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 0602601F / *Space 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**
Total Program Element	-	145.921	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	145.921
621010: *Space Survivability & Surveillance*	-	38.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38.300
624846: *Spacecraft Payload Technologies*	-	25.402	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.402
625018: *Spacecraft Protection Technology*	-	21.348	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	21.348
628809: *Spacecraft Vehicle Technologies*	-	60.871	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	60.871

A. Mission Description and Budget Item Justification

This program focuses on four major areas. First, the space survivability and surveillance area develops technologies to understand space weather and the geophysics environment for mitigation and exploitation of these effects to Air Force systems. Second, the spacecraft payload technologies area improves satellite payload operations by developing advanced component and subsystem capabilities. Third, the spacecraft protection area develops technologies for protecting United States space assets in potential hostile settings. The last major area, spacecraft vehicles, focuses on spacecraft platform and control technologies, and their interactions. Efforts in this program have been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

In FY 2019, the entirety of PE 0602601F, Space Technology, transfers to PE 1206601F, Space Technology, to provide increased transparency to the Office of the Secretary of Defense and Congress regarding Space Science and Technology Major Force Program 12 Space investment.

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

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	116.503	0.000	0.000	0.000	0.000
Current President's Budget	145.921	0.000	0.000	0.000	0.000
Total Adjustments	29.418	0.000	0.000	0.000	0.000
• Congressional General Reductions	-0.126	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	32.100	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-2.556	0.000			
• Other Adjustments	0.000	0.000	0.000	0.000	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: 624846: *Spacecraft Payload Technologies*		
Congressional Add: *Program increase*	9.828	0.000
Congressional Add Subtotals for Project: 624846	9.828	0.000
Project: 628809: *Spacecraft Vehicle Technologies*		
Congressional Add: *Program increase - spacecraft vehicle technologies*	2.457	0.000
Congressional Add: *Small satellites for resiliency and augmentation of space architecture*	19.263	0.000
Congressional Add Subtotals for Project: 628809	21.720	0.000
Congressional Add Totals for all Projects	31.548	0.000

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 0602601F / *Space Technology*	Project (Number/Name) 621010 / *Space Survivability & Surveillance*	

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
621010: *Space Survivability & Surveillance*	-	38.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38.300

A. Mission Description and Budget Item Justification

This project develops technologies to understand and control the space environment for warfighter's future capabilities. The focus is on characterizing and forecasting the battlespace environment for more realistic space system design, modeling, and simulation, as well as the battlespace environment's effect on space systems' performance. This includes technologies to specify and forecast the space environment for planning operations, ensure uninterrupted system performance, optimize space-based surveillance operations, and provide capability to mitigate or exploit the space environment for both offensive and defensive operations. Finally, this project includes the seismic research program that supports national requirements for monitoring nuclear explosions.

For FY 2019 and beyond, the entirety of the Project 621010, Space Survivability and Surveillance, is reported under PE 1206601F, Space Technology, Project 621010, Space Survivability and Surveillance. This administrative transfer provides increased transparency to the Office of the Secretary of Defense and Congress regarding Space Science and Technology Major Force Program 12 Space investment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Space Environment Research	12.660	0.000	0.000
Description: Develop techniques, forecasting tools, sensors, and technologies for specifying, monitoring, predicting, and controlling space environmental conditions hazardous to Department of Defense operational space and radar systems.			
FY 2019 Plans: For FY 2019, this work is performed under the Space Environment Research effort in PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance.			
FY 2020 Plans: Not applicable			
FY 2019 to FY 2020 Increase/Decrease Statement: Not applicable			
Title: Surveillance Technologies	8.202	0.000	0.000
Description: Develop advanced target detection techniques, spectral signature libraries, and decision aids for space-based sensors and surveillance 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 0602601F / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
For FY 2019, this work is performed under the Surveillance Technologies effort in PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable			
Title: Radiation Remediation Research ***Description:*** Conduct Radiation Belt Remediation research through development and validation of analytical performance models for remediation of Earth radiation belts following high altitude nuclear detonation. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Radiation Remediation Research effort in PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable	2.625	0.000	0.000
Title: Seismic Technologies ***Description:*** Develop seismic technologies to support national requirements for monitoring nuclear explosions with special focus on regional distances less than 2,000 kilometers from the sensors. ***FY 2019 Plans:*** For FY 2019, this work is performed the under the Seismic Technologies effort in PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable	6.281	0.000	0.000
Title: Alternative Navigation Technologies	8.532	0.000	0.000

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 0602601F / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Description: Develop new technologies based on cold atom physics that provide autonomous jam-proof precision inertial navigation to augment Global Positioning System in case of Global Positioning System-denial. Develop atomic clocks based on new technologies to replace legacy Global Positioning System atomic clocks. ***FY 2019 Plans:*** For FY 2019, this work is performed under Alternative Navigation Technologies effort in PE 1206601F, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	38.300	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602601F / *Space Technology*	Project (Number/Name) 624846 / *Spacecraft Payload 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
624846: *Spacecraft Payload Technologies*	-	25.402	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.402

A. Mission Description and Budget Item Justification

This project develops advanced technologies that enhance spacecraft payload operations by improving component and subsystem capabilities. The project focuses on development of advanced, space-qualified, survivable electronics, and electronics packaging technologies; development of advanced space data generation and exploitation technologies, including infrared sensors; and development of high-fidelity space simulation models that support space-based surveillance and space asset protection research and development for the warfighter.

In FY 2019, the entirety of Project 624846, Spacecraft Payload Technologies is reported under PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. This administrative transfer provides increased transparency to the Office of the Secretary of Defense and Congress regarding Space Science and Technology Major Force Program 12 Space investment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Space-Based Detector Technologies	3.235	0.000	0.000
Description: Develop advanced infrared device technologies that enable hardened space detector arrays with improved detection to perform acquisition, tracking, and discrimination of space objects and missile warning.			
FY 2019 Plans: For FY 2019, this work is performed under the Space-Based Detector Technologies effort in PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies.			
FY 2020 Plans: Not applicable			
FY 2019 to FY 2020 Increase/Decrease Statement: Not applicable			
Title: Space Electronics Research	2.669	0.000	0.000
Description: Develop technologies for space-based payload components such as radiation-hardened electronic devices, micro-electro-mechanical system devices, and advanced electronics packaging.			
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 0602601F / *Space Technology*	**Project (Number/Name)** 624846 / *Spacecraft Payload Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
For FY 2019, this work is performed under the Space Electronics Research effort in PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable			
Title: Modeling and Simulation Tools for Space Applications ***Description:*** Develop modeling and simulation tools for space-based ground surveillance systems, rendezvous and proximity operations, imaging of space systems, disaggregated satellite architecture, and space control payloads. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Modeling and Simulation Tools for Space Applications effort in PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable	5.216	0.000	0.000
Title: Alternative Positioning, Navigation, and Timing Technology ***Description:*** Identify and develop technologies that enable new, or enhance existing, United States positioning, navigation, and timing satellite capabilities by increasing resiliency and availability of accuracy, and/or increasing the affordability of providing current capabilities. Develop technologies to meet identified Air Force Space Command/Space and Missile Systems Center positioning, navigation, and timing space payload technology needs. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Alternative Positioning, Navigation, and Timing Technology effort in PE 1206601F, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable	4.454	0.000	0.000
Accomplishments/Planned Programs Subtotals	15.574	0.000	0.000

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 0602601F / *Space Technology*	**Project (Number/Name)** 624846 / *Spacecraft Payload Technologies*

	FY 2018	FY 2019
Congressional Add: Program increase	9.828	0.000
FY 2018 Accomplishments: Conducted Congressionally directed effort		
FY 2019 Plans: Not applicable		
Congressional Adds Subtotals	9.828	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602601F / *Space Technology*	Project (Number/Name) 625018 / *Spacecraft Protection 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
625018: *Spacecraft Protection Technology*	-	21.348	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	21.348

A. Mission Description and Budget Item Justification

This project develops the technologies for protecting United States space assets in potentially hostile environments to assure continued space system operation without performance loss in support of warfighter requirements. The project focuses on identifying and assessing spacecraft system vulnerabilities, developing threat warning technologies, and developing technologies to mitigate the effects of both intentional and unintentional threats.

In FY 2019, the entirety of Project 625018, Spacecraft Protection Technology is reported under PE 1206601F, Space Technology, Project 625018, Spacecraft Protection Technology. This administrative transfer provides increased transparency to the Office of the Secretary of Defense and Congress regarding Space Science and Technology Major Force Program 12 Space investment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Threat Warning Research	21.348	0.000	0.000
Description: Develop satellite threat warning technologies and tools for space defense. Exploit on-board inherent satellite resources, satellite-as-a-sensor, and self-aware satellite technologies. Develop technologies to detect, assess, and respond to threats and anomalies. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Threat Warning Research effort in PE 1206601F, Space Technology, Project 625018, Spacecraft Protection Technology. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	21.348	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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 0602601F / *Space Technology*	**Project (Number/Name)** 625018 / *Spacecraft Protection Technology*

D. Acquisition Strategy

N/A

E. Performance Metrics

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

Exhibit R-2A, RDT&E Project Justification: PB 2020 Air Force			Date: February 2019
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 0602601F / *Space Technology*	Project (Number/Name) 628809 / *Spacecraft 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
628809: *Spacecraft Vehicle Technologies*	-	60.871	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	60.871

A. Mission Description and Budget Item Justification

This project focuses on spacecraft platforms (for example, structures, power, and thermal management); satellite control (such as, signal processing and control); and space experiments of maturing technologies for space qualification.

In FY 2019, the entirety of Project 628809, Spacecraft Vehicle Technologies, is reported under PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. This administrative transfer provides increased transparency to the Office of the Secretary of Defense and Congress regarding Space Science and Technology Major Force Program 12 Space investment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Space Power/Thermal Research	6.160	0.000	0.000
Description: Develop technologies for advanced space platform subsystems such as cryocoolers, compact, high efficiency solar power cells and arrays, and innovative power generation concepts. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Space Power/Thermal Research effort in PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable			
Title: Space Structures and Controls Research	11.553	0.000	0.000
Description: Develop revolutionary and enabling technologies, including lighter weight, lower cost, high performance structures for space platforms; guidance, navigation, and controls hardware and software for next generation of space superiority systems. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Space Structures and Controls Research effort in PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2020 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 0602601F / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable			
Title: Space Experiments ***Description:*** Develop flight experiments to improve the capabilities of existing operational space systems and to enable new transformational space capabilities. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Space Experiments effort in PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable	12.180	0.000	0.000
Title: Space Communication Technologies ***Description:*** Develop technologies for next-generation space communications terminals and equipment and methods/techniques to enable future space system operational command and control concepts. ***FY 2019 Plans:*** For FY 2019, this work is performed under the Space Communication Technologies effort in PE 1206601F, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2020 Plans:*** Not applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Not applicable	9.258	0.000	0.000
Accomplishments/Planned Programs Subtotals	39.151	0.000	0.000

	FY 2018	FY 2019
Congressional Add: Program increase - spacecraft vehicle technologies	2.457	0.000

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 0602601F / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

	FY 2018	FY 2019
FY 2018 Accomplishments: Conducted Congressionally directed effort ***FY 2019 Plans:*** Not applicable		
Congressional Add: Small satellites for resiliency and augmentation of space architecture ***FY 2018 Accomplishments:*** Conducted Congressionally directed effort ***FY 2019 Plans:*** Not applicable	19.263	0.000
Congressional Adds Subtotals	21.720	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

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