Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	-	161.352	144.229	75.273	0.000	75.273	-	-	-	-	-	-
632480: *Aerospace Fuels*	-	2.386	2.434	0.000	0.000	0.000	-	-	-	-	-	-
633035: *Aerospace Power Technology*	-	39.670	104.795	18.216	0.000	18.216	-	-	-	-	-	-
634093: *Missile Rocket Propulsion Integ & Demo*	-	0.000	0.000	7.612	0.000	7.612	-	-	-	-	-	-
634921: *Aircraft Propulsion Subsystems Int*	-	18.016	0.000	11.610	0.000	11.610	-	-	-	-	-	-
634922: *Space & Missile Rocket Propulsion*	-	43.635	0.000	0.000	0.000	0.000	-	-	-	-	-	-
635098: *Advanced Aerospace Propulsion*	-	18.814	20.000	17.019	0.000	17.019	-	-	-	-	-	-
63681B: *Advanced Turbine Engine Gas Generator*	-	38.831	17.000	20.816	0.000	20.816	-	-	-	-	-	-

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 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.

All transfers detailed below are administrative realignments due to the stand up of the United States Space Force, and not new starts. This work will continue to be executed by the Air Force Research Laboratory Aerospace Systems Technology Directorate located in Wright Patterson Air Force Base, OH, Edwards Air Force Base, CA, or Arnold Air Force Base, TN.

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
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*

In FY 2022, the work and funding associated with advanced space technology demonstrations in PE 0603216F, Aerospace Propulsion, Project 634922, Space & Missile Rocket Propulsion, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206616SF, Space Advanced Technology Development/Demo, Project 634922, Space & Missile Rocket Propulsion, due to the creation of a new Appropriation for Space Force.

In FY 2022, the work and funding associated with missile rocket propulsion technologies in PE 0603216F, Aerospace Propulsion, are transferred from Project 634922, Space & Missile Rocket Propulsion, to Project 634093, Missile Rocket Propulsion Integ & Demo due to the creation of a new Appropriation for Space Force.

The Department of the Air Force technologies in this program are both enabling and enduring as we invest in maturing emerging technologies that address established mission gaps, and transformational technologies that address integrated enterprise capabilities intended to reshape the future force across air, space, and cyber warfighting domains. Development of transformational operational capabilities through advanced technology solutions focuses on five strategic capabilities: Global Persistent Awareness; Resilient Information Sharing; Rapid, Effective Decision-Making; Complexity, Unpredictability, and Mass; and Speed and Reach of Disruption and Lethality.

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, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 1206601SF, and 0602298F.

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.

This program is in Budget Activity 3, Advanced Technology Development because this budget activity includes development of subsystems and 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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	170.973	0.000	0.000	0.000	0.000
Current President's Budget	161.352	144.229	75.273	0.000	75.273
Total Adjustments	-9.621	144.229	75.273	0.000	75.273
• Congressional General Reductions	0.000	-0.263			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	57.000	37.000			
• Congressional Directed Transfers	0.000	107.492			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-5.632	0.000			
• Other Adjustments	-60.989	0.000	75.273	0.000	75.273

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force	Date: May 2021
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*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 633035: *Aerospace Power Technology*		
Congressional Add: *Program increase - silicon carbide research*	10.000	10.000
Congressional Add: *Program increase - multi-mode propulsion*	0.000	5.000
Congressional Add: *Program increase - low spool generator capabilites*	5.000	5.000
Congressional Add Subtotals for Project: 633035	15.000	20.000
Project: 634922: *Space & Missile Rocket Propulsion*		
Congressional Add: *Program increase - chemical apogee engines*	5.000	0.000
Congressional Add: *Program increase - upper stage engine maturation*	18.000	0.000
Congressional Add: *Program increase - space propulsion technologies*	2.000	0.000
Congressional Add: *Program increase - multi-mode propulsion*	0.000	0.000
Congressional Add Subtotals for Project: 634922	25.000	0.000
Project: 63681B: *Advanced Turbine Engine Gas Generator*		
Congressional Add: *Program increase - advanced turbine engine gas generator*	17.000	0.000
Congressional Add: *Program increase - small turbine engines for long range weapons*	0.000	17.000
Congressional Add Subtotals for Project: 63681B	17.000	17.000
Congressional Add Totals for all Projects	57.000	37.000

Change Summary Explanation

Increase in FY 2022 of 75.273 million is due to the following:

1) Congressional reversal of PE restructure

2) Realignment of Project 634922, Space & Missile Rocket Propulsion to PE 1206601SF, Project 634922, Space & Missile Rocket Propulsion, due to the creation of a new Appropriation for Space Force.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
632480: *Aerospace Fuels*	-	2.386	2.434	0.000	0.000	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

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.

This project includes the initiation and development of programs addressing DAF capability gaps and provides technologies for transformational future force capabilities. Transformational efforts will be identified through a competitive process and be responsive to DAF design priorities. Selected efforts will be designated as transformational, indicating enterprise-level priority.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Fuel-Related Thermal Management	0.731	0.746	0.000
Description: Demonstrate thermally stable fuels and fuel system hardware concepts to enhance cooling capacity (performance), minimize fuel coking, and reduce fuel system maintenance. ***FY 2021 Plans:*** Complete investigation of fuel heat sink approaches for thermal management of adaptive engines, such as on-board fuel deoxygenation. Complete investigation of heat exchangers including additive manufactured units. Complete the development of integrated test rigs to tests these approaches and assess efficiency of these approaches. ***FY 2022 Plans:*** Not applicable. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 funds decreased by 0.746 million compared to FY 2021. Justification for the decrease is described in plans above			
Title: Gas Turbine Combustion, Emissions, and Performance	0.621	0.633	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
Description: Develop and demonstrate efficacy of low-cost, environmentally friendly fuel approaches to assess and reduce soot/ particulate emissions from gas turbine engines. ***FY 2021 Plans:*** Complete advanced development of augmentor combustor/simulator to determine fuel effects on augmentor operability under realistic conditions. Complete study of fuel temperature limitations and use data to validate models. ***FY 2022 Plans:*** Not applicable. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 funds decreased by 0.633 million compared to FY 2021. Justification for the decrease is described in plans above.			
Title: Fuel Logistics ***Description:*** Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Air Force. ***FY 2021 Plans:*** Complete advanced development of fuel composition in-situ sensors to ensure thermal stability throughout platform mission. Complete advanced development of fuel sensors and mitigation products to detect and mitigate fuel bio-contamination. ***FY 2022 Plans:*** Not applicable. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 funds decreased by 0.844 million compared to FY 2021. Justification for the decrease is described in plans above.	0.827	0.844	0.000
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 2021 Plans:*** Complete development of generic alternative fuel specification annexes for commercial jet fuels used by Air Force. ***FY 2022 Plans:*** Not applicable. ***FY 2021 to FY 2022 Increase/Decrease Statement:***	0.207	0.211	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2022 funds decreased by 0.211 million compared to FY 2021. Justification for the decrease is described in plans above.			
Accomplishments/Planned Programs Subtotals	2.386	2.434	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
633035: *Aerospace Power Technology*	-	39.670	104.795	18.216	0.000	18.216	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

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 and enables 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.

This project includes the initiation and development of programs addressing DAF capability gaps and provides technologies for transformational future force capabilities. Transformational efforts will be identified through a competitive process and be responsive to DAF design priorities. Selected efforts will be designated as transformational, indicating enterprise-level priority.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: High Power Aircraft Subsystem Technologies	24.670	84.795	18.216
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 2021 Plans: Continue development and demonstration of system and component electrical power, electro-mechanical, and thermal technologies for high-power aircraft. 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. Continue development and demonstration of thermal management systems for megawatt applications. Complete development and demonstration of solid state electrical distribution technology for megawatt applications.			
FY 2022 Plans: Continue development and demonstration of system and component electrical power, electro-mechanical, and thermal technologies for high-power aircraft. Continue the development of hybrid-cycle power and thermal management system. Continue			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
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. Continue development and demonstration of thermal management systems for megawatt applications. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $66.579 million. Funding decrease due to reduced emphasis on high power aircraft subsystem technologies.			
Accomplishments/Planned Programs Subtotals	24.670	84.795	18.216

	FY 2020	FY 2021
Congressional Add: Program increase - silicon carbide research ***FY 2020 Accomplishments:*** Conduct Congressionally directed efforts. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	10.000	10.000
Congressional Add: Program increase - multi-mode propulsion ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Conduct Congressionally directed efforts. This effort will be executed in PE 0603216F Aerospace Propulsion & Power Technology, Project 634922 Space & Missile Rocket Propulsion.	0.000	5.000
Congressional Add: Program increase - low spool generator capabilites ***FY 2020 Accomplishments:*** Conduct Congressionally directed efforts. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	5.000	5.000
Congressional Adds Subtotals	15.000	20.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603216F / *Aerospace Propulsion and Power Technology*	Project (Number/Name) 634093 / *Missile Rocket Propulsion Integ & Demo*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
634093: *Missile Rocket Propulsion Integ & Demo*	-	0.000	0.000	7.612	0.000	7.612	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

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 and high-energy propellants. 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 efforts in this project contribute to the sustainment of the rocket propulsion industry, providing rocket propulsion technology for the entire Department of Defense (DoD). The efforts in this project are part of the Rocket Propulsion of the 21st Century (RP21) program. The efforts 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 2020	FY 2021	FY 2022
Title: Ballistic Missile Technologies	-	0.000	7.612
Description: Develop and demonstrate missile propulsion and post-boost control systems technologies for ballistic missiles.			
FY 2021 Plans: Before FY2022, this work is performed in PE 0603216F Aerospace Propulsion and Power Technology, Project 634922 Space & Missile Rocket Propulsion, Ballistic Missile Technologies effort.			
FY 2022 Plans: Continue development and test of solid rocket motors relevant to defense needs such as large air-launched boosters for high speed weapon application. Continue to design and develop modeling and simulation tools that more fully describe the physical processes that occur during manufacture and/or operation, and that reduce predictive uncertainty in design and analysis. Initiate development of advanced components and manufacturing processes for solid rocket motors including inert components, energetic components, and automated assembly operations.			
FY 2021 to FY 2022 Increase/Decrease Statement: FY 2022 increased compared to FY 2021 by $7.612 million. Funding increase is due to increased emphasis to demonstrate advanced components and manufacturing process and work transferring from PE 0603216F Aerospace Propulsion and Power			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 3	**R-1 Program Element (Number/Name)** PE 0603216F / *Aerospace Propulsion and Power Technology*	**Project (Number/Name)** 634093 / *Missile Rocket Propulsion Integ & Demo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Technology, Project 634922 Space & Missile Rocket Propulsion, Ballistic Missile Technologies effort to Project 634093 Missile Rocket Propulsion Integ & Demo.			
Accomplishments/Planned Programs Subtotals	-	0.000	7.612

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
634921: *Aircraft Propulsion Subsystems Int*	-	18.016	0.000	11.610	0.000	11.610	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

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 Versatile Affordable Advanced Turbine Engines (VAATE) 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 Aircraft Propulsion Subsystems Integration 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.

This project includes the initiation and development of programs addressing DAF capability gaps and provides technologies for transformational future force capabilities. Transformational efforts will be identified through a competitive process and be responsive to DAF design priorities. Selected efforts will be designated as transformational, indicating enterprise-level priority.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Missile/Remotely Piloted Aircraft Engine Performance	10.674	0.000	6.878
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 2021 Plans: Complete several key risk reduction testing of components for small engines. Finalize conceptual and preliminary design of small engine technology. Identify next innovative architecture, critical technologies and component designs for efficient small engines.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
Finalize the assembly of advanced concept additive manufacturing heat exchanger for small core engines. Finalize fabrication of recuperator for demonstration of increased core efficiency in small core engines. Initiate operational benefits analysis for missile and UAV systems. ***FY 2022 Plans:*** Continue next innovative architecture, critical technologies and component designs for efficient small engines. Continue operational benefits analysis for missile and unmanned aerial vehicle (UAV) systems. Initiate development of pervasive, hydrocarbon pressure gained propulsion fueled technologies. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $6.878 million. Funding increase due to increased emphasis on missile and remotely piloted aircraft engine performance.			
Title: Adaptive Turbine Engine Technologies ***Description:*** Design, fabricate, and demonstrate performance, durability, and operability technologies to mature adaptive turbine engine technologies. ***FY 2021 Plans:*** Analyze and evaluate conceptual design of adaptive engine technology and continue technology rig tests to decrease risk in core technology testing. Complete component tests of advanced variable turbine and innovative compression rear block designed to accept flow variations caused by variable turbine operation. ***FY 2022 Plans:*** Continue analyzing and evaluating conceptual design of adaptive engine technology and continue technology rig tests to decrease risk in core technology testing. Initiate maturation and integration of key technology through component and rig testing. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $4.732 million. Funding increase due to increased emphasis on adaptive turbine engine technologies.	7.342	0.000	4.732
Accomplishments/Planned Programs Subtotals	18.016	0.000	11.610

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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*

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
634922: *Space & Missile Rocket Propulsion*	-	43.635	0.000	0.000	0.000	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

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 efforts in this project contribute to the sustainment of the rocket propulsion industry, providing rocket propulsion technology for the entire Department of Defense (DoD) and National Aeronautics and Space Administration (NASA). The efforts in this project are part of the Rocket Propulsion 21st Century (RP21) program. The efforts 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.

This project includes the initiation and development of programs addressing DAF capability gaps and provides technologies for transformational future force capabilities. Transformational efforts will be identified through a competitive process and be responsive to DAF design priorities. Selected efforts will be designated as transformational, indicating enterprise-level priority.

In FY2022, the work and funding associated with space demonstrations in Project 634922, Space & Missile Rocket Propulsion, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206616SF, Project 634922, Space & Missile Rocket Propulsion, due to the creation of a new Appropriation for Space Force.

In FY2022, the work and funding associated with missile technology demonstrations in Project 634922, Space & Missile Rocket Propulsion, are transferred to Project 634093, Missile Rocket Propulsion Integ & Demo, due to the creation of a new Appropriation for Space Force.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Liquid Rocket Propulsion Technologies	10.063	0.000	0.000
Description: Develop liquid rocket propulsion technology for current and future space launch vehicles.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: Continue modular engine feasibility demonstration and flight experiment. ***FY 2022 Plans:*** In FY2022, the work and funding associated with space demonstrations in Project 634922, Space & Missile Rocket Propulsion, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206616SF, Project 634922, Space & Missile Rocket Propulsion, due to the creation of a new Appropriation for Space Force. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable.			
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 2021 Plans:*** Continue to develop and transition experimental, modeling and simulation, and theoretical efforts geared towards advanced thruster development with emphasis on understanding thrust scale-up. Continue to advance capabilities 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. Continue thrust scale-up effort for advanced non-toxic monopropellant thrusters. Continue electric propulsion thruster effort utilizing advanced non-toxic monopropellant. ***FY 2022 Plans:*** In FY2022, the work and funding associated with space demonstrations in Project 634922, Space & Missile Rocket Propulsion, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206616SF, Project 634922, Space & Missile Rocket Propulsion, due to the creation of a new Appropriation for Space Force. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable.	2.236	0.000	0.000
Title: Ballistic Missile Technologies ***Description:*** Develop and demonstrate missile propulsion and post-boost control systems technologies for ballistic missiles. ***FY 2021 Plans:***	3.914	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
Complete current technology maturation and demonstration efforts for post-boost technologies. Continue technology maturation and demonstration efforts for tactical missile technologies. Continue motor component modeling & simulation tool development, assessment, verification, and validations efforts geared towards reducing cost and schedule of new developments in an agile development landscape. ***FY 2022 Plans:*** In FY2022, the work and funding associated with missile technology demonstrations in Project 634922, Space & Missile Rocket Propulsion, are transferred to Project 634093, Missile Rocket Propulsion Integ & Demo, due to the creation of a new Appropriation for Space Force. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable.			
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 2021 Plans:*** Not applicable. ***FY 2022 Plans:*** Not applicable. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable.	2.422	0.000	0.000
Accomplishments/Planned Programs Subtotals	18.635	0.000	0.000

	FY 2020	FY 2021
Congressional Add: Program increase - chemical apogee engines ***FY 2020 Accomplishments:*** Conduct Congressionally directed efforts ***FY 2021 Plans:*** Not applicable.	5.000	0.000
Congressional Add: Program increase - upper stage engine maturation	18.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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*

	FY 2020	FY 2021
FY 2020 Accomplishments: Conduct Congressionally directed efforts ***FY 2021 Plans:*** Not applicable.		
Congressional Add: Program increase - space propulsion technologies ***FY 2020 Accomplishments:*** Conduct Congressionally directed efforts ***FY 2021 Plans:*** Not applicable.	2.000	0.000
Congressional Add: Program increase - multi-mode propulsion ***FY 2020 Accomplishments:*** Not applicable. ***FY 2021 Plans:*** Conduct Congressionally directed efforts.	0.000	0.000
Congressional Adds Subtotals	25.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
635098: *Advanced Aerospace Propulsion*	-	18.814	20.000	17.019	0.000	17.019	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

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. Efforts 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.

This project includes the initiation and development of programs addressing DAF capability gaps and provides technologies for transformational future force capabilities. Transformational efforts will be identified through a competitive process and be responsive to DAF design priorities. Selected efforts will be designated as transformational, indicating enterprise-level priority.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Scramjet Technologies	18.814	20.000	17.019
Description: Develop and demonstrate technologies for a hydrocarbon-fueled scramjet with robust operation up to Mach 7.			
FY 2021 Plans: Continue development of scramjet technologies to enhance operability including robust operation during maneuvers. Continue accelerated development and demonstration of tactically- relevant, long range, high speed strike scramjet engine designs, technologies, and components including ground and flight demonstrations needed for potential follow-on acquisition program. Initiate propulsion technology maturation activities for Multi-Mission Cruiser concept to expand performance capabilities of high speed systems.			
FY 2022 Plans: Continue development of scramjet technologies to enhance operability including robust operation during maneuvers and extended operating time. Continue development and demonstration of tactically-relevant, long range, high speed strike scramjet engine designs, technologies, and components including ground and flight demonstrations needed for potential follow-on acquisition			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
program. Continue propulsion technology maturation activities for Multi-Mission Cruiser concept to expand performance capabilities of high speed systems. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 decreased compared to FY 2021 by $2.981 million. Funding decreased due to reduced emphasis on scramjet technologies.			
Accomplishments/Planned Programs Subtotals	18.814	20.000	17.019

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
63681B: *Advanced Turbine Engine Gas Generator*	-	38.831	17.000	20.816	0.000	20.816	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

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 Aircraft Propulsion Subsystem Integration 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.

This project includes the initiation and development of programs addressing DAF capability gaps and provides technologies for transformational future force capabilities. Transformational efforts will be identified through a competitive process and be responsive to DAF design priorities. Selected efforts will be designated as transformational, indicating enterprise-level priority.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Core Engine Technologies	9.188	0.000	8.761
Description: Design, fabricate, and demonstrate performance predictions in core engines, using innovative engine cycles and advanced materials for turbofan and for turbojet engines.			
FY 2021 Plans: Complete detailed design of medium-scale efficient core demonstrator. Complete rig testing. Continue risk reduction component tests for medium-scale engine advanced fan and core. Complete conceptual design of large-scale adaptive core concepts. Complete design of bladed disks and bearing systems components for small cruise missile size engine. Complete development			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
of small cruise missile engine demonstrator test plans to improve life prediction capability for bladed disks and bearing systems. Initiate core tests for medium scale engines. ***FY 2022 Plans:*** Continue core tests for medium scale engines maturing key technologies. Initiate risk reduction component tests for medium-scale engine advanced fan and core. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $8.761 million. Funding increase due to increased emphasis on core 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 2021 Plans:*** Complete several key risk reduction testing of components for small engines (200-800 lbs class). Complete conceptual and preliminary design of small engine technology. Identify and assess innovative architecture, critical technologies and component designs for efficient, small engines. Continue assembly of advanced concept additive manufacturing heat exchanger for small core engines. Continue fabrication of recuperator for demonstration of increased core efficiency in small core engines. Continue to work medium scale core technologies. ***FY 2022 Plans:*** Continue assessing innovative architecture, critical technologies and component designs for efficient, small engines. Continue assembly of advanced concept additive manufacturing heat exchanger for small core engines. Continue fabrication of recuperator for demonstration of increased core efficiency in small core engines. Continue to work and mature medium scale core technologies. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $3.295 million. Funding increase due to increased emphasis on high pressure ratio core engine technologies.	3.456	0.000	3.295
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 2021 Plans:***	9.187	0.000	8.760

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
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 2020	FY 2021	FY 2022
Complete conceptual design of adaptive engine technology and initiate technology rig tests to decrease risk in core technology testing. Complete and evaluate compressor core test for large engines. Continue component tests of advanced variable turbine and innovative compression rear block designed to accept flow variations caused by variable turbine operation. ***FY 2022 Plans:*** Continue component tests of advanced variable turbine and innovative compression rear block designed to accept flow variations caused by variable turbine operation. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY 2022 increased compared to FY 2021 by $8.760 million. Funding increase due to increased emphasis on adaptive turbine engine core technologies.			
Accomplishments/Planned Programs Subtotals	21.831	0.000	20.816

	FY 2020	FY 2021
Congressional Add: Program increase - advanced turbine engine gas generator ***FY 2020 Accomplishments:*** Conduct Congressionally directed efforts ***FY 2021 Plans:*** Not applicable.	17.000	0.000
Congressional Add: Program increase - small turbine engines for long range weapons ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Conduct Congressionally directed efforts	0.000	17.000
Congressional Adds Subtotals	17.000	17.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.