Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force												Date: May 2021
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 1206601F / *Space Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	-	155.984	0.000	0.000	0.000	0.000	-	-	-	-	-	-
621010: *Space Survivability & Surveillance*	-	40.282	0.000	0.000	0.000	0.000	-	-	-	-	-	-
624846: *Spacecraft Payload Technologies*	-	19.047	0.000	0.000	0.000	0.000	-	-	-	-	-	-
625018: *Spacecraft Protection Technology*	-	23.753	0.000	0.000	0.000	0.000	-	-	-	-	-	-
628809: *Spacecraft Vehicle Technologies*	-	72.902	0.000	0.000	0.000	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity 02 due to the creation of a new Appropriation for Space Force.

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.

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 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 0602298F, and 1206601SF.

This work will still be executed by the Air Force Research Laboratory Space Vehicles (AFRL/RV) Technology Directorate located at Kirtland Air Force Base, New Mexico. This is an administrative realignment and not a New Start.

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 2022 Air Force	Date: May 2021
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	161.667	0.000	0.000	0.000	0.000
Current President's Budget	155.984	0.000	0.000	0.000	0.000
Total Adjustments	-5.683	0.000	0.000	0.000	0.000
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.456	0.000			
• SBIR/STTR Transfer	-1.776	0.000			
• Other Adjustments	-4.363	0.000	0.000	0.000	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 625018: *Spacecraft Protection Technology*		
Congressional Add: *Program increase-space situational awareness research*	4.872	0.000
Congressional Add Subtotals for Project: 625018	4.872	0.000
Project: 628809: *Spacecraft Vehicle Technologies*		
Congressional Add: *Program increase - operational cryogenic upper stage augmentation kit*	9.744	0.000
Congressional Add: *Program increase - thin-film photovoltaic energy*	6.821	0.000
Congressional Add: *Resilient space structure architecture*	14.616	0.000
Congressional Add Subtotals for Project: 628809	31.181	0.000
Congressional Add Totals for all Projects	36.053	0.000

Change Summary Explanation

There is no change between FY 2021 and FY 2022. The following statement is for historical context.

In FY 2021, work formerly performed under this program was moved to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, due to the creation of a new Appropriation for Space Force.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 1206601F / *Space Technology*	Project (Number/Name) 621010 / *Space Survivability & Surveillance*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
621010: *Space Survivability & Surveillance*	-	40.282	0.000	0.000	0.000	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Space Environment Research ***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 2021 Plans:*** For FY 2021, this work will be performed under the Space Environment Research effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	18.146	0.000	0.000
Title: Surveillance Technologies ***Description:*** Develop advanced target detection techniques, spectral signature libraries, and decision aids for space-based sensors and surveillance systems.	6.020	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
FY 2021 Plans: For FY 2021, this work will be performed under the Surveillance Technologies effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 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 2021 Plans:*** For FY 2021, this work will be performed under the Radiation Remediation Research effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	1.770	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 2021 Plans:*** For FY 2021, this work will be performed under the Seismic Technologies effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:***	5.809	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 621010 / *Space Survivability & Surveillance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Not applicable			
Title: Alternative Navigation Technologies	8.537	0.000	0.000
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 2021 Plans:*** For FY 2021, this work will be performed under the Alternative Navigation Technologies effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 621010, Space Survivability & Surveillance. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	40.282	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 1206601F / *Space Technology*	Project (Number/Name) 624846 / *Spacecraft Payload Technologies*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
624846: *Spacecraft Payload Technologies*	-	19.047	0.000	0.000	0.000	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Space-Based Detector Technologies	3.983	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 2021 Plans:*** For FY 2021, this work will be performed under the Space-Based Detector Technologies effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 624846, Spacecraft Payload Technologies ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable			
Title: Space Electronics Research	4.450	0.000	0.000
Description: Develop technologies for space-based payload components such as radiation-hardened electronic devices, microelectro-mechanical system devices, and advanced electronics packaging. ***FY 2021 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 624846 / *Spacecraft Payload Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
For FY 2021, this work will be performed under the Space Electronics Research effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 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 2021 Plans:*** For FY 2021, this work will be performed under the Modeling and Simulation Tools for Space Applications effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	5.564	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 2021 Plans:*** For FY 2021, this work will be performed under the Alternative Positioning, Navigation, and Timing Technology effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 624846, Spacecraft Payload Technologies. ***FY 2022 Plans:***	5.050	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 624846 / *Spacecraft Payload Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	19.047	0.000	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 1206601F / *Space Technology*	Project (Number/Name) 625018 / *Spacecraft Protection Technology*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
625018: *Spacecraft Protection Technology*	-	23.753	0.000	0.000	0.000	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

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 development of technologies to mitigate the effects of both intentional and unintentional threats.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Threat Warning Research	18.881	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 2021 Plans:*** For FY 2021, this work will be performed under the Threat Warning Research effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 625018, Spacecraft Protection Technology. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable			
Accomplishments/Planned Programs Subtotals	18.881	0.000	0.000

	FY 2020	FY 2021
Congressional Add: Program increase-space situational awareness research	4.872	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 625018 / *Spacecraft Protection Technology*

	FY 2020	FY 2021
FY 2020 Accomplishments: Conduct Congressionally directed effort. ***FY 2021 Plans:*** Not applicable.		
Congressional Adds Subtotals	4.872	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force			Date: May 2021
Appropriation/Budget Activity 3600 / 2	R-1 Program Element (Number/Name) PE 1206601F / *Space Technology*	Project (Number/Name) 628809 / *Spacecraft Vehicle Technologies*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
628809: *Spacecraft Vehicle Technologies*	-	72.902	0.000	0.000	0.000	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

In FY 2021, PE 1206601F, Space Technology efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, from Appropriation 3600, Budget Activity 02 due to the creation of a new Appropriation for Space Force.

This is an administrative realignment and not a New Start.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Space Power/Thermal Research	4.054	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 2021 Plans:*** For FY 2021, this work will be performed under the Space Power/Thermal Research effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable			
Title: Space Structures and Controls Research	10.115	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 2021 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
For FY 2021, this work will be performed under the Space Structures and Controls Research effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 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 2021 Plans:*** For FY 2021, this work will be performed under the Space Experiments effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	21.597	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 2021 Plans:*** For FY 2021, this work will be performed under the Space Communication Technologies effort in Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206601SF, Space Technology, Project 628809, Spacecraft Vehicle Technologies. ***FY 2022 Plans:*** Not applicable ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Not applicable	5.955	0.000	0.000
Accomplishments/Planned Programs Subtotals	41.721	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force		Date: May 2021
Appropriation/Budget Activity 3600 / 2	**R-1 Program Element (Number/Name)** PE 1206601F / *Space Technology*	**Project (Number/Name)** 628809 / *Spacecraft Vehicle Technologies*

	FY 2020	FY 2021
Congressional Add: Program increase - operational cryogenic upper stage augmentation kit ***FY 2020 Accomplishments:*** Conduct Congressionally directed effort ***FY 2021 Plans:*** Conduct Congressional directed effort.	9.744	0.000
Congressional Add: Program increase - thin-film photovoltaic energy ***FY 2020 Accomplishments:*** Conduct Congressionally directed effort. ***FY 2021 Plans:*** Not applicable.	6.821	0.000
Congressional Add: Resilient space structure architecture ***FY 2020 Accomplishments:*** Conduct Congressionally directed effort ***FY 2021 Plans:*** Not Applicable.	14.616	0.000
Congressional Adds Subtotals	31.181	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable