Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force											Date: February 2019	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602201F / *Aerospace Vehicle Technologies*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	151.637	160.461	147.724	0.000	147.724	150.700	159.677	145.523	148.851	Continuing	Continuing
622401: *Structures*	-	52.025	43.415	41.817	0.000	41.817	45.563	47.591	49.437	50.666	Continuing	Continuing
622403: *Flight Controls and Pilot-Vehicle Interface*	-	29.130	40.402	49.297	0.000	49.297	49.717	55.003	36.761	37.632	Continuing	Continuing
622404: *Aeromechanics and Integration*	-	28.663	30.932	28.595	0.000	28.595	29.503	30.635	31.910	32.571	Continuing	Continuing
622405: *High Speed Systems Technology*	-	41.819	45.712	28.015	0.000	28.015	25.917	26.448	27.415	27.982	Continuing	Continuing

A. Mission Description and Budget Item Justification

This effort investigates, develops, and analyzes aerospace vehicle technologies in the three primary areas of structures, controls, and aerodynamics for legacy and future aerospace vehicles. Advanced structures concepts are explored and developed to exploit new materials, fabrication processes, and design techniques. Vehicle, inter-vehicle, and intra-vehicle control technologies are developed and simulated for aerospace vehicles. Advanced aerodynamic vehicle configurations are developed and analyzed through simulations, experiments, and multi-disciplinary analyses. Resulting technologies improve performance of existing and future manned/unmanned and remotely piloted air vehicles, sustained high speed, and space access vehicles. Improvements include, but are not limited to, reduced energy use by efficient air platform designs, use of lightweight composite structures, and improved sustainment methods based on the condition of the platform and sub-systems. Projects in this effort 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 element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of such program funds would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 1206601F, and 0602298F.

As directed in the FY 2018 NDAA, Sec 825, amendment to PL 114-92 FY 2016 NDAA, Sec 828 Penalty for Cost Overruns, the FY 2018 Air Force penalty total is $14.373M. The calculated percentage reduction to each research, development, test and evaluation and procurement account will be allocated proportionally from all programs, projects, or activities under such account.

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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force	Date: February 2019
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	124.678	130.547	140.859	0.000	140.859
Current President's Budget	151.637	160.461	147.724	0.000	147.724
Total Adjustments	26.959	29.914	6.865	0.000	6.865
• Congressional General Reductions	-0.054	-0.086			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	31.000	30.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-2.393	0.000			
• Other Adjustments	-1.594	0.000	6.865	0.000	6.865

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: 622401: *Structures*		
Congressional Add: *Program increase - structures*	9.846	0.000
Congressional Add Subtotals for Project: 622401	9.846	0.000
Project: 622403: *Flight Controls and Pilot-Vehicle Interface*		
Congressional Add: *Program increase - human machine teaming*	0.000	4.000
Congressional Add: *Program increase - flight controls and pilot-vehicle interfaces*	0.000	5.000
Congressional Add Subtotals for Project: 622403	0.000	9.000
Project: 622405: *High Speed Systems Technology*		
Congressional Add: *Program increase - high speed systems technology*	5.908	6.000
Congressional Add: *Program increase - hypersonic vehicle structures*	9.846	10.000
Congressional Add: *Program increase - hypersonic research capability development*	4.923	0.000
Congressional Add: *Program increase - hypersonic wind tunnels*	0.000	5.000
Congressional Add Subtotals for Project: 622405	20.677	21.000
Congressional Add Totals for all Projects	30.523	30.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force	Date: February 2019
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*

Change Summary Explanation

Decrease in FY 2018 of $1.594 million in Other Adjustments is due to realignment of funds to PE 0602212F to support Research and Development Projects, 10 U.S.C. Section 2358.

Increase in FY 2020 of $6.865 million is due to the realignment and consolidation of Air Force Applied Research Science and Technology funding for Future Air Force Capabilities Applied Research efforts.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602201F / *Aerospace Vehicle Technologies*	Project (Number/Name) 622401 / *Structures*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622401: *Structures*	-	52.025	43.415	41.817	0.000	41.817	45.563	47.591	49.437	50.666	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops advanced structures concepts to exploit new materials and fabrication processes and investigates new concepts and design techniques. New structural concepts include low cost design and fabrication techniques, incorporating subsystem hardware items and adaptive mechanisms into the aerospace structures and/or skin of the platform.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Aircraft Service Life Technologies	21.992	22.637	15.109
Description: Develop an economic service life analysis capability comprised of analysis tools, methodologies, and structural health monitoring technologies. ***FY 2019 Plans:*** Continue methods for achieving lifing credit in advanced & enhanced metallic airframe components to extend structural life. Continue demonstration of Aircraft Digital Twin models and tools on legacy fleet aircraft. Initiate development of impact damage analysis criteria and methods for advanced composite structures. ***FY 2020 Plans:*** Complete methods for achieving lifing credit in advanced & enhanced metallic airframe components to extend structural life. Continue demonstration of Aircraft Digital Twin models and tools on legacy fleet aircraft. Complete development of impact damage analysis criteria and methods for advanced composite structures. Initiate lifing methods for durability and damage tolerance of aging composite structures on legacy fleet aircraft. Initiate development of digital maintenance models and virtual and augment reality maintenance tools. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $7.528 million. Funding decreased due to completion of efforts in structural lifing methods for composite and metallic structures in early FY 2020 and transition to composite structures life extension validation tests.			
Title: Vehicle Design Technologies	12.362	12.724	13.739
Description: Develop methodologies to reduce the cost and time involved from design to full-scale testing of structural concepts and aerospace systems. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622401 / *Structures*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Continue the development of advanced high fidelity aircraft design analysis tools. Complete parametric modeling methods for integrated multi-discipline collaborative design. Complete the development of design methods for low cost attritable aircraft concepts. Complete the evaluation of control effector concepts for supersonic tailless aircraft. Continue the development of integrating cost, mission effectiveness, and affordable manufacturing methods into the aircraft design analysis tools. Initiate the development of control effector designs for supersonic tailless aircraft. ***FY 2020 Plans:*** Continue the development of advanced high fidelity aircraft design analysis tools. Continue the development of integrating cost, mission effectiveness, and affordable manufacturing methods into aircraft design analysis tools (completing methods on low cost attritable aircraft concepts in FY 2020 and starting methods for other aircraft systems). Continue the development of control effector designs for supersonic tailless aircraft. Initiate new design techniques to quantify and trade risk impacts against performance in aircraft designs. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.015 million. Funding increased due to additional development in aerospace vehicle design tool methods.			
Title: Structural Concepts	7.825	8.054	12.969
Description: Develop design methods, processes, and lightweight, adaptive, and multifunctional structural concepts to capitalize on new materials, multi-role considerations, and technology integration into aircraft systems. ***FY 2019 Plans:*** Complete innovative energy efficient conformal load bearing antenna structural concepts. Continue development and verification of low cost attritable airframe concepts and manufacturing methods. Continue development of lightweight aircraft structural concepts to support Air Superiority 2030 and Advanced Mobility requirements. Initiate development of innovative structural design methods to dramatically reduce weight and complexity of aircraft structures. Initiate the development of fail-safe technologies for bonded unitized composite structures applicable to Mobility aircraft. ***FY 2020 Plans:*** Continue development and verification of low cost attritable airframe concepts and manufacturing methods (completing wing structure developments in FY 2020 and starting concepts for the fuselage and complete airframe). Complete development of lightweight aircraft structural concepts to support Air Superiority 2030 and Advanced Mobility requirements. Continue development of innovative structural design methods to dramatically reduce weight and complexity of aircraft structures. Continue the			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622401 / *Structures*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
development of fail-safe technologies for bonded unitized composite structures applicable to Mobility aircraft (completing durability requirements in FY 2020 and starting structural life component tests). ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $4.915 million. Funding increased due to additional emphasis in development of low cost structures in this major effort to support low cost attritable aircraft development.			
Accomplishments/Planned Programs Subtotals	42.179	43.415	41.817

	FY 2018	FY 2019
Congressional Add: Program increase - structures	9.846	0.000
FY 2018 Accomplishments: Conducted Congressionally directed efforts		
FY 2019 Plans: Not Applicable		
Congressional Adds Subtotals	9.846	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602201F / *Aerospace Vehicle Technologies*	Project (Number/Name) 622403 / *Flight Controls and Pilot-Vehicle Interface*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622403: *Flight Controls and Pilot-Vehicle Interface*	-	29.130	40.402	49.297	0.000	49.297	49.717	55.003	36.761	37.632	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops technologies that enable maximum affordable capability from manned, remotely-piloted and autonomous aerospace vehicles. Advanced control technologies are developed for maximum vehicle performance throughout the flight envelope and simulated in virtual environments. Resulting technologies contribute significantly towards the development of reliable autonomous or remotely piloted air vehicles, hypersonic aircraft, and extended-life legacy aircraft.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Advanced Flight Controls Technologies	6.676	7.196	6.790
Description: Develop technologies for advanced control-enabled capabilities, including flight controls, components, integrated vehicle management systems and software and system certification techniques for both manned/unmanned and remotely piloted aircraft. ***FY 2019 Plans:*** Continue the development, demonstration, and assessment of advanced flight control mechanization technologies for trusted and certifiable operations under adverse and contested environments. Continue the development of survivable and health-adaptive control system architecture. Complete the development of advanced automation capabilities for mobility aircraft and transition to advanced development. Continue the development of trusted autonomy approach, integrating certification processes and autonomy development. ***FY 2020 Plans:*** Continue the development, demonstration, and assessment of advanced flight control mechanization technologies for trusted and certifiable operations under adverse and contested environments. Complete the development of survivable and health-adaptive control system architecture. Continue the development of trusted autonomy approach, integrating certification processes and autonomy development. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $0.406 million. Justification for the decrease is described in the plans above.			
Title: Manned and Unmanned Teaming Technologies	17.345	18.699	17.644
Description: Develop technology for flight control systems that will permit safe interoperability between manned and remotely piloted aircraft and effective teaming in adverse and contested environments.			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622403 / *Flight Controls and Pilot-Vehicle Interface*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 Plans: Continue development, demonstration, and assessment of advanced control automation techniques. Continue the development of mixed initiative control techniques for teams of remotely piloted aircraft and/or manned-unmanned teams in contested, dynamic mission environments, as well as for the integration of unmanned systems into controlled airspace and airbase operations. Continue the development of robust, affordable Unmanned Aircraft System (UAS) operations in a terminal airspace environment. Continue the development of autonomous behaviors for safe, loyal wingman. ***FY 2020 Plans:*** Continue development, demonstration, and assessment of advanced control automation techniques. Continue the development of mixed initiative control techniques for teams of remotely piloted aircraft and/or manned-unmanned teams in contested, dynamic mission environments, as well as for the integration of unmanned systems into controlled airspace and airbase operations. Continue the development of robust, affordable Unmanned Air Systems (UAS) operations in a terminal airspace environment. Complete the development of autonomous behaviors for safe, loyal wingman. Initiate the development of autonomous behaviors for safe, effective manned-unmanned teams. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $1.055 million. Funding decreased due to the realignment and consolidation of Air Force Applied Research Science and Technology funding for Future Air Force Capabilities Applied Research efforts.			
Title: Flight Controls Technologies Modeling and Simulation ***Description:*** Develop tools and methods for capitalizing on simulation-based research and development of future aerospace vehicles. ***FY 2019 Plans:*** Continue modeling and simulation efforts to evaluate emerging autonomous and robust flight control technologies and concepts, as well as assess mission-level performance of integrated aerospace systems. Continue analyses of automated unmanned air systems and manned-unmanned teams in controlled airspace and airbase operations, as well as in adversarial mission environments. Continue trade studies of vehicle concepts for strike, mobility and reconnaissance. Continue manned-unmanned teaming evaluations. Continue development of autonomy for tactical aircraft operations. ***FY 2020 Plans:*** Continue modeling and simulation efforts to evaluate emerging autonomous and robust flight control technologies and concepts, as well as assess mission-level performance of integrated aerospace systems. Complete analyses of automated unmanned air systems and manned-unmanned teams in controlled airspace and airbase operations. Continue analyses of manned-unmanned teams in adversarial mission environments. Continue trade studies of vehicle concepts for strike, mobility and	5.109	5.507	5.196

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622403 / *Flight Controls and Pilot-Vehicle Interface*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
reconnaissance. Continue manned-unmanned teaming evaluations including rapid development of new capabilities. Complete development of autonomy for tactical aircraft operations. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $0.311 million. Justification for the decrease is described in the plans above.			
Title: Future AF Capabilities Applied Research ***Description:*** Investigate, design, and develop science and technologies supporting future Air Force capabilities to provide compelling advantage to the warfighter. To the greatest extent practical, research efforts will utilize modeling and simulation and cross-discipline systems integration (For example: air and space vehicles, avionics, propulsion, materials, human performance, cybersecurity, command, control, communications, computer and intelligence, sensors, electronic warfare, and conventional/ unconventional weapons). The National Defense Strategy and Air Force Science and Technology 2030 Strategy will inform investments over the FYDP. ***FY 2019 Plans:*** In FY 2019, this work is performed under multiple projects and efforts within the following Air Force Science and Technology Programs: 0602102F, Materials; 0602201F, Aerospace Vehicle Technologies; 0602202F, Human Effectiveness Applied Research; 0602203F, Aerospace Propulsion; 0602204F, Aerospace Sensors; 1206601F, Space Technology; 0602602F, Conventional Munitions; 0602605F, Directed Energy Technology; and 0602788F, Dominant Information Science and Methods. ***FY 2020 Plans:*** Continue to investigate and mature science and technology that enables future warfighting concepts to provide leap-ahead capabilities. The National Defense Strategy and Air Force Science and Technology 2030 Strategy focus this science and technology toward, but not limited to, the following capabilities: 1) global persistent awareness; 2) resilient information sharing; 3) rapid, effective decision-making; 4) complexity, unpredictability, and mass; and 5) speed and reach of disruption and lethality. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $19.667 million. Funding increased due to the realignment and consolidation of Air Force Applied Research Science and Technology funding for Future Air Force Capabilities Applied Research efforts.	0.000	0.000	19.667
Accomplishments/Planned Programs Subtotals	29.130	31.402	49.297

	FY 2018	FY 2019
Congressional Add: Program increase - human machine teaming	0.000	4.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622403 / *Flight Controls and Pilot-Vehicle Interface*

	FY 2018	FY 2019
FY 2018 Accomplishments: Not Applicable ***FY 2019 Plans:*** Conduct Congressionally directed efforts.		
Congressional Add: Program increase - flight controls and pilot-vehicle interfaces ***FY 2018 Accomplishments:*** Not Applicable ***FY 2019 Plans:*** Conduct Congressionally directed efforts.	0.000	5.000
Congressional Adds Subtotals	0.000	9.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602201F / *Aerospace Vehicle Technologies*	Project (Number/Name) 622404 / *Aeromechanics and Integration*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622404: *Aeromechanics and Integration*	-	28.663	30.932	28.595	0.000	28.595	29.503	30.635	31.910	32.571	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project develops aerodynamic configurations of a broad range of revolutionary, affordable aerospace vehicles. It matures and applies modeling and numerical simulation methods for fast and affordable aerodynamics prediction and integrates and demonstrates multi-disciplinary advances in airframe, propulsion, weapon and air vehicle control integration.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Aerodynamic Systems Technologies	7.582	8.181	6.407
Description: Develop aerodynamic assessment prediction methods centered on expanding the design capabilities of future air vehicles. ***FY 2019 Plans:*** Continue development and assessment of low cost attritable Unmanned Aircraft Vehicle (UAV) concepts. Complete assessment of efficient airfoil flow control and distributed propulsion concepts. Continue design assessments of distributed propulsion concepts for next generation Mobility. Initiate the development of a high fidelity aerodynamic analysis tool for the design of laser turrets applicable to Air Superiority 2030 requirements. ***FY 2020 Plans:*** Continue development and assessment of low cost attritable UAV concepts. Continue design assessments of distributed propulsion concepts for next generation Mobility. Continue the development of a high fidelity aerodynamic analysis tool for the design of laser turrets applicable to Air Superiority 2030 requirements (completing a sub-scale design in FY 2020 and starting a sub-scale build and full-scale turret design). Initiate the assessment and development of incorporating active flow control techniques into advanced design to enable new aircraft configurations. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $1.774 million. Funding decreased due to reduced emphasis in the high fidelity aerodynamic analysis for laser turret design and additional needs in the Aircraft Integration Technologies effort.			
Title: Next Generation Aerodynamic Technologies	9.137	9.860	7.087
Description: Develop and assess technologies for the next generation of multi-role large aircraft. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622404 / *Aeromechanics and Integration*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Complete development of high fidelity aerodynamic analysis and method development for future Air Superiority 2030. Complete development of practical laminar flow technologies for highly swept wings. Continue next generation tanker maturation and assess promising configurations in high and low speed wind tunnels. Complete distributed embedded propulsion wind tunnel test. Initiate wind tunnel tests of practical laminar flow treatments and coatings for highly swept wings applicable to Mobility applications. ***FY 2020 Plans:*** Continue next generation tanker maturation and assess promising configurations in high and low speed wind tunnels. Continue wind tunnel tests of practical laminar flow treatments and coatings for highly swept wings applicable to Mobility applications. Initiate the design of a small, pod-mounted tactical air refueling boom for future Mobility applications. Initiate the development of advanced high fidelity aerodynamic analysis tools for aircraft conceptual design. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $2.773 million. Funding decreased due to reduced emphasis in Next Generation Aerodynamic Technologies with the completion of the high fidelity aerodynamic analysis for Air Superiority 2030 and completion of the laminar flow technologies in 2019.			
Title: Aircraft Integration Technologies ***Description:*** Develop enabling technologies to allow efficient and effective integration of propulsion, weapons, and subsystems into current and future air vehicles. ***FY 2019 Plans:*** Continue development of advanced kinetic and directed energy weapons integration technologies for future air superiority. Complete the design of an integrated full flow path demonstration of a medium bypass embedded engine for next generation mobility. Initiate integrated full flow path demonstration of a medium bypass embedded engine for next generation mobility. Initiate propulsion integrations component wind tunnels tests for Air Superiority 2030 requirements. ***FY 2020 Plans:*** Continue development of advanced kinetic and directed energy weapons integration technologies for Air Superiority 2030. Continue integrated full flow path demonstration of a medium bypass embedded engine for next generation mobility, completing the system requirements definition in FY 2020 and starting the full flow bath demonstration design. Continue propulsion integrations component wind tunnels tests for Air Superiority 2030 requirements. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $2.210 million. Funding increased due to additional resources required for the design phase of integrated full flow path demonstration of a medium bypass embedded engine.	11.944	12.891	15.101
Accomplishments/Planned Programs Subtotals	28.663	30.932	28.595

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622404 / *Aeromechanics and Integration*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not Applicable.

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602201F / *Aerospace Vehicle Technologies*	Project (Number/Name) 622405 / *High Speed Systems Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622405: *High Speed Systems Technology*	-	41.819	45.712	28.015	0.000	28.015	25.917	26.448	27.415	27.982	Continuing	Continuing

A. Mission Description and Budget Item Justification

This effort investigates, analyzes, and develops high speed/hypersonic aerospace vehicle technologies. Advanced high temperature structures concepts are explored and developed to exploit new materials, fabrication processes, and design techniques. Advanced aerodynamic vehicle configurations are developed and analyzed through simulations, experiments, and multi-disciplinary analyses. Advanced flight control technologies are developed and simulated for hypersonic vehicles. These technologies will enable future high speed; weapons, intelligence, surveillance, and reconnaissance systems; and space access vehicles.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: High Speed Systems Technology	12.291	14.366	16.286
Description: Develop design analysis methods and technologies for high speed systems in for extreme flight conditions. ***FY 2019 Plans:*** Continue maturation of innovative structural concepts for high speed/hypersonic air vehicles. Continue development of analytical methods for predicting structural response needed for design and evaluation of hot primary structure for hypersonic vehicles. Continue to assess the impact of path dependent structural behavior on the service life prediction for hot structures encountering extreme environments. Continue to develop and integrate model uncertainty methods into multi-disciplinary simulations and quantify its impact on the structural margin. Continue development of structural analysis methods and technology for hot structure concepts under extreme environment loading conditions. Continue the assessment of the aerospace community to quantify the structural margins for extreme environment hot structure through experimental validation of ground test articles. Continue development of structural life prediction methodology for extreme environment structures and thermal protection systems. Initiate development on novel designs and demonstration of integrated hot structures for hypersonic reusable air platforms. ***FY 2020 Plans:*** Continue maturation of innovative structural concepts for high speed/hypersonic air vehicles. Continue development of analytical methods for predicting structural response needed for design and evaluation of hot primary structure for hypersonic vehicles. Continue to assess the impact of path dependent structural behavior on the service life prediction for hot structures encountering extreme environments. Continue to develop and integrate model uncertainty methods into multi-disciplinary simulations and quantify its impact on the structural margin. Continue development of structural analysis methods and technology for hot structure concepts under extreme environment loading conditions. Continue the assessment of the aerospace community to quantify the structural margins for extreme environment hot structure through experimental validation of ground test articles. Continue			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622405 / *High Speed Systems Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
development of structural life prediction methodology for extreme environment structures and thermal protection systems. Continue development on novel designs and demonstration of integrated hot structures for hypersonic reusable air platforms. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $1.920 million. Justification for the increase is to focus activities in design and life prediction on a proposed flight demonstration in FY 2022.			
Title: High Speed Vehicle Aeromechanics and Integration	8.851	10.346	11.729
Description: Develop new and improved components, concepts, and designs for sustained flight of high-speed/hypersonic expendable and re-useable vehicles. Conduct analyses of high speed/hypersonic vehicles to enable revolutionary capabilities. ***FY 2019 Plans:*** Complete the manufacturing of flight vehicle hardware for Hypersonic International Flight Research Experimentation 5c. Continue to mature critical technologies for high speed/hypersonic flight. Continue development of design/analysis techniques/ tools and 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 development of high speed system concepts that provide revolutionary capabilities. Continue investigation of aeromechanic technologies to reduced drag and enable robust stability and control at low dynamic pressure flight conditions. Continue efforts to characterize high-speed phenomena and develop and validate fundamental high- speed technologies through experimental testing. Continue assessment of mission-level effectiveness and refinement of definition of preferred high speed weapon alternatives and limited life hypersonic intelligence, surveillance, and reconnaissance vehicles. Continue assessment of campaign-level benefits of preferred high speed weapon alternatives. ***FY 2020 Plans:*** Continue to mature critical technologies for high speed/ hypersonic flight. Continue development of design/analysis techniques/ tools and 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 development of high speed system concepts that provide revolutionary capabilities. Continue investigation of aeromechanic technologies to reduced drag and enable robust stability and control at low dynamic pressure flight conditions. Continue efforts to characterize high-speed phenomena and develop and validate fundamental high- speed technologies through experimental testing. Continue assessment of mission-level effectiveness and refinement of definition of preferred high speed weapon alternatives and limited life hypersonic intelligence, surveillance, and reconnaissance vehicles. Continue assessment of campaign-level benefits of preferred high speed weapon alternatives. ***FY 2019 to FY 2020 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622405 / *High Speed Systems Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
FY 2020 increased compared to FY 2019 by $1.383 million. Funding increased due to additional vehicle design and propulsion integration activities to support proposed flight demonstration in FY 2022.			
Accomplishments/Planned Programs Subtotals	21.142	24.712	28.015

	FY 2018	FY 2019
Congressional Add: Program increase - high speed systems technology ***FY 2018 Accomplishments:*** Conducted Congressionally directed efforts ***FY 2019 Plans:*** Conduct Congressionally directed efforts	5.908	6.000
Congressional Add: Program increase - hypersonic vehicle structures ***FY 2018 Accomplishments:*** Conducted Congressionally directed efforts ***FY 2019 Plans:*** Conduct Congressionally directed efforts	9.846	10.000
Congressional Add: Program increase - hypersonic research capability development ***FY 2018 Accomplishments:*** Conducted Congressionally directed efforts ***FY 2019 Plans:*** Not Applicable	4.923	0.000
Congressional Add: Program increase - hypersonic wind tunnels ***FY 2018 Accomplishments:*** Not Applicable ***FY 2019 Plans:*** Conduct Congressionally directed efforts.	0.000	5.000
Congressional Adds Subtotals	20.677	21.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

Not Applicable

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force		Date: February 2019
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 0602201F / *Aerospace Vehicle Technologies*	**Project (Number/Name)** 622405 / *High Speed Systems Technology*

E. Performance Metrics

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