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Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Office of the Secretary Of Defense **Date:** February 2020

Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide I BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602251D8Z I <i>Applied Research for the Advancement of S&T Priorities</i>
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	47.550	59.567	60.400	60.722	-	60.722	60.740	60.746	60.749	60.758	Continuing	Continuing
227: <i>Applied Research for the Advancement of S&T Priorities</i>	47.550	59.567	60.400	60.722	-	60.722	60.740	60.746	60.749	60.758	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Applied Research for the Advancement of Science and Technology (S&T) Priorities (ARAP) program element (PE) enables the early launch of S&T applied research projects to shape Components' investments. The PE focuses on the design, development, and improvement immature technologies and new processes to achieve general mission requirements and to translate promising research into solutions for military needs. In addition, the PE enables concept exploration efforts and studies of alternative concepts. The research projects are aligned with the Department of Defense (DoD) S&T priorities and designated focus areas that include non-system specific technology efforts and feasibility assessments and are formulated and managed by teams of subject matter experts drawn from the Office of the Secretary of Defense, the Military Services, and the Defense Agencies. The PE also provides support to the S&T Communities of Interest (Cols).

B. Program Change Summary (\$ in Millions)

	<u>FY 2019</u>	<u>FY 2020</u>	<u>FY 2021 Base</u>	<u>FY 2021 OCO</u>	<u>FY 2021 Total</u>
Previous President's Budget	60.550	62.200	60.240	-	60.240
Current President's Budget	59.567	60.400	60.722	-	60.722
Total Adjustments	-0.983	-1.800	0.482	-	0.482
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-8.800			
• Congressional Adds	-	7.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.973	-			
• Other Adjustments	-0.010	-	0.542	-	0.542
• Economic Assumption	-	-	-0.060	-	-0.060

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

Project: 227: *Applied Research for the Advancement of S&T Priorities*

Congressional Add: *Per- and Polyfluoroalkyl Substances (PFAS) Modeling*

	FY 2019	FY 2020
	-	7.000
Congressional Add Subtotals for Project: 227	-	7.000
Congressional Add Totals for all Projects	-	7.000

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Appropriation/Budget Activity
0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2:
Applied Research

R-1 Program Element (Number/Name)
PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*

Change Summary Explanation

Program adjustments are consistent with higher priority DoD requirements.

In FY 2020:

Program reduced by -\$8.800 million for excess growth.

Program increased by \$7.000 million for per- and polyfluoroalkyl substances (PFAS) modeling.

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Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602251D8Z / <i>Applied Research for the Advancement of S&T Priorities</i>	Project (Number/Name) 227 / <i>Applied Research for the Advancement of S&T Priorities</i>
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
<i>227: Applied Research for the Advancement of S&T Priorities</i>	47.550	59.567	60.400	60.722	-	60.722	60.740	60.746	60.749	60.758	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Applied Research for the Advancement of Science and Technology (S&T) Priorities program was established to implement Department-wide technology development portfolios and foster Tri-Service research areas of common interest within cross-cutting S&T efforts. The program has three investment areas: (1) large, three-year applied research programs selected by the S&T Executives; (2) smaller, two-year technology ‘seedling’ programs nominated by the Communities of Interest (Cols) to address technology gaps or opportunities; and (3) technical support to the Cols. The execution of the program by the Office of the Secretary of Defense and the support it provides to the Cols assures strategic oversight and multi-agency coordination.

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

	FY 2019	FY 2020	FY 2021
<p>Title: Applied Research for the Advancement of S&T Priorities</p> <p>Description: The program focuses on fostering tri-service research areas of common interest within cross-cutting S&T efforts that give the joint warfighter a technological advantage. It is intended to focus on emerging areas of science, to build expertise within Department of Defense laboratories, to include investment in laboratory infrastructure and people, and will be a foundation for further investments by the Services following the completion of the projects.</p> <p>Cross-cutting efforts align with the S&T Priorities, such as Electronic Warfare, Human Systems, Autonomy, and Cyber, as well other focus areas, such as Advanced Materials, Biomedical, Weapons, Quantum, and Command, Control, Communications, Computers and Intelligence.</p> <p>FY 2020 Plans: Defense Optical Channel Program (DOC-P) (\$15 million) (Year 3 of 3): – Finalize DoD relevant applications for both digital and microwave Free Space Optical. – Build Free Space Optical brass board terminals for both digital and microwave forms. – Perform outdoor range testing on new free space optical terminals. – Validate Modulated laser format for Optical Time Transfer at 2.3 km outdoor range. – Demonstrate pulsed based Optical Time Transfer. – Demonstrate Multi-use and Multi-access Optical Time Transfer and communication links with frequency combs. – Validate propagation losses through free-space Quantum-communication experiments and characterize channel through quantum information metrics.</p> <p>Enhanced Energetics Effects (EEE) (\$15 million) (Year 2 of 3):</p>	46.000	47.200	54.522

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

	FY 2019	FY 2020	FY 2021
<ul style="list-style-type: none"> - Machine-learning model development, for energetic material synthesis and for propellant burn rate predictions. - In-depth characterization and reaction mechanisms studies of aluminum nanoclusters encapsulated in fullerenes and aluminum-carbon core/shell structures and lab-scale detonation velocity measurements of these materials. - Characterization and testing of aluminized nano-CL20 and amorphous-CL20 explosive and propellant formulations to measure burn rates and detonation velocities. - Begin additive manufacturing production of chosen concept and post-production characterization to include initiator/ignitor, propelling charge, rocket assist grain/motor, and warhead. - Three labs with continuous flow processing equipment will perform a comparative DNAN (2,4-Dinitroanisole) synthesis study, and then start scale-up studies. - A few minimum-smoke and reduced smoke rocket propellant formulation will be chosen for scale up and small-motor testing. <p>Topologically Enabled Devices (TEDs) (\$14 million) (Year 1 of 3)</p> <ul style="list-style-type: none"> - Supports parallel efforts (led by the Navy and Air force) to develop next generation memory and optoelectronic devices, also utilizing topological materials. - This program will produce (1) a novel, low-power transistor consuming 100x less energy per operation than state-of-the-art (SOA); (2) non-volatile magnetic memory devices require 100x less power and operating 1000x faster than SOA; (3) a circularly polarized light detector implemented at chip-scale; and (4) an on-chip laser isolator to enable high performance integrated photonic circuits. <p>- Selection of next high-impact program for FY 2020 (\$1.000 million).</p> <p>- Fund seedling projects - for Two Years: FY19 Seedlings (Year 2 of 2): (1) Establishing the Critical Tests for Machine Understanding for Humane-Machine Teaming; (2) 150-Volt Ultra-wide Bandgap High Efficiency RF Amplifier Technology; and (3) FY 2020 award new seedling(s).</p> <p>FY 2021 Plans:</p> <ul style="list-style-type: none"> - Continue FY 2020 Applied Research for the Advancement of S&T Priorities projects: (1) Enhanced Energetics Effects (EEE) (Year 3 of 3); and (2) Topologically Enabled Devices (TEDs) (Year 2 of 3). Select and initiate FY 2021 Applied Research for the Advancement of S&T Priorities project. - Continue to fund selected FY 2020 (to be identified in 3rd Quarter FY 2020) and new FY 2021 (to be identified in 3rd Quarter FY 2021) seedling projects. <p>FY 2020 to FY 2021 Increase/Decrease Statement:</p>			

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
The decrease reflects changes in budget fluctuations.				
Title: S&T Communities of Interest (Cols)		5.567	6.200	6.200
Description: The S&T Cols effort facilitates cooperation and collaboration among Components; it optimizes the development of critical S&T efforts across the DoD enterprise. The efforts include the development of technology roadmaps and the integration of technology planning. The Cols select and examine critical technology areas to address gaps or opportunities.				
FY 2020 Plans: - Provide technical support to the Cols (\$6.200 million), i.e., Advanced Electronics; Air Platforms; Autonomy; Biotechnology; Command, Control, Communications, Computers, and Intelligence (C4I); Cyber; Directed Energy - Non-Lethal Weapons; Electronic Warfare; Energy and Power; Ground and Sea Platforms; Human Systems; Kinetic Weapons Technologies; Materials and Manufacturing Processes; Sensors and Processing; and Space.				
FY 2021 Plans: - Continue to provide technical support to the Cols (\$6.200 million), i.e., Advanced Electronics; Air Platforms; Autonomy; Biotechnology; Command, Control, Communications, Computers, and Intelligence (C4I); Cyber; Directed Energy - Non-Lethal Weapons; Electronic Warfare; Energy and Power; Ground and Sea Platforms; Human Systems; Kinetic Weapons Technologies; Materials and Manufacturing Processes; Sensors and Processing; and Space.				
FY 2020 to FY 2021 Increase/Decrease Statement: The level of effort is consistent between FY 2020 and FY 2021.				
Title: Additive Manufacturing (AM) of Energetics		8.000	-	-
Description: Additive manufacturing (AM) of energetics provides the ability for tailored and integrated munitions with enhanced capabilities. Integration of unique printed structures and printed energetics with smart fusing can allow for more agile manufacturing processes with reduced development times. As a cross-service area of interest, the Department of Defense Communities of Interest in Materials and Manufacturing Processes and Weapons Technologies have engaged in discussions to identify areas of collaboration. In order to rapidly advance additive manufacturing of energetics, a joint effort across the services and the Department of Energy would support the programs interested in AM of energetics, such as Program Executive Office for Ammunition, Next Generation Hand-Grenade, Harpoon, and Lightweight torpedo.				
Accomplishments/Planned Programs Subtotals		59.567	53.400	60.722
		FY 2019	FY 2020	
Congressional Add: Per- and Polyfluoroalkyl Substances (PFAS) Modeling		-	7.000	

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	FY 2019	FY 2020
FY 2020 Plans: Implement an Applied Research for the Advanced of S&T Priorities (ARAP) project to assess concerns about the human health and environmental impacts of per- and polyfluoroalkyl substances (PFAS).		
Congressional Adds Subtotals	-	7.000

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

N/A

Remarks

D. Acquisition Strategy

N/A