Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Air Force											Date: February 2018	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*					R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	104.695	104.499	115.462	0.000	115.462	115.610	117.682	115.734	118.075	Continuing	Continuing
632480: *Aerospace Fuels*	-	2.054	2.302	2.340	0.000	2.340	2.386	2.434	2.483	2.532	Continuing	Continuing
633035: *Aerospace Power Technology*	-	21.229	13.934	23.954	0.000	23.954	22.170	22.375	18.492	18.866	Continuing	Continuing
634921: *Aircraft Propulsion Subsystems Int*	-	17.896	17.902	18.058	0.000	18.058	18.400	18.767	19.147	19.537	Continuing	Continuing
634922: *Space & Missile Rocket Propulsion*	-	26.313	28.799	29.264	0.000	29.264	29.847	30.443	31.062	31.690	Continuing	Continuing
635098: *Advanced Aerospace Propulsion*	-	22.622	28.797	20.194	0.000	20.194	20.595	21.009	21.435	21.867	Continuing	Continuing
63681B: *Advanced Turbine Engine Gas Generator*	-	14.581	12.765	21.652	0.000	21.652	22.212	22.654	23.115	23.583	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program develops and demonstrates technologies to achieve enabling and revolutionary advances in turbine, advanced-cycle, rocket, and space propulsion as well as electrical power, thermal management, and fuels. The program has six projects, each focusing on technologies with a high potential to enhance the performance of existing and future Air Force weapon systems. The Aerospace Fuels project develops and demonstrates improved hydrocarbon fuels and advanced propulsion systems, including those for air-breathing, high-speed/hypersonic flight. The Aerospace Power Technology project develops and demonstrates adaptive power and thermal management components, controls, and systems for high-power payloads and aircraft as part of energy-optimized aircraft development. The Aircraft Propulsion Subsystems Integration (ASPI) project develops demonstrator engines by integrating the engine cores demonstrated in the Advanced Turbine Engine Gas Generator project with low-pressure components. The Space and Missile Rocket Propulsion project develops and demonstrates innovative rocket propulsion technologies, propellants, and manufacturing techniques. The Advanced Aerospace Propulsion project develops the scramjet propulsion cycle to a technology readiness level appropriate for in-flight demonstration and for full integration with other engine cycles (including turbine and rocket based). The Advanced Turbine Engine Gas Generator project develops and demonstrates core turbine engine technologies for current and future aircraft propulsion systems.

Portions of the Aerospace Fuels, ASPI, and Advanced Turbine Gas Generator projects support adaptive cycle technology demonstrations, which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

Projects in this program have been coordinated through the Department of Defense (DoD) Science and Technology (S&T) Executive Committee process to harmonize efforts and eliminate duplication.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Air Force	Date: February 2018
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*

This program element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602601F, 0602602F, 0602605F, 0602788F, 1206601F, and 0602298F.

This effort is in Budget Activity 3, Advanced Technology Development, because this budget activity includes development of subsystems, components, and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	94.594	104.499	112.332	0.000	112.332
Current President's Budget	104.695	104.499	115.462	0.000	115.462
Total Adjustments	10.101	0.000	3.130	0.000	3.130
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	15.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-1.254	0.000			
• SBIR/STTR Transfer	-3.645	0.000			
• Other Adjustments	0.000	0.000	3.130	0.000	3.130

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 633035: *Aerospace Power Technology*		
Congressional Add: *Silicon Carbide Research*	14.506	0.000
Congressional Add Subtotals for Project: 633035	14.506	0.000
Congressional Add Totals for all Projects	14.506	0.000

Change Summary Explanation

Increase in FY 2019 due to realignment of funds for High-Speed Strike Weapon (HSSW).

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*	Project (Number/Name) 632480 / *Aerospace Fuels*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
632480: *Aerospace Fuels*	-	2.054	2.302	2.340	0.000	2.340	2.386	2.434	2.483	2.532	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project evaluates and demonstrates improved hydrocarbon fuels, unique special application fuels, alternate fuels and advanced, novel aerospace propulsion technologies for Air Force applications, including high-speed and hypersonic flight and technologies to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. The advanced fuel emphasis is on demonstrating new thermally stable, high-heat sink, and controlled chemically reacting fuels for a conventional turbine engine, turbine-based combined cycle engines, and other advanced propulsion systems. The project also evaluates and demonstrates fuel system components that minimize cost, reduce maintenance, and improve performance of future aerospace systems. The advanced propulsion emphasis is on demonstrating concepts for combined cycle, ramjet, and scramjet engines. A portion of this project supports the demonstration of adaptive cycle technologies. This project develops component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, and durability for widely varying mission needs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Fuel-Related Thermal Management	0.601	0.674	0.685
Description: Demonstrate thermally stable fuels and fuel system hardware concepts to enhance cooling capacity (performance), minimize fuel coking, and reduce fuel system maintenance.			
FY 2018 Plans: Continue investigation of fuel heat sink approaches for thermal management of adaptive engines, including on-board fuel deoxygenation.			
FY 2019 Plans: Continue investigation of fuel heat sink approaches for thermal management of adaptive engines, including on-board fuel deoxygenation.			
FY 2018 to FY 2019 Increase/Decrease Statement: FY 2019 increased compared to FY 2018 by $0.011 million. Justification for the increase is described in the plans above.			
Title: Gas Turbine Combustion, Emissions, and Performance	0.545	0.611	0.621
Description: Develop and demonstrate efficacy of low-cost, environmentally friendly fuel approaches to assess and reduce soot/ particulate emissions from gas turbine engines.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 632480 / *Aerospace Fuels*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Initiate development of augmentor combustor/simulator to determine fuel effects on augmentor operability under realistic conditions. ***FY 2019 Plans:*** Contnue development of augmentor combustor/simulator to determine fuel effects on augmentor operability under realistic conditions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.010 million. Justification for the increase is described in the plans above.			
Title: Fuel Logistics ***Description:*** Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Air Force. ***FY 2018 Plans:*** Complete evaluation of advanced additives for water sequestration and mitigation of biological growth. ***FY 2019 Plans:*** Initiate development of fuel composition in-situ sensors to ensure thermal stability throughout platform mission. Initiate development of fuel sensors and mitigation products to detect and mitigate fuel bio-contamination. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.014 million. Justification for the increase is described in the plans above.	0.726	0.813	0.827
Title: Alternative Jet Fuels ***Description:*** Characterize and demonstrate the use of alternative hydrocarbon jet fuel to comply with Air Force certifications and standards for jet fuels. ***FY 2018 Plans:*** Continue development of generic alternative fuel specification annexes for commercial jet fuels used by Air Force. ***FY 2019 Plans:*** Continue development of generic alternative fuel specification annexes for commercial jet fuels used by Air Force. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.003 million. Justification for the increase is described in the plans above.	0.182	0.204	0.207
Accomplishments/Planned Programs Subtotals	2.054	2.302	2.340

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 632480 / *Aerospace Fuels*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*	Project (Number/Name) 633035 / *Aerospace Power Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
633035: *Aerospace Power Technology*	-	21.229	13.934	23.954	0.000	23.954	22.170	22.375	18.492	18.866	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates system and subsystem integration to include adaptive architectures, actuation, electrical power, thermal management, and distribution for aerospace applications. This project develops and demonstrates the components, controls and systems required to satisfy the operational needs of current and future aircraft as well as to enable the use of future high-power payloads. This technology enhances reliability and survivability, and reduces vulnerability, weight, and life cycle costs of air platforms. The electrical power system components developed are projected to provide a two-fold to five-fold improvement in aircraft reliability and maintainability, and a reduction in power system weight. This project is integrated into energy optimized aircraft efforts and power and thermal programs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: High Power Aircraft Subsystem Technologies	6.723	13.934	23.954
Description: Develop and demonstrate integrated architecture, controls and components for power generation, conditioning, and distribution; energy storage components; and thermal management and subsystem technologies for integration into high power aircraft.			
FY 2018 Plans: Continue development and demonstration of system and component electrical power, electro-mechanical, and thermal technologies for high-power aircraft. Continue development of actuation technology for applications with power, volume, and thermal limitations. Continue the development of hybrid-cycle power and thermal management system. Continue development of advanced power generation and distribution system. Continue development and demonstration of integrated, adaptive megawatt-class tactical aircraft power and thermal capability. Initiate development and demonstration of megawatt class architecture, controls and integration. Initiate development and demonstration of robust electrical power systems for megawatt applications. Initiate development and demonstration of thermal management systems for megawatt applications. Initiate development and demonstration of solid state electrical distribution technology for megawatt applications.			
FY 2019 Plans: Continue development and demonstration of system and component electrical power, electro-mechanical, and thermal technologies for high-power aircraft. Continue development of actuation technology for applications with power, volume, and thermal limitations. Continue the development of hybrid-cycle power and thermal management system. Continue development of advanced power generation and distribution system. Continue development and demonstration of integrated, adaptive megawatt-class tactical aircraft power and thermal capability. Continue development and demonstration of megawatt class architecture, controls and integration. Continue development and demonstration of robust electrical power systems for megawatt applications.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 633035 / *Aerospace Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Continue development and demonstration of thermal management systems for megawatt applications. Continue development and demonstration of solid state electrical distribution technology for megawatt applications. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $10.020 million. Justification for the increase is due to increased emphasis in high power aircraft subsystems.			
Accomplishments/Planned Programs Subtotals	6.723	13.934	23.954

	FY 2017	FY 2018
Congressional Add: Silicon Carbide Research ***FY 2017 Accomplishments:*** Conducted Congressionally directed efforts. ***FY 2018 Plans:*** N/A	14.506	0.000
Congressional Adds Subtotals	14.506	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*	Project (Number/Name) 634921 / *Aircraft Propulsion Subsystems Int*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
634921: *Aircraft Propulsion Subsystems Int*	-	17.896	17.902	18.058	0.000	18.058	18.400	18.767	19.147	19.537	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates technology to increase turbine engine operational reliability, durability, mission flexibility, and performance while reducing weight, fuel consumption, and cost of ownership. The Aircraft Propulsion Subsystems Integration (APSI) project includes demonstrator engines for manned systems and efficient small-scale propulsion for remotely piloted aircraft and cruise missile applications. The demonstrator engines integrate the core (high- pressure spool) technology developed under the Advanced Turbine Engine Gas Generator (ATEGG) project with the engine (low-pressure spool) technology such as fans, turbines, engine controls, mechanical systems, exhaust nozzles, and augmentors. Additionally, this project includes activities to improve propulsion safety and readiness. This project also focuses on integration of inlets, nozzles, engine-to-airframe compatibility, and power and thermal management subsystems technologies. The APSI project provides aircraft with potential for longer range and higher cruise speeds with lower specific fuel consumption, surge power for successful engagements, high sortie rates with reduced maintenance, reduced life cycle cost, and improved survivability, resulting in increased mission effectiveness. Technologies developed are applicable to sustained high-speed vehicles and responsive space launch. The APSI project is focused on improving propulsion capabilities while at the same time reducing the cost of ownership. Anticipated technology advances include turbine engine improvements providing approximately twice the range for a sustained supersonic combat aircraft, doubling the time on station with ten times the power output for surveillance aircraft and propulsion for a high speed supersonic missile with double the range for time sensitive targets. A portion of this project supports the demonstration of adaptive cycle technologies, which develop component technology for an adaptive cycle engine architecture that provides optimized performance, fuel efficiency, high power extraction, integrated thermal management, and durability for widely varying mission needs.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Missile/Remotely Piloted Aircraft Engine Performance	10.650	10.653	10.746
Description: Design, fabricate, and test component technologies for limited-life engines to improve the performance, durability, and affordability of missile and remotely piloted aircraft engines.			
FY 2018 Plans: Complete supersonic turbojet engine altitude testing. Complete Preliminary Design Review (PDR) of medium-scale efficient core demonstrator. Initiate detailed design of medium-scale efficient core demonstrator. Continue risk reduction testing of components for 200lb thrust and 650lb thrust engines. Complete PDR of 200lb thrust engine and Critical Design Review (CDR) of 650lb thrust engine. Complete PDR of durability test utilizing small scale cruise missile engine to validate advanced design and life prediction tools for medium and large engine applications. Continue the development of derivative supersonic turbojet engines for missile			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 634921 / *Aircraft Propulsion Subsystems Int*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and high speed accelerators. Initiate design of advanced turbine based accelerator with reusable hypersonics applications. Continue the assessment of Air Force Research Laboratory (AFRL) vehicle and propulsion system integration efforts. ***FY 2019 Plans:*** Complete detailed design of and CDR of a medium-scale efficient core demonstrator. Initiate risk reduction component testing of a medium-scale efficient core demonstrator. Continue risk reduction testing of components for 200lb thrust and 650lb thrust engines. Complete CDR of 200lb thrust engine. Completion of testing of 650lb engine. Complete CDR of durability test utilizing small scale cruise missile engine to validate advanced design and life prediction tools for medium and large engine applications. Continue the development of derivative supersonic turbojet engines for missile and high speed accelerators. Continue design of advanced turbine based accelerator with reusable hypersonics applications. Continue the assessment of AFRL vehicle and propulsion system integration efforts. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.093 million. Justification for this increase is described in the plans above.			
Title: Adaptive Turbine Engine Technologies ***Description:*** Design, fabricate, and demonstrate performance, durability, and operability technologies to mature adaptive turbine engine technologies. ***FY 2018 Plans:*** Complete ground testing of experimental adaptive turbine engine core. Initiate and complete the assessment of the acquired and processed data from the ground testing of experimental adaptive turbine engine core and comparison to analytical prediction tools to validate reduced specific fuel consumption, improved thrust-to-weight, and reduced cost. Continue to provide subject matter expert support to Adaptive Engine Transition Program (AETP) to ensure knowledge transition and successful incorporation of test results into AETP design. Initiate and complete design for integrated power and thermal management engine demonstrator to facilitate investigation and mapping of off-design operations for integrated propulsion, power and thermal management. Initiate hardware fabrication for an adaptive engine for utilization as an integrated power and thermal management engine demonstrator. ***FY 2019 Plans:*** Continue to provide subject matter expert support to AETP. Complete fabrication of components for integrated power and thermal management engine demonstrator. Continue hardware fabrication for an adaptive engine for utilization as an integrated power and thermal management engine demonstrator. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.063 million. Justification for this increase is described in the plans above.	7.246	7.249	7.312
Accomplishments/Planned Programs Subtotals	17.896	17.902	18.058

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 634921 / *Aircraft Propulsion Subsystems Int*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*	Project (Number/Name) 634922 / *Space & Missile Rocket Propulsion*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
634922: *Space & Missile Rocket Propulsion*	-	26.313	28.799	29.264	0.000	29.264	29.847	30.443	31.062	31.690	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates advanced and innovative low-cost rocket turbo-machinery and components, and low-cost space launch propulsion technologies. Additionally, this project develops technologies for the sustainment of strategic systems (including solid rocket motor boosters and missile propulsion, post boost control, and aging and surveillance efforts) and tactical rockets. Characteristics such as environmental acceptability, affordability, reliability, responsiveness, reduced weight, and reduced operation and launch costs are emphasized. Increased life and performance of propulsion systems are key goals. Technology areas investigated include ground demonstrations of compact, lightweight, advanced propulsion technologies, higher efficiency energy conversion systems (derived from an improved understanding of combustion fundamentals), and high-energy propellants. Technological advances in this project could improve the performance of expendable payload capabilities by approximately twenty to fifty percent and reduce launch, operations, and support costs by approximately thirty percent. Responsiveness and operability of propulsion systems will be enhanced for reusable launch systems. Aging and surveillance thrusts for solid rocket motors could reduce lifetime prediction uncertainties for individual motors by fifty percent, enabling motor replacement for cause. The thrusts in this project contribute to the sustainment of the rocket propulsion industry, providing rocket propulsion technology for the entire DoD and National Aeronautics and Space Administration (NASA). The thrusts in this project are part of the Rocket Propulsion 21 (RP21) program. The thrusts in this project are reviewed by a DoD level steering committee annually for relevance to DoD missions and achievement of technical goals defined by the RP21 program.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Liquid Rocket Propulsion Technologies	19.837	20.923	19.314
Description: Develop liquid rocket propulsion technology for current and future space launch vehicles.			
FY 2018 Plans: Complete development of hydrocarbon engine components and initiate preparation for integrated testing. Complete testing of the full-scale preburner. Continue fabrication of the Turbopump. Initiate study for next generation liquid propulsion technology demonstration effort focused on modularity and cost reduction.			
FY 2019 Plans: Complete preparation for integrated testing. Complete fabrication of the Turbopump. Continue study for next generation liquid propulsion technology demonstration effort focused on modularity and cost reduction. Initiate integrated testing of hydrocarbon engines components			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 634922 / *Space & Missile Rocket Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2019 decreased compared to FY 2018 by $1.609 million. Justification for the decrease is due to a decreased emphasis in liquid rocket propulsion technology.			
Title: On-Orbit Propulsion Technologies ***Description:*** Develop solar electric, electric, and monopropellant propulsion technologies for existing and future satellites, upper stages, orbit transfer vehicles, and satellite maneuvering. ***FY 2018 Plans:*** Continue to develop and transition experimental, modeling and simulation, and theoretical efforts geared towards advanced thruster development with additional emphasis on understanding thrust scale-up. Initiate the extension of the capability to study next generation of hypergolic fuels, including propellant characterization, drop-in testing, and lab-scale thruster demonstration. Continue analysis and development of multimode propulsion opportunities to combine high efficiency and high thrust capabilities on a common propellant. ***FY 2019 Plans:*** Continue to develop and transition experimental, modeling and simulation, and theoretical efforts geared towards advanced thruster development with additional emphasis on understanding thrust scale-up. Continue to extend capability to study next generation of hypergolic fuels, including propellant characterization, drop-in testing, and lab-scale thruster demonstration. Continue analysis and development of multi mode propulsion opportunities to combine high efficiency and high thrust capabilities on a common propellant. Initiate thrust scale-up effort for advanced non-toxic mono-propellant thrusters. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $0.107 million. Justification for the increase is described in the plans above.	0.464	1.649	1.756
Title: Ballistic Missile Technologies ***Description:*** Develop and demonstrate missile propulsion and post-boost control systems technologies for ballistic missiles. ***FY 2018 Plans:*** Continue technology demonstration effort on advanced missile case, insulation, and nozzle technologies and validation of physics-based modeling, simulation, and analysis tools for ballistic and tactical missile solid rocket motors. Continue technology maturation and demonstration efforts for post-boost technologies and tactical missile technologies. ***FY 2019 Plans:***	4.792	2.664	4.682

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 634922 / *Space & Missile Rocket Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Complete technology demonstration effort on advanced missile case, insulation, and nozzle technologies and validation of physics-based modeling, simulation, and analysis tools for ballistic and tactical missile solid rocket motors. Continue technology maturation and demonstration efforts for post-boost technologies and tactical missile technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $2.018 million. Justification for the increase is an increased emphasis in ballistic missile technologies.			
Title: Strategic System Motor Surveillance ***Description:*** Develop and demonstrate aging and surveillance technologies for strategic systems to reduce lifetime prediction uncertainty for individual motors, enabling motor replacement for cause. ***FY 2018 Plans:*** Continue to apply next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. Continue advanced sensor analysis development efforts to further improve data acquisition and reduce uncertainty in ballistic missile life predictions. Continue to improve the fidelity and precision of non-destructive evaluation tools to increase the capability to determine flaw size, orientation, and location. Continue the support of transition of previous tools, models, data management system to user. Continue long-term validation of tools through long-term aging of sub-scale motors. Continue sub-scale motors dissection to validate the sensor and analytical analysis of each motor. Initiate maturation and demonstration of advanced sensor, non-destructive evaluation, modeling and supporting technology development efforts to detect and explain phenomena to further improve data acquisition and reduce uncertainty in ballistic and tactical missile solid rocket motor life predictions. ***FY 2019 Plans:*** Continue to apply next generation of chemical and aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, and non-destructive analysis tools. Continue advanced sensor analysis development efforts to further improve data acquisition and reduce uncertainty in ballistic missile life predictions. Continue to improve the fidelity and precision of non-destructive evaluation tools to increase the capability to determine flaw size, orientation, and location. Continue to support the transition of previous tools, models, data management system to user. Continue long-term validation of tools through long-term aging of sub-scale motors. Continue sub-scale motors dissection to validate the sensor and analytical analysis of each motor. Continue maturation and demonstration of advanced sensor, non-destructive evaluation, modeling and supporting technology development efforts to detect and explain phenomena to further improve data acquisition and reduce uncertainty in ballistic and tactical missile solid rocket motor life predictions. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	1.220	3.563	3.512

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 634922 / *Space & Missile Rocket Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2019 decreased compared to FY 2018 by $0.051 million. Justification for the decrease is described in the plans above.			
Accomplishments/Planned Programs Subtotals	26.313	28.799	29.264

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force			Date: February 2018
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*	Project (Number/Name) 635098 / *Advanced Aerospace Propulsion*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
635098: *Advanced Aerospace Propulsion*	-	22.622	28.797	20.194	0.000	20.194	20.595	21.009	21.435	21.867	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops and demonstrates, via ground and flight tests, the scramjet propulsion cycle to a technology readiness level appropriate for full integration with other engine cycles (including turbine and rocket-based) to provide the Air Force with transformational military capabilities. The primary focus is on the hydrocarbon-fueled, scramjet engine. Multi-cycle engines will provide the propulsion systems for possible application to support aircraft and weapon platforms operating up to Mach 7. Thrusts include: scramjet flow-path optimization to enable operation over the widest possible range of Mach numbers; active combustion control to assure continuous positive thrust (even during mode transition); robust flame-holding to maintain stability through flow distortions; and maximized volume-to-surface area to minimize the thermal load imposed by the high-speed engine. Thermal management plays a vital role in scramjet and combined cycle engines, including considerations for protecting low speed propulsion systems (e.g., turbine engines) during hypersonic flight.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Scramjet Technologies	22.622	28.797	20.194
Description: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation up to Mach 7.			
FY 2018 Plans: Initiate the design and analyze flight weight, medium scale high-speed propulsion systems in preparation for future ground test. Continue development and demonstration of tactically compliant subsystems, including scramjet engine start system, fuel system, and engine controls. Initiate direct-connect test of tactically compliant cold start system in flight weight hardware. Continue development of scramjet technologies to enhance operability including robust operation during maneuvers. Complete direct connect testing of medium scale engine components at the Aerodynamic and Propulsion Test Unit (APTU) in support of reusable air platform technology development.			
FY 2019 Plans: Initiate scramjet combustor maturation efforts for flight-compliant designs based on results from direct connect testing of medium scale engine components at APTU. Continue development and demonstration of tactically compliant subsystems, including scramjet engine start system, fuel system, and engine controls. Continue development of scramjet technologies to enhance operability including robust operation during maneuvers. Continued accelerated development and demonstration of tactically-relevant long range high speed strike scramjet engine technologies including ground and flight demonstrations needed for potential follow-on acquisition program.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 635098 / *Advanced Aerospace Propulsion*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2019 decreased compared to FY 2018 by $8.603 million. Justification for the decrease is due to realignment for hypersonics and laser technology.			
Accomplishments/Planned Programs Subtotals	22.622	28.797	20.194

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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 2019 Air Force											Date: February 2018	
Appropriation/Budget Activity 3600 / 3					R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*				Project (Number/Name) 63681B / *Advanced Turbine Engine Gas Generator*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
63681B: *Advanced Turbine Engine Gas Generator*	-	14.581	12.765	21.652	0.000	21.652	22.212	22.654	23.115	23.583	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019**
Title: Core Engine Technologies	6.241	5.463	9.268
Description: Design, fabricate, and demonstrate performance predictions in core engines, using innovative engine cycles and advanced materials for turbofan and for turbojet engines. ***FY 2018 Plans:*** Complete Preliminary Design Review (PDR) of medium-scale efficient core demonstrator. Initiate detailed design of medium-scale efficient core demonstrator. Initiate design of large-scale adaptive core concepts. Complete green run and baseline testing of a small cruise missile size engines for use as future sustainment demonstrator. Initiate detailed design of bladed disks and bearing systems components for small cruise missile size engine. Initiate development of small cruise missile engine demonstrator test plans to improve life prediction capability. ***FY 2019 Plans:*** Complete design and Critical Design Review (CDR) of medium-scale efficient core demonstrator. Initiate risk reduction component tests for medium-scale engine advanced fan and core. Initiate build of medium-scale engine. Complete design and CDR of large-scale adaptive core concepts. Complete development of small cruise missile engine demonstrator test plans to			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 63681B / *Advanced Turbine Engine Gas Generator*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
improve life prediction capability for bladed disks and bearing systems. Complete design and CDR of bladed disks and bearing systems components for small cruise missile size engine. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $3.805 million. Justification for the increase is due to an increased emphasis engine technologies.			
Title: High Pressure Ratio Core Engine Technologies ***Description:*** Design, fabricate, and demonstrate high overall pressure ratio engine cores to provide increased durability and affordability with lower fuel consumption for turbofan and for turboshaft engines. ***FY 2018 Plans:*** Continue risk reduction testing of components for 200lb thrust and 650lb thrust engines. Complete Preliminary Design Review (PDR) of 200lb thrust engine and Critical Design Review (CDR) of 650lb thrust engine. Complete fabrication of advanced concept additive manufacturing heat exchanger for small core engines. Complete design and CDR of recouperator for demonstration of increased core efficiency in small core engines. ***FY 2019 Plans:*** Complete risk reduction testing of components for 200lb thrust and 650lb thrust engines. Complete CDR of 200lb thrust engine. Initiate assembly of advanced concept additive manufacturing heat exchanger for small core engines. Initiate fabrication of recouperator for demonstration of increased core efficiency in small core engines. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $1.380 million. Justification for the increase is due to an increased emphasis in engine technology.	2.264	1.982	3.362
Title: Adaptive Turbine Engine Core Technologies ***Description:*** Design, fabricate, and demonstrate adaptive turbine engine cores to provide increased durability and affordability with lower fuel consumption for turbofan and for turboshaft engines. ***FY 2018 Plans:*** Complete final ground testing of final Adaptive Engine Technology Demonstrator core demonstrator. Complete data reduction to validate predictions and provided technical information/lessons learned to Adaptive Engine Technology Program to ensure successful design. Continue design and initiate long lead procurement for advanced air dominance adaptive core demonstrator and risk reduction rigs. Complete the selection of technologies to be incorporated into adaptive engine demonstrator design. Initiate the evaluation of application of high temperature Polymer Matrix Composite (PMC) and Ceramic Matrix Composites	6.076	5.320	9.022

Exhibit R-2A, RDT&E Project Justification: PB 2019 Air Force		Date: February 2018
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 63681B / *Advanced Turbine Engine Gas Generator*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
(CMCs) to reduce system weight and improve cycle efficiency. Initiate analyses of adaptive engine technologies operational mission impact. ***FY 2019 Plans:*** Complete Preliminary Design Review and procurement of long lead hardware for advanced air dominance adaptive core demonstrator and risk reduction rigs. Initiate detailed design advanced air dominance adaptive core demonstrator. Initiate component tests of advanced variable turbine and innovative compression rear block designed to accept flow variations caused by variable turbine operation. Complete the evaluation of application of high temperature PMC and CMCs to reduce system weight and improve cycle efficiency. Complete analyses of adaptive engine technologies operational mission impact. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increased compared to FY 2018 by $3.702 million. Justification for the increase is due to an increased emphasis in engine technology.			
Accomplishments/Planned Programs Subtotals	14.581	12.765	21.652

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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.