and other combustion systems. Demonstrated novel small internal combustion engine concepts that improve system performance. Used advanced modeling and simulation tools to understand combustion processes and to guide combustion system design. Employed new chemistry models for alternative fuels. Tested concept designs for adaptive combustors for ultra efficient turbine engine components which reduce harmful emissions. ***FY 2012 Plans:*** Evaluate alternative fuels in combustion systems at relevant engine conditions. Test full-scale compact combustor concept relevant to highly efficient, embedded turbine engine goals. Demonstrate small-scale propulsion system operation using reduced-octane fuels. Employ new physical models in simulation tools. Investigate pressure gain combustion concepts for application to propulsion systems. Continue studies of pulse					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
detonation engine-turbine interactions. Investigate feasibility of rotary detonation engines (RDE) and continuous detonation engines. ***FY 2013 Base Plans:*** Develop new models for combustion processes at high pressure conditions. Test combustion system design that produce low pollutant emissions. Test RDE concepts. Decrease in FY 2013 due to higher Department of Defense priorities. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 2. ***Description:*** Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies. ***FY 2011 Accomplishments:*** Used two-color planar laser induced fluorescence techniques to measure temperature in relevant-environment combustion systems. Developed robust line-of-sight measurement techniques for temperature and species and apply to engine systems. Developed simultaneous high-speed planar laser-induced fluorescence and particle-image velocimetry for measurements of species and velocity fields in practical combustion devices. Expanded line-of-sight measurement techniques for temperature and species to include many simultaneous lines of sight and tomographic reconstruction of complex reacting flowfields characteristic of real-world hardware. Applied advanced optical diagnostics suites for characterization and improvement of engine combustors and afterburners. ***FY 2012 Plans:*** Apply line-of-sight measurement techniques for temperature and species to combustion systems in a relevant engine environment. Demonstrate simultaneous high-speed planar laser-induced fluorescence and particle-image velocimetry for measurements of species and velocity fields in practical combustion devices. Demonstrate tomographic reconstruction of reacting flowfields in relevant combustion systems. ***FY 2013 Base Plans:***	1.171	1.311	1.128	-	1.128

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Apply advanced laser diagnostics and novel optics configurations to high pressure test cell environment. Demonstrate particle image velocimetry in high pressure combustion test apparatus. Investigate high-speed measurement techniques for combustion temperature and species. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 3. ***Description:*** Develop, test, and qualify advanced turbine engine lubricants. Generate and maintain military specifications for aviation engine lubricants. ***FY 2011 Accomplishments:*** Completed Technology Readiness Level (TRL) 5 full-scale bearing endurance test on second enhanced ester candidate oil in preparation for an engine demonstration. Supported full transition of enhanced ester oil to the operational fleet by coordinating with engine manufacturers and users. Conducted adaptive components for high efficiency risk mitigation bearing and gear rig tests with enhanced ester oil in preparation for 2013 demonstration engine test. Demonstrated anti-coke surface modifiers on sub-scale supersonic lube system components. Expanded development of intelligent prognostics for lubrication system health monitoring. Investigated advanced lube system thermal and health management technologies for highly embedded efficient turbine engines. ***FY 2012 Plans:*** Demonstrate anti-coke surface modifiers on full-scale lubrication system components. Develop engine mechanical system health management control algorithms for active rotor thrust balancing. Develop suite of technologies for intelligent lube system prognostics and health monitoring, such as integrated debris capture devices, real-time oil debris monitoring, and vibration sensing. Develop lubrication system thermal management technologies for reduced heat generation and improved heat dissipation for efficient turbine engines. ***FY 2013 Base Plans:*** Demonstrate lube system health management control algorithms with full-scale TRL 5 rig hardware. Test enhanced ester oils in demonstrator turbine engines. Continue investigating advanced lube system thermal management technologies for fuel efficient turbine engines. Develop new oil traction models and validate experimentally. ***FY 2013 OCO Plans:***	4.463	4.966	4.181	-	4.181

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
N/A					
Title: Major Thrust 4. ***Description:*** Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-sized turbine engine applications. ***FY 2011 Accomplishments:*** Investigated fatigue life and spall propagation of Vacuum Induction Melted-Vacuum Arc Remelted (VIM-VAR) bearings. Completed mechanical systems risk mitigation test activities for adaptive components for high efficiency. Developed coupled bearing and rotor dynamic models for virtual simulation of mechanical systems for advanced engines. Continued developing reliable bearing technologies for sustained hi-mach reusable and limited-life engines. Completed fabrication of active rotor thrust balance bearing test rig. ***FY 2012 Plans:*** Conduct shakedown tests of active thrust balance rig. Develop and demonstrate robust thrust load sensing devices for highly loaded engine thrust bearings. Develop bearing spall debris monitoring model and limits and incorporate into thrust load control algorithm. Demonstrate oil debris monitoring technology fused with vibration sensing on seeded fault bearing rig tests. Develop new bearing heat generation models for engines and validate with full-scale bearing experimental performance data. ***FY 2013 Base Plans:*** Conduct parametric active thrust control experiments to validate load control algorithms. Conduct seeded fault bearing tests to validate reliable active and autonomous thrust load control. Integrate active thrust control, vibration, and oil debris sensing for complete TRL 5 mechanical system health management system. Coordinate plans for demonstrating active thrust control system in future TRL 6 engine demonstration. ***FY 2013 OCO Plans:*** N/A	4.559	5.073	4.363	-	4.363
Accomplishments/Planned Programs Subtotals	17.734	20.069	15.874	-	15.874

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• N/A: *N/A*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623048: *Combustion and Mechanical Systems*

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force			DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
623066: *Turbine Engine Technology*	64.278	67.702	102.188	-	102.188	75.523	42.355	42.628	43.520	Continuing	Continuing

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, adaptive cycle technologies, and structural design. This project develops component technology for an adaptive cycle engine architecture that provides optimized performance/fuel efficiency for widely varying mission needs. This project supports joint Department of Defense, agency, and industry efforts to focus turbine propulsion technology on national needs. The program plan is relevant across capability areas for global responsive strike, capable unmanned war-fighting, tactical and global mobility, responsive space lift, and persistent intelligence, surveillance, and reconnaissance (ISR).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Title: Major Thrust 1.	38.101	41.133	34.578	-	34.578
Description: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports.					
FY 2011 Accomplishments: Developed and applied advanced modeling and simulation rules and tools for advanced components. Developed computational fluid dynamics methodology for analyzing turbine flows. Developed ceramic matrix composite lifing models. Conducted bench and rig tests for validation of components with significantly improved efficiency. Performed rig testing of lightweight, simple, adaptive cycle features, an efficient, wide-flow range compressor, an efficient, high temperature turbine capable of operating over large swings in required work, and an efficient, lightweight, low observable (LO)-compatible exhaust system. Developed and applied advanced modeling and simulation rules and tools to initiate definition and design of efficient, very high pressure ratio core component technologies that will offer a step change improvement in engine specific fuel consumption.					
FY 2012 Plans: Develop modeling and simulation rules and tools for advanced components including advanced interactive cost analysis tools for adaptive core components and unsteady aerodynamics/aeromechanics models. Conduct bench and rig tests to validate unsteady aerodynamics/aeromechanics models. Continue rig testing adaptive cycle features, an efficient compressor, an efficient turbine, and an efficient exhaust system. Continue to develop					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
and apply advanced modeling and simulation rules and tools to initiate definition and design of efficient, very high pressure ratio core component technologies. ***FY 2013 Base Plans:*** Develop modeling and simulation tools for advanced components including coupled aerothermal models and turbine durability design. Conduct bench and rig test using test using surface mapping thin film temperature gages. Develop high resolution non-contact stress measurement systems for high frequency response measurement. Demonstrate engine efficiency improvements from active clearance and flow control. Conduct rig testing of high power low emission combustion. Develop improved compressor aerodynamic design tools to extend engine operability and efficiency. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 2. ***Description:*** Develop turbofan/turbojet engine components (i.e., fans, nozzles, etc.) used in engines for fighters, bombers, sustained supersonic strike and hypersonic cruise vehicles, and transports. ***FY 2011 Accomplishments:*** Developed and applied advanced modeling and simulation rules and tools for advanced components. Developed durable damping/erosion coating systems. Conducted rig testing of advanced fan design for application to a variable cycle engine concept. Conducted rig testing of advanced low pressure turbine design for application to a variable cycle engine concept. Rig tested lightweight, simple, LO-compatible inlet and exhaust system. ***FY 2012 Plans:*** Develop modeling and simulation rules and tools for advanced components including: advanced interactive cost analysis tools for adaptive engine components; unsteady aerodynamics and aeromechanics models; augmentor combustion processes; and probability-based cooled turbine airfoil high cycle fatigue prediction methods. Conduct bench and rig tests to validate unsteady aerodynamics/aeromechanics models and probabilistic cooled turbine airfoil high cycle fatigue prediction methods. Develop and validate test protocols and improved augmentor rig test capabilities. Continue rig testing of advanced fan design, advanced low pressure turbine design, and lightweight, simple, LO-compatible inlet and exhaust systems. ***FY 2013 Base Plans:***	19.237	19.510	14.672	-	14.672

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Develop modeling and simulation tools including methods to predict behavior of serpentine inlets and nozzles. Demonstrate methods to detect/predict incipient bearing damage to ensure engine operation. Decrease in FY 2013 due to higher Department of Defense priorities. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 3. ***Description:*** Develop limited life engine components for missile and remotely piloted aircraft (RPA) applications, including long-range supersonic and hypersonic vehicles. ***FY 2011 Accomplishments:*** Developed and applied advanced modeling and simulation rules and tools for advanced limited life components. Designed and rig tested advanced limited life components. ***FY 2012 Plans:*** Develop and apply advanced modeling and simulation rules and tools for ceramic material small turbine blades, variable area turbines, and integration/performance of lubeless bearings. Develop and evaluate components to increase pressure ratio by 50% in this size class with minimum efficiency loss. ***FY 2013 Base Plans:*** Develop and apply advanced modeling and simulation tools for variable cycle component design, advanced cooling concepts, compact augmentors, and composite structures. Demonstrate advanced designs in rig testing. ***FY 2013 OCO Plans:*** N/A	5.309	5.400	3.993	-	3.993
Title: Major Thrust 4. ***Description:*** Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports. ***FY 2011 Accomplishments:*** Developed and applied advanced modeling and simulation rules and tools for advanced limited life components. ***FY 2012 Plans:***	1.631	1.659	1.545	-	1.545

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Develop and apply advanced modeling and simulation rules and tools for emissions and noise to decrease detection. Develop and evaluate components to increase thrust-to-weight ratio and to decrease specific fuel consumption, production cost, and development cost. ***FY 2013 Base Plans:*** Develop and apply advanced modeling and simulation tools for advanced cooling concepts, high efficiency gearboxes, and high performance airfoils. Develop advanced vibration and temperature sensors for use in demonstration of engine durability requirements. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 5. ***Description:*** Develop high performance, durable components which enable adaptive turbine engine technologies. ***FY 2011 Accomplishments:*** N/A ***FY 2012 Plans:*** N/A ***FY 2013 Base Plans:*** Conduct bench and rig tests to validate technologies and mitigate risk of adaptive fan, high pressure compressor, combustor, turbine, thermal management, and augmentor/exhaust nozzle components, which reduce specific fuel consumption, improve thrust-to-weight, and reduce cost. ***FY 2013 OCO Plans:*** N/A	-	-	47.400	-	47.400
Accomplishments/Planned Programs Subtotals	64.278	67.702	102.188	-	102.188

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• N/A: *N/A*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623066: *Turbine Engine Technology*

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force			DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
623145: *Aerospace Power Technology*	31.346	32.639	30.061	-	30.061	27.801	28.677	28.739	28.848	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Title: Major Thrust 1. ***Description:*** Develop electrical power and thermal management component and subsystem technologies with low volume displacement for delivery of high power for manned and unmanned systems. ***FY 2011 Accomplishments:*** Performed hardware-in-the-loop simulation tests to validate power and thermal management systems that provide continuous thermal balancing of critical systems over a range of mission profiles. Assessed component technologies for application to directed energy weapon concepts. ***FY 2012 Plans:*** Perform tip-to-tail modeling and simulation to identify solutions for platform level power and thermal management needs of next generation military air platforms. ***FY 2013 Base Plans:*** Design and develop adaptive power and thermal management subsystems for next generation military air platforms based on platform level tip-to-tail modeling and simulation energy optimization. ***FY 2013 OCO Plans:*** N/A	27.366	26.831	25.473	-	25.473
Title: Major Thrust 2.	3.980	5.808	4.588	-	4.588

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 623145: *Aerospace Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Description: Develop technologies for special purpose applications, including hybrid electrical power, thermal management systems, and energy conversion/storage components and subsystems. ***FY 2011 Accomplishments:*** Developed increased fuel flexibility and integrated energy harvesting technologies for expanded special purpose applications for improved power and energy density. Performed integrated flight-weight subsystems flight tests to demonstrate power and energy density goals. ***FY 2012 Plans:*** Develop fully ruggedized hybrid power subsystems and energy harvesting components. Perform flight tests of these subsystems to demonstrate achievement of power and energy density goals for special purpose applications. Explore technology set for development of power systems for micro air vehicles. Note: In FY 2012, efforts in this thrust are increased due to higher AF priorities. ***FY 2013 Base Plans:*** Develop and test small and micro remote piloted aircraft power systems to provide enhanced capability and endurance and logistical fuel compatibility. ***FY 2013 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	31.346	32.639	30.061	-	30.061

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• N/A: *N/A*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force			DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
624847: *Rocket Propulsion Technology*	56.966	60.390	55.293	-	55.293	54.888	54.689	54.727	59.374	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops rocket propulsion technologies for space access, space maneuver, missiles, the sustainment of strategic systems (including solid boost/ missile propulsion, post boost control, aging and surveillance efforts), and tactical missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, technology for sustainment of strategic systems, and innovative space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Technologies are developed to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the sustainment of the rocket propulsion industry, providing rocket propulsion technology for the entire Department of Defense. Technologies developed under this program enable capabilities of interest to both the Department of Defense and NASA. Efforts include modeling and simulation, proof of concept tests of critical components, advanced component development, and ground-based tests. Aging and surveillance efforts could reduce lifetime prediction uncertainties for individual motors by 50 percent, enabling motor replacement for cause.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Title: Major Thrust 1.	3.838	4.943	6.208	-	6.208
Description: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellants, and monopropellants to increase space launch payload capability and refine new synthesis methods.					
FY 2011 Accomplishments: Conducted experimental and analytical evaluation of potential hydrocarbon fuel additives to improve performance of kerosene. Continued synthesis and downselect process and scale-up of 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. Explored and developed advanced ionic liquids. Continued scale-up experiments of promising ionic liquids for further characterization. Continued proof of concept for new computational code to predict molecular properties of various promising propellant ingredients. Continued evaluation of suitability for ionic liquid propellants for missile defense interceptor and spacecraft propulsion demonstrations. Continued technology transfer to industry for production of downselected propellants. Continued high performance bi-propellant identification and synthesis program.					
FY 2012 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Conduct experimental and analytical evaluation of potential hydrocarbon fuel additives to improve performance of kerosene. Continue synthesis and downselect process and scale-up of promising high energy-density materials candidates. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Explore and develop advanced ionic liquids including synthesis and characterization. Continue scale-up experiments of promising ionic liquids for further characterization. Continue evaluation of suitability for ionic liquid propellants for missile defense interceptor and spacecraft propulsion demonstrations. Continue technology transfer to industry for production of downselected propellants. Continue high performance bi-propellant identification and synthesis program. ***FY 2013 Base Plans:*** Conduct experimental and analytical evaluation of potential hydrocarbon fuel additives to improve performance of kerosene. Continue synthesis and downselect process and scale-up of promising high energy-density materials candidates. Evaluate scaled-up propellants in advanced combustion devices to determine materials compatibility and performance to include supporting large-scale motor tests. Explore and develop advanced ionic liquids including synthesis and characterization. Continue scale-up experiments of promising ionic liquids for further characterization. Continue evaluation of suitability for ionic liquid propellants for missile defense interceptor and spacecraft propulsion demonstrations. Continue technology transfer to industry for production of downselected propellants. Continue high performance bi-propellant identification and synthesis program. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 2. ***Description:*** Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles. ***FY 2011 Accomplishments:*** Characterized, studied, and evaluated shear injector performance to ensure chamber/injector compatibility and prevent damage to engines. Validated study results in more realistic rocket-chamber conditions and begin transition of predictive tools to industry. Developed, analyzed, and transitioned advanced combustion device technology, including injectors and chambers. 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. Characterized design changes in high heat flux test	7.988	7.364	7.766	-	7.766

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
rig in preparation for evaluating cooling channel designs. Conducted validation and verification of advanced modeling and simulation capabilities. Performed pre-selection of most promising advanced propulsion concepts; applied realistic computational models to optimize performance. Refined experimental demonstrations of proof-of-concepts; continued development of realistic computational models. Conducted system trade studies with improved performance models to evaluate potential return on investment.					
FY 2012 Plans: Using data obtained from a hydrocarbon demonstrator engine, characterize, study, and evaluate injector performance to ensure chamber/injector compatibility and prevent damage to engines. Validate study results in more realistic rocket-chamber conditions and transition of predictive tools to industry. Feed advanced combustion device technology into hydrocarbon boost efforts, continue additional analysis on changing designs and concepts. 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 modeling and simulation capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models. Conduct system trade studies with improved performance models to evaluate potential return on investment.					
FY 2013 Base Plans: Using data obtained from a hydrocarbon demonstrator engine, characterize, study, and evaluate injector performance to ensure chamber/injector compatibility and prevent damage to engines. Validate study results in more realistic rocket-chamber conditions and transition of predictive tools to industry. Begin efforts looking at multi-injector designs and control effectors. Feed advanced combustion device technology into a hydrocarbon boost demo and to various contractor designs, continue additional analysis on changing designs and concepts. 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 modeling and simulation capabilities. Perform pre-selection of most promising advanced propulsion concepts; apply realistic computational models to optimize performance. Refine experimental demonstrations of proof-of-concepts, continue development of realistic computational models.					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Conduct system trade studies with improved performance models to evaluate potential return on investment. Begin development of modeling tools for characterization of rocket plumes in air and space. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 3. ***Description:*** Develop advanced material applications for lightweight components and material property enhancements for current and future rocket propulsion systems. ***FY 2011 Accomplishments:*** Developed new advanced ablative components using hybrid polymers. Continued to characterize and finalize processing parameters of new nano-reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Developed new advanced materials for use with high-energy propellants. Continued to explore applications of nanocomposites for the hydrocarbon boost demo and other liquid rocket engine components and optimize processing technology using multifunctional nanomaterials. Continued to characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials exploring various transition opportunities. ***FY 2012 Plans:*** Develop new material formulations that better address the challenges inside solid rockets. Continue to characterize and finalize processing parameters of new reinforced high temperature polymers and scale-up processing of carbon-carbon materials. Refine formulations of polymers for use in various liquid rocket engine components. Continue to characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials exploring various transition opportunities. ***FY 2013 Base Plans:*** Develop new material formulations that better address the challenges inside solid rockets. Continue to characterize and finalize processing parameters of new reinforced high temperature polymers and scale-up processing of carboncarbon materials. Refine formulations of polymers for use in various liquid rocket engine components. Continue to characterize and understand the mechanisms behind a new class of hydrophobic and oleophobic materials exploring various transition opportunities. Decrease in FY 2013 due to higher Department of Defense priorities. ***FY 2013 OCO Plans:***	5.492	5.722	1.000	-	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
N/A					
Title: Major Thrust 4.	24.437	17.103	11.345	-	11.345
Description: Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles. ***FY 2011 Accomplishments:*** Developed enabling hydrocarbon boost technology for future spacelift concepts and continue risk reduction activities. Continued development of engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Developed advanced hydrocarbon engine technologies using fuels other than kerosene. Developed and demonstrated in-house, moderate scale liquid rocket component testing capability. Developed high performance compact liquid rocket engine technologies. Continued development and evaluation of bipropellant technologies. ***FY 2012 Plans:*** Continue development of enabling hydrocarbon boost technology for future spacelift concepts and continue risk reduction activities for the development of hydrocarbon boost technologies. Continue development of engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene. Develop and demonstrate in-house, moderate scale liquid rocket component testing capability. Develop high performance compact liquid rocket engine technologies. Continue development and evaluation of bipropellant technologies. Note: In FY 2012, efforts in this thrust are decreased due to higher AF priorities. ***FY 2013 Base Plans:*** Develop enabling hydrocarbon boost technology for future spacelift concepts and continue risk reduction activities for the development of hydrocarbon boost technologies. Continue development of engine health monitoring technologies supporting the hydrocarbon boost technology development effort. Develop advanced hydrocarbon engine technologies using fuels other than kerosene. Develop and demonstrate in-house, moderate scale liquid rocket component testing capability. Develop high performance compact liquid rocket engine technologies. Continue development and evaluation of bipropellant technologies. Note: In FY 2013, efforts in this thrust are decreased due to higher AF priorities. ***FY 2013 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
N/A					
Title: Major Thrust 5.	5.391	4.930	7.580	-	7.580
Description: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for satellites and satellite constellations. ***FY 2011 Accomplishments:*** Evaluated advanced plasma thrusters for microsatellites propulsion systems. Scale-up tested monopropellants, evaluated advanced ignition schemes and chamber concepts. Assessed advanced chemical propulsion technology developments for satellite thrusters; continued component developments. Developed advanced multi-mode chemical-electric propulsion concepts for satellites; continued component developments. Developed next generation high power electric spacecraft propulsion. Continued advanced modeling and simulation tool developments to improve design and analysis tools for a wide range of spacecraft propulsion concepts/ technologies. ***FY 2012 Plans:*** Characterize advanced plasma thrusters for microsatellites propulsion systems. Conduct scale-up of advanced monopropellants, evaluate advanced ignition schemes and chamber concepts. Assess advanced chemical propulsion technology developments for satellite thrusters and continue component developments. Develop advanced multi-mode chemical-electric propulsion concepts for satellites and continue component developments. Continue development of next generation high power electric spacecraft propulsion. Continue advanced modeling and simulation tool developments to improve design and analysis tools for a wide range of spacecraft propulsion concepts/technologies. ***FY 2013 Base Plans:*** Continue characterization of advanced plasma thrusters for microsatellites propulsion systems. Conduct scale-up of advanced monopropellants, evaluate advanced ignition schemes and chamber concepts. Assess advanced chemical propulsion technology developments for satellite thrusters and continue component developments. Develop advanced multi-mode chemical-electric propulsion concepts for satellites and continue component developments. Continue development of next generation high power electric spacecraft propulsion. Continue advanced modeling and simulation tool developments to improve design and analysis tools for a wide range of spacecraft propulsion concepts/technologies. Begin exploration into new generation of bipropellant					

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
spacecraft thruster technologies. Note: In FY 2013, efforts in this thrust are increased due to higher AF priorities. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 6. ***Description:*** Develop missile propulsion and boost technologies for space access and strike applications. ***FY 2011 Accomplishments:*** Continued the component development and risk reduction efforts for future Missile Propulsion demonstration. Demonstrated components for solid rocket motors. Developed advanced tactical propulsion technologies. Continued development and evaluation of next generation of updated, physics-based modeling, simulation, and analysis tools for missile propulsion components and applications. Completed sub-scale propellant development efforts. ***FY 2012 Plans:*** Test components as part of risk reduction efforts for future missile propulsion demonstration. Develop advanced tactical propulsion technologies. Continue development and evaluation of next generation of updated, physics-based modeling, simulation, and analysis tools for missile propulsion components and applications. ***FY 2013 Base Plans:*** Develop advanced tactical propulsion technologies. Continue development and evaluation of next generation of updated, physics-based modeling, simulation, and analysis tools for missile propulsion components and applications. ***FY 2013 OCO Plans:*** N/A	7.791	14.884	11.784	-	11.784
Title: Major Thrust 7. ***Description:*** Develop missile propulsion technologies and aging and surveillance technologies for ballistic missiles. ***FY 2011 Accomplishments:*** Conducted advanced service life prediction technology program. Developed and applied existing and advanced sensors to be attached to solid rocket motors and tools that can integrate sensor data into existing aging	2.029	5.444	9.610	-	9.610

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
and surveillance tool suite. Continued efforts to integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Continued development of next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. ***FY 2012 Plans:*** Conduct sub-scale testing of existing and advanced sensors to be attached to solid rocket motors and tools that can integrate sensor data into existing aging and surveillance tool suite. Integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Apply next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. ***FY 2013 Base Plans:*** Conduct sub-scale testing of existing and advanced sensors to be attached to solid rocket motors and tools that can integrate sensor data into existing aging and surveillance tool suite. Integrate advanced aging and surveillance technologies into demonstrations to validate and verify efforts to reduce uncertainties and accurately model motor behavior. Apply next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. Note: In FY 2013, efforts in this thrust are increased due to higher AF priorities. ***FY 2013 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	56.966	60.390	55.293	-	55.293

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• N/A: *N/A*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 624847: *Rocket Propulsion Technology*

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force			DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 625330: *Aerospace Fuel Technology*	

COST ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
625330: *Aerospace Fuel Technology*	6.480	6.239	5.494	-	5.494	5.475	5.275	5.312	5.426	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Title: Major Thrust 1. ***Description:*** Conduct evaluations and perform technical assessments of alternative hydrocarbon fuels derived from coal, natural gas, and biomass for use in legacy and advanced aerospace systems. ***FY 2011 Accomplishments:*** Completed component "fit-for-purpose" evaluations of up to 100 percent synthetic paraffinic kerosene (SPK) and made recommendation as to maximum SPK in blend use. Completed initial evaluations of biomass derived aviation fuels and assessment of associated carbon dioxide footprint. Conducted follow-on component evaluations as available fuel quantities permit. ***FY 2012 Plans:*** Develop link between fully-synthetic fuel composition and basic physical properties and rig test performance. ***FY 2013 Base Plans:*** Decrease in FY 2013 due to higher Department of Defense priorities. ***FY 2013 OCO Plans:*** N/A	3.087	3.151	-	-	-
Title: Major Thrust 2.	1.100	1.088	-	-	-

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APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 625330: *Aerospace Fuel Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Description: Develop and demonstrate advanced components and conduct performance assessments of advanced aircraft integrated thermal and energy management systems for engines and aircraft. ***FY 2011 Accomplishments:*** Assessed advanced aircraft thermal management designs. Developed and assessed techniques to improve the thermal characteristics of aviation fuels used in integrated thermal and energy management systems. Developed advanced hydrocarbon based endothermic fuel technologies applicable to combined cycle engines. ***FY 2012 Plans:*** Assess advanced catalyst approaches to enhancing heat sink in hydrocarbon-based endothermic fuels. ***FY 2013 Base Plans:*** Decrease in FY 2013 due to higher Department of Defense priorities. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 3. ***Description:*** Study and evaluate low-cost approaches to reduce fuel logistics footprint to reduce cost. Study fuel logistics vulnerabilities and develop detection and mitigation technologies. ***FY 2011 Accomplishments:*** Assessed aberrant logistical fuels to support field operations and investigate impact of novel corrective actions. Evaluated low-cost fuel additives and assessment of the impact on biological growth in fuel. Continued the investigation of actions to mitigate the growth of biological agents in fuel. Investigated the development of biological mutations in fuel leading to the development of resistance to chemical biocides and antifungal agents. ***FY 2012 Plans:*** Develop biological growth mitigation approaches for commercial jet fuels in support of AF effort to implement commercial off-the-shelf jet fuels. Evaluate approaches for portable hydrogen generation to support emergency field power generation. ***FY 2013 Base Plans:***	1.000	1.000	5.494	-	5.494

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Assess impact of conversion to commercial jet fuel (without JP-8 additives) on biological growth in base fuel systems. Note: In FY 2013, efforts in this thrust are increased due to higher AF priorities. ***FY 2013 OCO Plans:*** N/A					
Title: Major Thrust 4. ***Description:*** Develop and test advanced emissions diagnostic techniques for airbreathing propulsion systems. Conduct evaluations of the combustion and emissions characteristics of aviation fuels. ***FY 2011 Accomplishments:*** Developed diagnostic protocols for aircraft ground emissions measurements and performed emissions evaluations on fielded engines to investigate particulate formation and composition. Developed emissions diagnostics applicable to advanced high pressure combustor systems. Assessed combustion emissions from biomass derived aviation fuels. Conducted assessment of combustion emissions from blends of coal/biomass derived aviation fuels. ***FY 2012 Plans:*** Implement advanced particulate diagnostics in high-pressure combustor test rig. Assess emissions from fully-synthetic fuels relative to JP-8 and JP-8/synthetic blends. ***FY 2013 Base Plans:*** Decrease in FY 2013 due to higher Department of Defense priorities. ***FY 2013 OCO Plans:*** N/A	1.293	1.000	-	-	-
Accomplishments/Planned Programs Subtotals	6.480	6.239	5.494	-	5.494

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total	FY 2014	FY 2015	FY 2016	FY 2017	Cost To Complete	Total Cost
• N/A: *N/A*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2013 Air Force		DATE: February 2012
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 2: *Applied Research*	R-1 ITEM NOMENCLATURE PE 0602203F: *Aerospace Propulsion*	PROJECT 625330: *Aerospace Fuel Technology*

E. Performance Metrics

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