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Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force **Date:** April 2022

Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>
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COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	-	190.732	190.683	172.861	0.000	172.861	174.787	176.980	180.725	184.647	Continuing	Continuing
623012: <i>Advanced Propulsion Technology</i>	-	8.338	17.679	17.358	0.000	17.358	17.674	18.021	18.402	18.802	Continuing	Continuing
623048: <i>Combustion and Mechanical Systems</i>	-	3.481	11.345	4.659	0.000	4.659	4.756	4.858	4.961	5.065	Continuing	Continuing
623066: <i>Turbine Engine Technology</i>	-	58.252	68.350	68.146	0.000	68.146	69.777	70.973	72.441	74.018	Continuing	Continuing
623145: <i>Aerospace Power Technology</i>	-	49.630	42.557	38.199	0.000	38.199	36.856	37.563	38.358	39.188	Continuing	Continuing
624847: <i>Rocket Propulsion Technology</i>	-	64.736	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing
625171: <i>Missile Rocket Propulsion</i>	-	0.000	42.114	36.039	0.000	36.039	37.067	36.754	37.566	38.381	Continuing	Continuing
625330: <i>Aerospace Fuel Technology</i>	-	6.295	8.638	8.460	0.000	8.460	8.657	8.811	8.997	9.193	Continuing	Continuing

A. Mission Description and Budget Item Justification

This effort develops propulsion and power technologies to achieve enabling and revolutionary aerospace technology capabilities. The effort has six current projects, each focusing on a technology area critical to the Department of the Air Force. The Advanced Propulsion Technology project develops high-speed air breathing propulsion engines to include combined cycle, ramjet, and hypersonic scramjet technologies. The Combustion and Mechanical Systems project develops engine mechanical system technologies: bearings, seals, drives, and lubricants as well as combustion components, concepts, and technologies for legacy and advanced turbine engines. The Turbine Engine Technology project develops enabling capabilities to enhance performance and affordability of existing weapon systems and develops component technologies for ultra-high pressure ratio, substantially improved durability, and adaptive cycle engine architecture to provide optimized performance, fuel efficiency, and life for widely varying mission needs. The Aerospace Power Technology project develops electrical power and thermal control technologies for military applications that remove operational limitations and enable advanced vehicle designs and high-power mission systems. The Missile Rocket Propulsion project develops advances in rocket propulsion technologies for tactical missiles and the sustainment of strategic systems. The Aerospace Fuel Technology project evaluates fuels and related technologies for legacy and advanced turbine engines, scramjets, rotating detonation engines and combined-cycle engines. Efforts 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.

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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 program element would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602020F, 0602102F, 0602201F, 0602202F, 0602204F, 0602602F, 0602605F, 0602788F, 0602298F, and 1206601SF.

Funds in this program element may be used to investigate specified technology advancements in air, space and/or cyber domains.

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.

In FY 2022, the work and funding associated with space technology research in Program 0602203F, Aerospace Propulsion, Project 624847, Rocket Propulsion Technology, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, Program 1206601SF, Project 624847, Rocket Propulsion Technology, 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 Program 0602203F, Aerospace Propulsion are transferred from Project 624847, Rocket Propulsion Technology to Project 625171, Missile Rocket Propulsion Technology due to the creation of a new Appropriation for Space Force.

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

B. Program Change Summary (\$ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	201.048	174.683	0.000	0.000	0.000
Current President's Budget	190.732	190.683	172.861	0.000	172.861
Total Adjustments	-10.316	16.000	172.861	0.000	172.861
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	16.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	2.391	0.000			
• SBIR/STTR Transfer	-4.837	0.000			
• Other Adjustments	-7.870	0.000	172.861	0.000	172.861

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 623066: *Turbine Engine Technology*

	FY 2021	FY 2022

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Congressional Add Details (\$ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Congressional Add: <i>Program Increase - Modular open system architecture for turbine engine technology</i>	0.000	6.000
Congressional Add Subtotals for Project: 623066	0.000	6.000
Project: 623145: Aerospace Power Technology		
Congressional Add: <i>Emergency power and cooling thermal management growth</i>	0.000	5.000
Congressional Add Subtotals for Project: 623145	0.000	5.000
Project: 624847: Rocket Propulsion Technology		
Congressional Add: <i>Program increase - small business research for rocket technology</i>	2.415	-
Congressional Add Subtotals for Project: 624847	2.415	-
Project: 625171: Missile Rocket Propulsion		
Congressional Add: <i>Program increase - Small business research for rocket technology</i>	0.000	5.000
Congressional Add Subtotals for Project: 625171	0.000	5.000
Congressional Add Totals for all Projects	2.415	16.000

Change Summary Explanation

Decrease in FY 2021 reflects Cong Adds Realignment to appropriate program and reprogramming to support Research and Development Projects, 10 U.S.C. Section 2363, an amendment to PL 110-417, 10 U.S.C. Section 2358 and 10 U.S.C. 2805(d)(1)(B).

The FY2022 President's Budget submittal did not reflect FY2023 through FY2026 funding. Therefore, an explanation of the change between the two budget positions for FY2023 cannot be made in a relevant manner.

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force										Date: April 2022		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / Aerospace Propulsion				Project (Number/Name) 623012 / Advanced Propulsion Technology			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
623012: <i>Advanced Propulsion Technology</i>	-	8.338	17.679	17.358	0.000	17.358	17.674	18.021	18.402	18.802	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
Title: Hypersonic Scramjet Technologies	8.338	17.679	17.358
Description: Develop robust hydrocarbon fueled scramjet engine components and technologies to improve performance, operability, durability, and scalability for future platforms.			
FY 2022 Plans: Continue development and demonstration of advanced engine components to improve scramjet operating margin, operating time, and to refine scramjet scaling laws for expendable and reusable applications. Continue development of low internal drag flame stabilization devices, instrumentation, endothermic fuels, and flight test engine components. Continue propulsion studies and design efforts required for the development and demonstration of an engine flight test that expands the flight environment of current high speed propulsion systems.			
FY 2023 Plans: Continue development and demonstration of advanced, high speed engine components to improve operating margin, operating time and scaling laws for expendable and reusable applications. Continue development of low internal drag flame stabilization devices, instrumentation, endothermic fuels, and flight test engine components. Initiate development of design and analysis techniques and tools as well as experimental approaches to enable enhanced high-speed air induction system starting, operability, and performance for propulsion integration concepts over a wide range of flight conditions. Continue propulsion studies and design efforts required for the development and demonstration of an engine flight test that expands the flight environment of current high speed propulsion systems.			
FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 decreased compared to FY2022 by \$0.321 million. Funding decrease due to decreased emphasis on high speed propulsion technologies.			
Accomplishments/Planned Programs Subtotals	8.338	17.679	17.358

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

N/A

Remarks

D. Acquisition Strategy

Not applicable.

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force										Date: April 2022		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>				Project (Number/Name) 623048 / <i>Combustion and Mechanical Systems</i>			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
623048: <i>Combustion and Mechanical Systems</i>	-	3.481	11.345	4.659	0.000	4.659	4.756	4.858	4.961	5.065	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

In FY2023, Combustion Technologies, Diagnostic Technologies, and Bearing Technologies efforts in this Project will transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology, in order to effectively and efficiently align resources to Aerospace Systems Core Technical Competencies.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
Title: Combustion Technologies	1.438	4.687	0.000
Description: Develop, test, and evaluate revolutionary combustion and propulsion concepts for gas turbine, pulse detonation, and combined cycle engines for missiles, manned and unmanned systems.			
FY 2022 Plans:			
Continue exploring interactions and effects of compressor and turbine components on the combustor and combustor materials to reduce engine weight and increase efficiency. Continue using advanced diagnostics tools to develop high-quality datasets for use by academia and industry for model development and verification. Continue the determination of necessary reference performance and operability combustion systems and metrics to decrease the cost of certifying new and alternative fuels in weapon systems. Continue to support development of advanced computational fluid dynamics (CFD) models to reduce combustor and augmentor design costs. Continue development of computations, modeling and simulation, and research experimentation of advanced combustion concepts including pressure gain combustion components and system level architectures. Continue to explore advanced combustion and flameholding concepts working towards improved understanding at relevant operating conditions such as sub-atmospheric (less than 1 atmosphere) and high pressure (greater than 10 atmospheres); this includes fundamental combustion modeling and fluid-dynamic phenomena on high speed systems and rocket propulsion and advanced turbine engine applications, identifying modeling and simulation concepts/approaches to address combustion chemistry and			

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
<p>physics and light/matter interactions, for high speed systems exploring turbulent combustion modeling in advanced configurations, exploring advanced combustion including pressure gain propulsion as it relates to new applications and architectures. Continue the development and demonstration of new tools and use of new designs and materials to improve efficiency, power under quiet operations. Continue investigation to identify and assess disruptive propulsion/power concepts and evaluate concepts. Continue development of new technologies for unmanned aircraft system propulsion/power systems for improved understanding at relevant operating conditions.</p> <p>FY 2023 Plans: In FY2023, this effort will transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology in order to effectively and efficiently align resources to Aerospace Systems Core Technical Competencies.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 decreased compared to FY2022 by \$4.687 million. Funding decrease is due to transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology.</p>				
<p>Title: Diagnostic Technologies</p> <p>Description: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies.</p> <p>FY 2022 Plans: Continue supporting computational fluid dynamics combustion modeling by providing, insights for interpreting experimental results using existing Modeling & Simulation methodologies and applying recently developed high-speed, spatially resolved laser diagnostics to our representative, single- element combustion experiments in order to demonstrate and deliver measurements of key combustion species and flow properties under high pressure conditions. Continue development of diagnostic tools/ methods for robust measurement capability in engine test cells and full annular ground test environments including reacting and nonreacting spray experiments for liquid fuel spray model development and employment of Nonintrusive optical diagnostics that will be used to obtain accurate, spatially/temporally resolved data. This provides the local flow field data required for comparisons to results of numerical simulations. Continue the development of improved numerical methods and turbulent combustion models to guide design and development of experimental components and systems utilizing existing Modeling & Simulation methodologies.</p> <p>FY 2023 Plans: In FY2023, this effort will transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology in order to effectively and efficiently align resources to Aerospace Systems Core Technical Competencies.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement:</p>		0.247	0.805	0.000

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
FY2023 decreased compared to FY2022 by \$0.805 million. Funding decrease is due to transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology.				
<p>Title: Lubricant Technologies</p> <p>Description: Develop, test, and qualify advanced turbine engine lubricants. Generate and maintain military specifications for aviation engine lubricants.</p> <p>FY 2022 Plans: Continue developing innovative fluids by; defining target requirements for new polyol ester oils, conducts Research & Development for new/enhanced turbine engine oils for legacy & emerging engines, qualifies new & updated engine oil products for legacy & emerging engines. Continue the development of lubricant modeling through characterization of heat generation, lubrication system cooling effectiveness, failure progression of bearing materials under relevant engine conditions, and overall system performance of advanced bearing concepts for model validation. Continue supporting the warfighter on field-related mechanical system issues. Continue performance validation study of advanced bearing designs/materials, lubricant & lubrication system components via full-scale high-fidelity laboratory parametric testing at representative engine operating conditions. Continue the generation of the fatigue life database & assess fatigue growth characteristics of state of the art baseline, emerging, & advanced engine rolling element bearing materials thru sub-scale experimental investigations</p> <p>FY 2023 Plans: Continue developing innovative fluids by; defining target requirements for new polyol ester oils, conduct Research & Development for new/enhanced turbine engine oils for legacy & emerging engines, qualify new & updated engine oil products for legacy & emerging engines. Continue the development of lubricant modeling through characterization of heat generation, lubrication system cooling effectiveness, failure progression of bearing materials under relevant engine conditions, and overall system performance of advanced bearing concepts for model validation. Continue supporting the warfighter on field-related mechanical system issues. Continue performance validation study of lubricant & lubrication system components via full-scale high-fidelity laboratory parametric testing at representative engine operating conditions. Complete the generation of the fatigue life database & assess fatigue growth characteristics of state of the art baseline, emerging, & advanced engine rolling element bearing materials thru sub-scale experimental investigations Initiate development of applied rotor dynamics models for design.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$1.873 million. Funding increase due to increased emphasis in turbine engine lubricants for next generation systems to include autonomous collaborative platforms.</p>		0.855	2.786	4.659
Title: Bearing Technologies		0.941	3.067	0.000

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
<p>Description: Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-scale turbine engine applications.</p> <p>FY 2022 Plans: Continue developing physics-based bearing life model based on bearing alloy fatigue and microstructural investigations, including bearing life factors for advanced bearing materials. Continue incorporating fatigue life, fault evolution, and parametric heat generation of advanced material systems into the models. Continue development of oil-free bearing technology for Unmanned Air Systems. Continue the development and demonstration of propulsion technologies for subsonic expendable and attritable air platforms, small and medium scale propulsion technologies, and evaluate lubricants, mechanical systems, bearing technology and combustion concepts for advanced turbine engines. Continue the development of fundamental knowledge of bearing material rolling contact fatigue failure mechanisms and lubricant interactions through microstructural investigations and failure analysis.</p> <p>FY 2023 Plans: In FY2023, this effort will transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology in order to effectively and efficiently align resources to Aerospace Systems Core Technical Competencies.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 decreased compared to FY2022 by \$3.067 million. Funding decrease is due to transfer to Program 0602203F, Aerospace Propulsion, Project 623066, Turbine Engine Technology.</p>			
Accomplishments/Planned Programs Subtotals	3.481	11.345	4.659

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

N/A

Remarks

D. Acquisition Strategy

Not applicable.

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Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / Aerospace Propulsion				Project (Number/Name) 623066 / Turbine Engine Technology			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
623066: <i>Turbine Engine Technology</i>	-	58.252	68.350	68.146	0.000	68.146	69.777	70.973	72.441	74.018	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops technology to increase turbine engine operational reliability, durability, mission flexibility, and performance, while reducing weight, fuel consumption, and cost of ownership. Analytical and experimental areas of emphasis are fans and compressors, high temperature combustors, turbines, internal flow systems, controls, augmentor and exhaust systems, integrated power and thermal management systems, engine inlet integration, mechanical systems, conceptual cycle technologies, and structural design. This project develops component technology for an adaptive cycle engine architecture that provides both optimized performance and fuel efficiency for widely varying mission needs. This project supports joint Department of Defense, agency, and industry efforts to focus turbine propulsion technology on national needs. The project plan is relevant across capability areas for global responsive strike, tactical and global mobility, responsive space lift, and persistent intelligence, surveillance, and reconnaissance (ISR).

In FY2023, Combustion Technologies, Diagnostic Technologies, and Bearing Technologies efforts will transfer from PE 0602203F, Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems, to this Project 623066 Turbine Engine Technology, in order to effectively and efficiently align resources to Aerospace Systems Core Technical Competencies.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
Title: Turbofan/Turbojet Engine Core Technologies	25.703	27.461	23.761
Description: Develop core turbofan/turbojet engine components (i.e., compressors, combustors, and turbines) for fighters, bombers, sustained supersonic/hypersonic cruise vehicles, and transports.			
FY 2022 Plans: Continue development of improved aerodynamic design tools and analysis methods to extend engine operability and efficiency.			
FY 2023 Plans: Continue development of improved aerodynamic design tools and analysis methods to extend engine operability and efficiency. Initiate transonic fan distortion tolerance and transfer study to enable design-for-integration and reliable assessment for embedded engines. Initiate high lift /high work turbine study to reduce turbine stage /blade count.			
FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 decreased compared to FY2022 by \$3.700 million. Funding decreased due to decreased emphasis on turbofan/turbine engine core technologies for large scale turbine engines.			
Title: Turboshaft/Turboprop and Small Turbofan Engine Technologies	4.457	4.793	4.896

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
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Description: Develop components for turboshaft/turboprop and small turbofan engines for trainers, rotorcraft, special operations aircraft, and theater transports.

FY 2022 Plans:
Continue to demonstrate advanced component designs in rig testing. Continue to utilize validation data to develop improved test protocol for small engine augmentor designs. Continue development and validation of modeling and simulation tools for the design and analysis of turbine components with mission-tailored aero-performance and highly efficient cooling geometries. Continue the new innovative architectures, critical technologies, exploration of targeted life applications for small missile and remotely piloted aircraft applications; evaluate critical technologies that will increase range, performance, durability, electrical power and thermal capacity of these systems. Continue the exploration of new small engine technologies that can operate in high speed applications; evaluate risk reduction technologies to increase usage time of systems. Continue demonstrating advanced component designs and modeling tools in rig and engine testing. Continue to utilize validation data to develop improved test protocol for small engine designs. Continue development and validation of modeling and simulation tools for the design and analysis of engine components with new manufacturing processes. Continue the exploration of advanced integrated engine controls with potential for synergistic airframe system level benefits. Continue exploration of new small and medium size engine technologies for increased fuel efficiency, propulsive capability, power and thermal management, and reduced life cycle cost. Continue identification of new architectures and critical technologies for integrated power and thermal systems. Continue identification of requirements and develop models for simulation of highly integrated systems.

FY 2023 Plans:
Complete current demonstration phase of advanced component designs in rig testing. Complete validation of data to develop improved test protocol for small engine augmentor designs. Complete development and validation phase of modeling and simulation tools for the design and analysis of turbine components with mission-tailored aero-performance and highly efficient cooling geometries. Complete application evaluation in new innovative architectures, critical technologies, exploration of targeted life applications for small missile and remotely piloted aircraft applications; evaluate critical technologies that will increase range, performance, durability, electrical power and thermal capacity of these systems. Continue the exploration of new small engine technologies that can operate in high speed applications; evaluate risk reduction technologies to increase usage time of systems. Complete demonstrating advanced component designs and modeling tools in rig and engine testing. Continue to utilize validation data to develop improved test protocol for small engine designs. Complete development and validation of modeling and simulation tools for the design and analysis of engine components with new manufacturing processes. Complete the exploration of advanced integrated engine controls with potential for synergistic airframe system level benefits. Continue exploration of new small and medium size engine technologies for increased fuel efficiency, propulsive capability, power and thermal management, and

FY 2021	FY 2022	FY 2023

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
<p>reduced life cycle cost. Continue identification of new architectures and critical technologies for integrated power and thermal systems. Continue identification of requirements and develop models for simulation of highly integrated systems.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$0.103 million. Funding increase due to increased emphasis on turboshaft/turboprop and small turbofan engine technologies for small scale turbine engines.</p>				
<p>Title: Revolutionary Propulsion Technology</p> <p>Description: Develop, test, and evaluate revolutionary propulsion concepts for gas turbine, pressure gain propulsion, and combined cycle engines for missiles, manned and unmanned systems.</p> <p>FY 2022 Plans: Continue identification of control technology elements applicable to integrated propulsion/power/thermal solutions. Continue evaluation of power and thermal modeling of advanced architectures into aircraft system level multidisciplinary analysis and optimization tools: explore new control methods for integrated propulsion, power and thermal management; continue evaluation of integration of advanced augmentors and ramburners; continue exploration of new expendable and attritable architectures. Continue the development and evaluation of advanced, integrated propulsion technologies for supersonic expendable, attritable, and reusable strike and Intelligence, Surveillance, and Reconnaissance (ISR) systems. Continue studies for exploration of advanced propulsion technologies. Continue exploration and evaluation of innovative architectures for affordable & efficient airlaunched propulsion capability from Mach 3 to Mach 5+, and turbine based combined cycle propulsion capability to Mach 5+.</p> <p>FY 2023 Plans: Continue identification of control technology elements applicable to integrated propulsion/power/thermal solutions. Complete evaluation of power and thermal modeling of advanced architectures into aircraft system level multidisciplinary analysis and optimization tools. Continue evaluation of integration of advanced augmentors and ramburners. Continue exploration of new expendable and attritable architectures. Continue the development and evaluation of advanced, integrated propulsion technologies for supersonic expendable, attritable, and reusable strike and Intelligence, Surveillance, and Reconnaissance (ISR) systems. Continue studies for exploration of advanced propulsion technologies. Complete exploration and evaluation of innovative architectures for affordable & efficient airlaunched propulsion capability from Mach 3 to Mach 5+, and turbine based combined cycle propulsion capability to Mach 5+.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$0.364 million. Funding increase due to increased emphasis on revolutionary propulsion technology to include rotating detonation engines.</p>		15.746	16.861	17.225
<p>Title: Missile and Unmanned Aerial Systems (UAS) Engine Technologies</p>		12.346	13.235	13.521

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
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Description: Develop limited life engine components for missile and Unmanned Aerial System (UAS) applications, including longrange subsonic, supersonic and hypersonic vehicles.

FY 2022 Plans:

Continue identification of control technology elements applicable to integrated propulsion/power/thermal solutions. Continue evaluation of power and thermal modeling of advanced architectures into aircraft system level multidisciplinary analysis and optimization tools: explore new control methods for integrated propulsion, power and thermal management; continue evaluation of integration of advanced augmentors and ramburners; continue exploration of new expendable and attritable architectures. Continue the development and evaluation of advanced, integrated propulsion technologies for supersonic expendable, attritable, and reusable strike and Intelligence, Surveillance, and Reconnaissance (ISR) systems. Continue exploration of new engine concepts for missile and unmanned systems.

FY 2023 Plans:

Complete identification of control technology elements applicable to integrated propulsion/power/thermal solutions. Continue evaluation of power and thermal modeling of advanced architectures into aircraft system level multidisciplinary analysis and optimization tools: explore new control methods for integrated propulsion, power and thermal management; Complete evaluation of integration of advanced augmentors and ramburners; continue exploration of new expendable and attritable architectures. Complete the development and evaluation of advanced, integrated propulsion technologies for supersonic expendable, attritable, and reusable strike and Intelligence, Surveillance, and Reconnaissance (ISR) systems. Continue exploration of new engine concepts for missile and unmanned systems. Initiate lifetime demonstration of limited life engine components.

FY 2022 to FY 2023 Increase/Decrease Statement:

FY2023 increased compared to FY2022 by \$0.286 million. Funding increase due to increased emphasis on engine technologies for missiles and unmanned aerial systems to include hypersonic vehicles.

Title: Combustion Technologies	-	0.000	4.788
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Description: Develop, test, and evaluate revolutionary combustion and propulsion concepts for gas turbine, pulse detonation, and combined cycle engines for missiles, manned and unmanned systems.

FY 2022 Plans:

In FY2022, this effort is performed in PE 0602203F, Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems.

FY 2023 Plans:

Continue exploring interactions and effects of compressor and turbine components on the combustor and combustor materials to increase efficiency and improve altitude ignition & operability. Complete use of advanced diagnostics tools to develop high-

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 623066 / <i>Turbine Engine Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
<p>quality datasets for use by academia and industry for model development and verification. Complete research in the determination of necessary reference performance and operability combustion systems and metrics to decrease the cost of certifying new and alternative fuels in weapon systems. Complete support of development of advanced computational fluid dynamics (CFD) models to reduce combustor and augmentor design costs. Continue development of computations, modeling and simulation, and research experimentation of advanced combustion concepts including pressure gain combustion components and system level architectures. Complete planned exploration of advanced combustion and flameholding concepts working towards improved understanding at relevant operating conditions such as sub-atmospheric (less than 1 atmosphere) and high pressure (greater than 10 atmospheres); this includes fundamental combustion modeling and fluid-dynamic phenomena on high speed systems and rocket propulsion and advanced turbine engine applications, identifying modeling and simulation concepts/approaches to address combustion chemistry and physics and light/matter interactions, for high speed systems exploring turbulent combustion modeling in advanced configurations, exploring advanced combustion including pressure gain propulsion as it relates to new applications and architectures. Continue the development and demonstration of new design, modeling and simulation and testing methods to improve efficiency and operability. Continue investigation to identify and assess disruptive propulsion/power concepts and evaluate concepts. Continue development of new technologies for unmanned aircraft system propulsion/power systems for improved understanding at relevant operating conditions. Initiate exploration of applied high speed combustion and combustor design. Initiate exploration of rotating detonation engines for next generation combustion systems. Initiate the development of improved numerical methods and combustion models to guide design and applied development of combustion components and systems.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$4.788 million. Funding increase is due to transfer from PE 0602203F Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems and increased emphasis in combustion technology for next generation systems to include high speed systems.</p>			
<p>Title: Diagnostic Technologies</p> <p>Description: Develop and demonstrate optical, electromechanical, and laser diagnostic tools and sensors for application to revolutionary propulsion technologies.</p> <p>FY 2022 Plans: In FY2022, this effort is performed in PE 0602203F, Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems.</p> <p>FY 2023 Plans: Complete support to current phase in computational fluid dynamics combustion modeling by providing insights for interpreting experimental results using existing Modeling & Simulation methodologies and applying recently developed high-speed, spatially resolved laser diagnostics to our representative, single- element combustion experiments in order to demonstrate and deliver</p>	-	0.000	0.822

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 623066 / <i>Turbine Engine Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
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<p>measurements of key combustion species and flow properties under high pressure conditions. Continue development of diagnostic tools/ methods for robust measurement capability in engine test cells and full annular ground test environments including reacting and nonreacting spray experiments for liquid fuel spray model development and employment of Nonintrusive optical diagnostics that will be used to obtain accurate, spatially/temporally resolved data. Initiate the application of optical diagnostic to challenging engine environments including detonations, high pressures, and multiphase. Complete the development of improved numerical methods and turbulent combustion models to guide design and development of experimental components and systems utilizing existing Modeling & Simulation methodologies.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$0.822M. Funding increase is due to transfer from PE 0602203F Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems.</p>			
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<p>Title: Bearing Technologies</p> <p>Description: Develop and test advanced bearing material technology and bearing concepts for small, intermediate, and large-scale turbine engine applications.</p> <p>FY 2022 Plans: In FY2022, this effort is performed in PE 0602203F, Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems.</p> <p>FY 2023 Plans: Continue developing physics-based bearing life model based on bearing alloy fatigue and microstructural investigations, including bearing life factors for advanced bearing materials. Continue incorporating fatigue life, fault evolution, and parametric heat generation of advanced material systems into the models. Continue development of oil-free bearing technology for Unmanned Air Systems. Continue the development and demonstration of propulsion technologies for subsonic expendable and attritable air platforms, small and medium scale propulsion technologies, and evaluate lubricants, mechanical systems, bearing technology and combustion concepts for advanced turbine engines. Continue the development of fundamental knowledge of bearing material rolling contact fatigue failure mechanisms and lubricant interactions through microstructural investigations and failure analysis.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$3.133M. Funding increase is due to transfer from PE 0602203F Aerospace Propulsion, Project 623048, Combustion and Mechanical Systems.</p>	-	0.000	3.133
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Accomplishments/Planned Programs Subtotals	58.252	62.350	68.146
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	FY 2021	FY 2022
Congressional Add: Program Increase - Modular open system architecture for turbine engine technology	0.000	6.000

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 623066 / <i>Turbine Engine Technology</i>
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	FY 2021	FY 2022
FY 2021 Accomplishments: Not applicable.		
FY 2022 Plans: Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	0.000	6.000

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

N/A

Remarks

D. Acquisition Strategy

Not applicable.

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force										Date: April 2022		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>				Project (Number/Name) 623145 / <i>Aerospace Power Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
623145: <i>Aerospace Power Technology</i>	-	49.630	42.557	38.199	0.000	38.199	36.856	37.563	38.358	39.188	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
Title: High Power System Technologies	49.630	37.557	38.199
Description: Develop integrated system architecture, controls, and component technologies to provide for the large amounts of electrical power needed, and concurrent thermal mitigation required, by current and future manned and unmanned systems.			
FY 2022 Plans: Continue development of system and component electrical power, electro-mechanical, and thermal technologies for high-power applications. Complete development of hybrid approaches to power generation, storage, and application as well as thermal management. Continue testing of subsystems hardware in conjunction with continued platform level tip-to-tail modeling and simulation for energy optimization. Continue development of advanced, safe energy storage, power distribution, and management systems to include Silicon Carbide applications and batteries and fan tip generator development. Complete power and thermal development toward demonstration of tactical aircraft high-power payload capability to include +/-270 Volts Direct Current (VDC) power generation and storage. Continue analysis and development of adaptive power and thermal control systems for highpower aircraft to include open system integration and test. Continue weapon system contractor support for platform integration of advanced power and thermal system architectures. Continue medium-scale propulsion, power and thermal system studies and development to include innovative, integrated hybrid architectures.			
FY 2023 Plans: Continue development of system and component electrical power, electro-mechanical, and thermal technologies for high-power applications. Continue testing of subsystems hardware in conjunction with continued platform level tip-to-tail modeling and simulation for energy optimization. Complete development of advanced, safe energy storage, power distribution, and management systems to include Silicon Carbide applications and batteries and fan tip generator development. Complete analysis and development of adaptive power and thermal control systems for high-power aircraft to include open system integration and			

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 623145 / <i>Aerospace Power Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
test. Complete weapon system contractor support for platform integration of advanced power and thermal system architectures. Continue medium-scale propulsion, power and thermal system studies and development to include innovative, integrated hybrid architectures. Initiate development of advanced power and thermal capabilities for future hypersonic aircraft. Initiate development of adaptive, affordable power and thermal technologies for emerging medium-scale platforms and mission capabilities.			
<i>FY 2022 to FY 2023 Increase/Decrease Statement:</i> FY2023 increased compared to FY2022 by \$0.642 million. Funding increase due to increased emphasis in technology for high power systems for next generation systems to include autonomous collaborative platforms.			
Accomplishments/Planned Programs Subtotals	49.630	37.557	38.199

	FY 2021	FY 2022
<i>Congressional Add:</i> Emergency power and cooling thermal management growth	0.000	5.000
<i>FY 2021 Accomplishments:</i> Not applicable.		
<i>FY 2022 Plans:</i> Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	0.000	5.000

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

N/A

Remarks

D. Acquisition Strategy

Not applicable.

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force										Date: April 2022		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / Aerospace Propulsion				Project (Number/Name) 624847 / Rocket Propulsion Technology			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
624847: <i>Rocket Propulsion Technology</i>	-	64.736	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops rocket propulsion technologies for space access, space maneuver, the sustainment of strategic systems (including solid boost/missile propulsion, post boost control, aging and surveillance efforts), and tactical missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, technology for sustainment of strategic systems, and innovative space propulsion concepts. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Develop technologies to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the sustainment of the rocket propulsion industry, providing rocket propulsion technology for the entire Department of Defense (DoD). Technologies under this project enable capabilities of interest to both DoD and National Aeronautics and Space Administration (NASA). Tasks include: modeling and simulation; proof of concept tests of critical components; advanced component development; and ground-based tests. Aging and surveillance tasks could reduce lifetime prediction uncertainties for individual motors by 50%, enabling motor replacement for cause. All thrusts are part of the Rocket Propulsion 21 (RP21) collaboration and are reviewed by a DoD level steering committee yearly for relevance to DoD missions and progress towards RP21 Goals.

In FY 2022, the work and funding associated with space technology research in Program 0602203F, Aerospace Propulsion, Project 624847, Rocket Propulsion Technology, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, Program 1206601SF, Project 624847, Rocket Propulsion Technology, 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 Program 0602203F, Aerospace Propulsion are transferred from Project 624847, Rocket Propulsion Technology to Project 625171, Missile Rocket Propulsion Technology due to the creation of a new Appropriation for Space Force.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
Title: Fuel Technologies	12.561	0.000	0.000
Description: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellants, and monopropellants to increase space launch payload capability and refine new synthesis methods.			
FY 2022 Plans: In FY2022, work and funding associated with fuel technologies in Project 624847, Rocket Propulsion Technology, are transferred to Project 625171, Missile Rocket Technology, due to the creation of a new Appropriation for Space Force.			
FY 2023 Plans: Not applicable			
FY 2022 to FY 2023 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022		
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 624847 / <i>Rocket Propulsion Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
Not applicable				
<p>Title: Liquid Engine Combustion Technologies</p> <p>Description: Develop advanced liquid engine combustion technology for improved performance, while preserving chamber lifetime and reliability needs for engine uses in heavy lift space vehicles.</p> <p>FY 2022 Plans: In FY2022, the work and funding associated with liquid engine combustion technologies in Project 624847, Rocket Propulsion Technology, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Project 624847, Rocket Propulsion Technology, due to the creation of a new Appropriation for Space Force.</p> <p>FY 2023 Plans: Not applicable</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: Not applicable</p>		11.186	0.000	0.000
<p>Title: Advanced Liquid Engine Technologies</p> <p>Description: Develop advanced liquid engine technologies for improved performance, while increasing life and reliability needs for engine uses in expendable and reusable launch vehicles.</p> <p>FY 2022 Plans: In FY2022, the work and funding associated with advanced liquid engine technology in Project 624847, Rocket Propulsion Technology, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Project 624847, Rocket Propulsion Technology, due to the creation of a new Appropriation for Space Force.</p> <p>FY 2023 Plans: Not applicable</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: Not applicable</p>		4.952	0.000	0.000
<p>Title: On-Orbit Propulsion Technologies</p> <p>Description: Develop solar electric, solar thermal, chemical, and advanced propulsion technologies for station-keeping, repositioning, and orbit transfer for satellites and satellite constellations.</p> <p>FY 2022 Plans:</p>		7.631	0.000	0.000

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 624847 / <i>Rocket Propulsion Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
<p>In FY2022, the work and funding associated with on-orbit propulsion technologies in Project 624847, Rocket Propulsion Technology, are transferred to Appropriation 3620F, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Project 624847, Rocket Propulsion Technology, due to the creation of a new Appropriation for Space Force.</p> <p>FY 2023 Plans: Not applicable</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: Not applicable</p>			
<p>Title: Ballistic and Tactical Propulsion Technologies</p> <p>Description: Develop missile propulsion technologies and aging & surveillance technologies for ballistic and tactical missiles.</p> <p>FY 2022 Plans: In FY2022 the work and funding associated with ballistic and tactical propulsion technologies in Project 624847, Rocket Propulsion Technology, are transferred to Project 625171, Missile Rocket Technology, due to the creation of a new Appropriation for Space Force.</p> <p>FY 2023 Plans: Not applicable</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: Not applicable</p>	25.991	0.000	0.000
Accomplishments/Planned Programs Subtotals	62.321	0.000	0.000

	FY 2021	FY 2022
Congressional Add: Program increase - small business research for rocket technology	2.415	-
FY 2021 Accomplishments: Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	2.415	-

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
Not applicable.

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force										Date: April 2022		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / Aerospace Propulsion				Project (Number/Name) 625171 / Missile Rocket Propulsion			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
625171: <i>Missile Rocket Propulsion</i>	-	0.000	42.114	36.039	0.000	36.039	37.067	36.754	37.566	38.381	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops rocket propulsion technologies for the sustainment of strategic systems (including solid boost/missile propulsion, post boost control, aging and surveillance efforts), and tactical missiles. Analytical and experimental areas of emphasis are propellants, propellant management, combustion, rocket material applications, and technology for sustainment of strategic systems. Technologies of interest will improve reliability, performance, survivability, affordability, and environmental compatibility of these systems. Develop technologies to reduce the weight and cost of components using new materials and improved designs and manufacturing techniques. All efforts in this project contribute to the sustainment of the rocket propulsion industry, providing rocket propulsion technology for the entire Department of Defense (DoD). Tasks include: modeling and simulation; proof of concept tests of critical components; advanced component development; and ground-based tests. Aging and surveillance tasks could reduce lifetime prediction uncertainties for individual motors by 50%, enabling motor replacement for cause. All efforts are part of the Rocket Propulsion of the 21st Century (RP21) collaboration and are reviewed by a DoD level steering committee yearly for relevance to DoD missions and progress towards RP21 Goals.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
Title: Fuel Technologies	0.000	12.146	10.565
Description: Develop, characterize, and test advanced hydrocarbons, energetics, solid propellants, and monopropellants to increase space launch payload capability and refine new synthesis methods.			
FY 2022 Plans: Complete development of solid rocket propellant binder systems for use across operationally relevant conditions. Continue to devise, synthesize, scale-up, and characterize novel energetic ingredients for monopropellants, fuels, and oxidizers, for use across the span of space and missile applications including tactical, strategic, and in-space thrust and attitude control. Continue to formulate, scale-up, and evaluate formulations of solid and liquid rocket propellants, including green monopropellants. Continue to identify, evaluate, and adapt 21st century automated formulation and production techniques to enable more rapid and agile munitions production arrangements. Continue research in high- temperature resins, insulators, and composite case fabrication techniques to enable high performance rocket motor cases.			
FY 2023 Plans: Continue to devise, synthesize, scale-up, and characterize novel energetic ingredients for monopropellants, fuels, and oxidizers, for use across the span of space and missile applications including tactical, strategic, and in-space thrust and attitude control. Continue to formulate, scale-up, and evaluate formulations of solid and liquid rocket propellants, including green monopropellants. Continue to identify, evaluate, and adapt 21st century automated formulation and production techniques to enable more rapid			

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022		
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 625171 / <i>Missile Rocket Propulsion</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
and agile munitions production arrangements. Continue research in high- temperature resins, insulators, and composite case fabrication techniques to enable high performance rocket motor cases. FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 decreased compared to FY2022 by \$1.581 million. Funding decreased due to decreased emphasis in fuel technologies for strategic solid rocket propulsion.				
Title: Ballistic and Tactical Propulsion Technologies Description: Develop missile propulsion technologies and aging and surveillance technologies for ballistic and tactical missiles. FY 2022 Plans: Continue to apply next generation of chemical and mechanical aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, to user needs and unique challenges. Complete development of advanced sensor, non-destructive evaluation, modeling and supporting technology development efforts to detect and explain phenomena further improve data acquisition and reduce uncertainty in tactical, hypersonic, and ballistic missile solid rocket motor service life predictions. Complete long-term validation of tools through long-term aging and testing of sub-scale motors. Continue to develop advanced tactical propulsion and concepts. Complete propellant development efforts including long-life and other novel propellant systems. Continue development, evaluation, verification, and validation of next generation of updated, physics-based modeling, simulation, and analysis tools for rapid and agile missile propulsion design, analysis, and production to include designs for 21st century material processing techniques and hardware. Continue to support advanced component technologies for missile propulsion applications for strategic and strike systems helping to ensure their long-term sustainment. Initiate automated solid rocket motor production techniques and equipment to enable more rapid and agile munitions production and logistic support. FY 2023 Plans: Continue to apply next generation of chemical and mechanical aging mechanism modeling, simulation, and analysis tools, sensor schemes and tools, to user needs and unique challenges. Continue to develop advanced tactical propulsion hardware and concepts. Continue development, evaluation, verification, and validation of next generation of physics-based modeling, simulation, and analysis (MS&A) tools for rapid and agile missile propulsion design, analysis, and production to include designs for 21st century material processing techniques and hardware. Continue to support advanced component technologies for missile propulsion applications for strategic and strike systems helping to ensure their long-term sustainment. Continue automated solid rocket motor production techniques and components to enable more rapid and agile munitions production and logistic support. FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$0.506 million. Funding increase due to increased emphasis on ballistic and tactical propulsion technologies to include automated solid rocket motor production techniques.		0.000	24.968	25.474
Accomplishments/Planned Programs Subtotals		0.000	37.114	36.039

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 625171 / <i>Missile Rocket Propulsion</i>
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	FY 2021	FY 2022
Congressional Add: Program increase - Small business research for rocket technology	0.000	5.000
FY 2021 Accomplishments: Not applicable.		
FY 2022 Plans: Conduct Congressionally directed efforts.		
Congressional Adds Subtotals	0.000	5.000

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

N/A

Remarks

D. Acquisition Strategy

Not applicable

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force										Date: April 2022		
Appropriation/Budget Activity 3600 / 2					R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>				Project (Number/Name) 625330 / <i>Aerospace Fuel Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
625330: <i>Aerospace Fuel Technology</i>	-	6.295	8.638	8.460	0.000	8.460	8.657	8.811	8.997	9.193	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2021	FY 2022	FY 2023
<p>Title: Alternative Fuels</p> <p>Description: Investigate novel sustainable aviation fuels for engines, missiles, aircraft, sustained high-speed vehicles, hypersonic, and responsive space launch applications. Conduct evaluations and perform technical assessments of alternative fuels developed from unconventional sources for use in legacy and advanced aerospace systems. Support development of alternative fuel specification for commercial jet fuels with Federal Aviation Agency.</p> <p>FY 2022 Plans: Initiate investigation and development of novel sustainable aviation fuels and technologies for potential propulsion performance enhancement.</p> <p>FY 2023 Plans: Continue investigation and development of novel sustainable and alternative aviation fuels and technologies for potential propulsion performance and logistical enhancements.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$0.016 million. Funding increase due to increased emphasis on alternative fuels.</p>	0.598	0.636	0.652
<p>Title: Integrated Thermal and Energy Management</p> <p>Description: Develop advanced and specialty fuels, components, associated technologies, and conduct performance assessments of advanced integrated thermal and energy management systems for engines, missiles, aircraft, sustained high-speed vehicles, hypersonic, and responsive space launch. Evaluate stability and performance of advanced and specialty fuels.</p> <p>FY 2022 Plans:</p>	1.911	2.728	2.796

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022		
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 625330 / <i>Aerospace Fuel Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
<p>Continue the development and evaluation of novel additives, catalysts, and fuel composition and fuel system approaches enable new hypersonic applications. Continue model development for integrated thermal and energy management that include designs and evaluation of vehicle fuel systems, and prototype sensors to monitor the fuel chemistry that produces coke deposits and characterization of system-level impacts from thermally-stressed fuel. Continue evaluation of fuel reaction models that enable high temperature systems for evaluating endothermic fuels. Continue investigation of fuel heat sink approaches for thermal management of advanced engines and other systems that evaluate integrated power and thermal management approaches. Continued the development of fuel models for system design and evaluation of fuel system. Continue development of sensors and analysis techniques for monitoring fuel chemistry that causes deposits. Continue characterization system-level impacts of emerging aviation technologies. Continue studies using fuel as a thermal management fluid to meet Air Force requirements. Continue investigation of fuel heat exchangers including additive manufactured units and their reaction to fuels. Continue developing integrated test rigs to tests these approaches and assess efficiency of these approaches.</p> <p>FY 2023 Plans: Continue the development and evaluation of novel fuel additives, catalysts, compositions, and system approaches enabling new hypersonic applications and expanding into other advance concepts and system-level impacts of emerging aviation technologies. Continue development of fuel related integrated thermal and energy management technologies including models for designs and evaluation of vehicle fuel systems, methods to monitor the fuel coking and other chemistry, and characterization methods for system-level impacts from thermally-stressed fuel, as well as expanding use as a thermal management fluid. Continue prototype sensors to monitor the fuel chemistry that produces coke deposits and characterization of system-level impacts from thermally-stressed fuel. Continue evaluation of fuel reaction models that enable high temperature systems for evaluating advanced fuels including endothermic fuels. Continue investigation of fuel heat sink approaches for thermal management of advanced engines and other systems that evaluate integrated power and thermal management approaches to include heat exchangers. Continue development of fuel models for system design and evaluation of fuel system. Continue development of sensors and analysis techniques for monitoring fuel chemistry that causes deposits. Complete characterization system-level impacts of emerging aviation technologies. Complete studies using fuel as a thermal management fluid to meet Air Force requirements. Complete investigation of fuel heat exchangers as an independent investigation including additive manufactured units and their reaction to fuels. Continue developing integrated test rigs to tests these approaches and assess their efficiency.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY2023 increased compared to FY2022 by \$0.068 million. Funding increase due to increased emphasis on integrated thermal and energy management.</p>				
Title: Fuel Logistics and Sustainment		1.914	2.728	2.796
Description: Study and evaluate low-cost approaches to reduce fuel logistics footprint to reduce cost. Study fuel logistics vulnerabilities and develop detection and mitigation technologies. Identify, develop, and demonstrate low-cost approaches to reducing the fuel logistics footprint for the Department of the Air Force.				

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 625330 / <i>Aerospace Fuel Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
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FY 2022 Plans:
Continue supporting fuel sustainment issues as needed, to understand problems and work to find solutions. Continue development of compositional analysis that can be verified across services and leverages a database of specification and extended compositional information to advance data visualization and analytics. Continue approaches to be able to: capture fuel stability limiters to minimize logistics vulnerabilities; develop detection and mitigations for fuel biocontamination to support logistics readiness; and develop fuel sensing technologies with coordination and collaboration across the government. Continue thermal stability studies, models (such as chemistry, fuel system, and hybrid) developments, and technologies (such as additives, deoxygenation, and platform thermal stability sensors) developments for traditional, specialty, and sustainable aviation fuels under simulated operational domain conditions to ensure readiness across the Air Force's operational domains. Continue to analyze and develop fuels, fuel blends, and catalyst formulations that provide endothermic cooling capacity for hypersonic applications. Continue study of fuels and models for next generation vehicles.

FY 2023 Plans:
Continue support of fuel sustainment issues as needed, to understand current needs and problems as well as work to find solutions. Continue development of fuel compositional analyses methods that are verifiable across services and leverages a database of specification and extended compositional information to advance data visualization and analytics. Continue method developments to capture fuel stability limiters to minimize logistics vulnerabilities; develop detection and mitigations for fuel biocontamination to support logistics readiness; and develop fuel-sensing technologies with coordination and collaboration across the government. Continue thermal stability studies (such as chemistry, fuel system, and hybrid developments), and technologies (such as additives, deoxygenation, and platform thermal stability sensors); and models and technologies developments for traditional, specialty, and sustainable aviation fuels under simulated current and future operational domain conditions to ensure Air Force's readiness. Continue to analyze and develop fuels, fuel blends, catalyst formulations, accessories, and models for operational requirement of hypersonic application and extending into other next generation applications and vehicles. Complete study of fuels and models for next generation vehicles.

FY 2022 to FY 2023 Increase/Decrease Statement:
FY2023 increased compared to FY2022 by \$0.068 million. Funding increase due to increased emphasis on logistics and sustainment for fuel.

Title: Combustion Emissions and Performance	1.872	2.546	2.216
Description: Develop and test applied emissions diagnostic techniques for air breathing propulsion systems. Evaluate aviation fuel for combustion and emissions characteristics and fuel composition performance impacts. Identify and develop approaches to improve system performance and emissions across different fuels and types.			
FY 2022 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force	Date: April 2022
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Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602203F / <i>Aerospace Propulsion</i>	Project (Number/Name) 625330 / <i>Aerospace Fuel Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
<p>Continue development of augmentor combustor/simulator to determine fuel effects on augmentor operability under realistic conditions. Initiate studies of impact on combustor performance and emissions based on fuel chemistry (traditional, specialty, and sustainable aviation fuels), and fuel entrance temperature well above historic use levels, and other operational impacts, such as high altitude. Initiate development of low temperature catalyst augmented combustion technologies.</p> <p><i>FY 2023 Plans:</i> Complete development of augmentor combustor/simulator to determine fuel effects on augmentor operability under realistic conditions. Continue studies of impact on combustor performance and emissions based on fuel chemistry (traditional, specialty, and sustainable aviation fuels), and fuel entrance temperature well above historic use levels, and other operational impacts, such as high altitude. Continue development of low temperature catalyst augmented combustion technologies.</p> <p><i>FY 2022 to FY 2023 Increase/Decrease Statement:</i> FY2023 decreased compared to FY2022 by \$0.330 million. Funding decreased due to decreased emphasis on combustion emissions and performance.</p>			
Accomplishments/Planned Programs Subtotals	6.295	8.638	8.460

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

N/A

Remarks

D. Acquisition Strategy

Not applicable.