Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Office of the Secretary Of Defense	Date: May 2021
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602251D8Z *I Applied Research for the Advancement of S&T Priorities*

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	-	58.450	53.359	65.015	-	65.015	-	-	-	-	-	-
227: *Applied Research for the Advancement of S&T Priorities*	-	58.450	53.359	65.015	-	65.015	-	-	-	-	-	-

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, develop Department of Defense (DoD) expertise in emerging technology areas, and build DoD facility capabilities. The PE focuses on the design, development, and improvement of 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 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 (CoIs) multi-agency collaboration and coordination. The S&T CoIs produce Joint S&T Roadmaps to contribute to the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) Modernization Priority Roadmaps.

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	60.400	60.722	60.740	-	60.740
Current President's Budget	58.450	53.359	65.015	-	65.015
Total Adjustments	-1.950	-7.363	4.275	-	4.275
• Congressional General Reductions	-	-7.363			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.940	-			
• Undistributed Reduction - Excess to Need	-0.010	-	-	-	-
• Program Adjustment	-	-	4.275	-	4.275

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 227: *Applied Research for the Advancement of S&T Priorities*		
Congressional Add: *Per- and Polyfluoroalkyl Substances (PFAS) Modeling*	7.000	-

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Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add Subtotals for Project: 227	7.000	-
Congressional Add Totals for all Projects	7.000	-

Change Summary Explanation

FY 2022 increase for the Power Thermal Management project.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense			Date: May 2021
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	Project (Number/Name) *227 / Applied Research for the Advancement of S&T Priorities*	

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
227: *Applied Research for the Advancement of S&T Priorities*	-	58.450	53.359	65.015	-	65.015	-	-	-	-	-	-

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 S&T Communities of Interest (CoIs) to address technology gaps or opportunities; and (3) support to the CoIs. The execution of the program by the Office of the Secretary of Defense and the support it provides to the CoIs assures joint strategic S&T oversight and multi-Service, multi-agency collaboration and coordination.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Applied Research for the Advancement of S&T Priorities (ARAP)	45.250	48.559	55.215

Description: The program focuses on cross-cutting S&T efforts that foster tri-service research areas of common interest that give the joint warfighter a technological advantage. It focuses on emerging areas of science, building expertise within the DoD laboratories, including investment in laboratory infrastructure and people, and on research areas that are a foundation for further investments by the Services following the completion of the projects.

Cross-cutting efforts are aligned with S&T Priorities, such as Electronic Warfare, Human Systems, Autonomy, Space, Kinetic Weapons, Directed Energy and Non-Lethal Weapons, Cyber, Sensors and Processing, Command, Control, Communications, Computers and Intelligence, Air Platforms, and Ground and Sea Platforms, as well other focus areas, such as Materials and Manufacturing Processes, Advanced Electronics, Energy and Power Technologies, Biotechnology, and Armed Services Biomedical Research Evaluation and Management.

FY 2021 Plans:

Continue to fund current ARAP projects: (1) Enhanced Energetics Effects (EEE) (Year 3 of 3); (2) Topologically Enabled Devices (TEDs) (Year 2 of 3); and (3) A Combined Development Pipeline for Novel Neuromorphic Hardware (NeuroPipe) (Year 1 of 3).

(1) Enhanced Energetics Effects:
- Develop Machine-Learned (ML) computational tools to predict synthetic chemical routes for energetic molecules to predict simple pathways. The database is being augmented for synthesis of more exotic energetics. Also building a database for predicting propellant burn rates using ML tools.
- Scale up novel forms of the most energetic explosive ingredients to be transitioned to a production facility.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Office of the Secretary Of Defense		Date: May 2021
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	**Project (Number/Name)** *227 / Applied Research for the Advancement of S&T Priorities*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
- Develop Additive Manufacturing (AM) feed-stocks and mixing print heads, using improved topology optimization computations to design best AM energetic structures to print. - Prepare and scale up new rocket propellant formulations for rocket motor testing. - Improve ML computational tools and make accessible to synthesis chemists. - Formulate novel forms of the most-energetic explosive ingredient into explosives to provide high brisance and into propellant formulations to increase range. - Print a gun-projected, rocket-propelled, fragmenting warhead as a demonstrator of AM of energetics, metal weapon cases and flexible electronics. - Transition new rocket propellants to industry and test at the seven-inch motor scale. (2) Topologically-Enabled Devices (TEDs): - Continue material growth and processing investigations to complete material combination down-select for transistor, memory, and optoelectronic devices. - Demonstrate initial functioning prototype topological electronic and optoelectronic components. - Develop test beds and establish test procedures at each agency for joint Year 3 demonstration projects in Terahertz speed electronics, non-volatile memory, infrared communications and sensing, and miniaturized integrated optoelectronics. (3) A Combined Development Pipeline for Novel Neuromorphic Hardware (NeuroPipe): - Develop software for first test memristor chip. - Develop spiking neuron network (SNN) models for two types of memristors. - Develop SNN algorithms. - Develop infrastructure for heterogonous device design, oxide memristor processing, 2D materials based heterogonous device design, organic/inorganic materials integration, and large scale deposition of ferroelectric materials. Select and initiate a new FY 2021 ARAP project. Continue to fund current seedlings projects, including: (1) Optical Multi-Channel Beamforming for Electronic Warfare (year 2 of 2); (2) 150 Volt Ultra-Wide Bandgap High-Efficiency RF Amplifier Technology (year 2 of 2); (3) Establishing the Critical Tests for Machine Understanding for Human-Machine Teaming (year 2 of 2). Select up to three new FY 2021 seedling projects (to be identified in 3rd Quarter FY 2020). ***FY 2022 Plans:*** Continue ARAP projects, including: (1) Topologically Enabled Devices (TEDs) (Year 3 of 3); (2) A Combined Development Pipeline for Novel Neuromorphic Hardware (NeuroPipe) (Year 2 of 3); and (3) FY 2021 project.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
(1) Topologically-Enabled Devices (TEDs): - Continue exploration, optimization, and process development of topological electronic and magnetic materials. - Demonstrate multi-bit topological transistor and memory circuit with necessary integration and packaging. - Demonstrate polarization sensitive topological optoelectronic sensors for communication and LiDAR imaging. - Integrated topological laser demonstration on atomic clock chip. (2) A Combined Development Pipeline for Novel Neuromorphic Hardware (NeuroPipe): - Design and mask tape-out of Complementary metal-oxide semiconductor (CMOS) front-end (first test chip), Nanophotonic reservoir computing device (tunable coupling and dynamical stability in network of five nanolasers) - Demonstrate reservoir computing with single time-multiplexed nanolaser node - Develop Memristor spiking neural networks (SNN) hardware - Develop novel memristor material/device testbed or for CMOS first test chip - Develop ion-gated memristors test hardware operating with different weight levels, high frequency switching for 100 100 devices - Demonstrate reconfigurability up to 10 weight levels and 10mV resolution. (3) Continue FY 2021 ARAP project to be selected during FY 2021. Select and initiate a new FY 2022 ARAP project. Continue up to three seedling programs awarded in FY 2021. Select and initiate a new FY 2022 seedling project (to be identified in 3rd Quarter FY 2022). ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Changes reflect the selection and initiation of a new FY 2022 seedling project.			
Title: S&T Communities of Interest (CoIs) ***Description:*** The S&T CoIs facilitate coordination and collaboration across Components to reduce duplication and optimize the development of critical S&T efforts across the DoD enterprise. Their efforts include the development of joint S&T roadmaps and the planning of technology integration. The CoIs assess and address capability gaps and their multi-domain operational impact. ***FY 2021 Plans:*** Continue to provide support to the CoIs, i.e., Advanced Electronics; Air Platforms; Autonomy; Armed Services Biomedical Research Evaluation and Management. Biotechnology; Command, Control, Communications, Computers, and Intelligence (C4I);	6.200	4.800	4.800

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Cyber; Directed Energy - Non-Lethal Weapons; Electronic Warfare; Energy and Power; Ground and Sea Platforms; Human Systems; Kinetic Weapons; Materials and Manufacturing Processes; Sensors and Processing; and Space. ***FY 2022 Plans:*** Continue to provide support to the CoIs, i.e., Advanced Electronics; Air Platforms; Autonomy; Armed Services Biomedical Research Evaluation and Management. 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; Materials and Manufacturing Processes; Sensors and Processing; and Space. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** No changes.			
Title: Power Thermal Management ***Description:*** The program focuses on cross-cutting power and thermal Applied Research efforts that enable integration of high-power and high-energy mission systems on platforms. The program pursues solutions to challenges or gaps in power and thermal technologies, research areas and DoD laboratory expertise, including investment in laboratory infrastructure and people, that are a foundation for platform-integrated and fielded capability. Cross-cutting efforts include power and thermal technologies and subcomponents that support more than one domain (air, sea, land, or space) or address power and thermal technologies required for standardization to broadly realize capability across multiple platforms. ***FY 2022 Plans:*** Investigate and mature technologies that enable cross-domain solutions for large-scale energy storage on platforms in a manner that is safe and scalable and delivers power and energy densities appropriate for advanced mission systems. Support cross-domain modeling of power and thermal architecture necessary to assess challenges and advance emerging thermal technologies that enable advanced mission systems. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2022 increase reflects program initiation.	-	-	5.000
Accomplishments/Planned Programs Subtotals	51.450	53.359	65.015

	FY 2020	FY 2021
Congressional Add: Per- and Polyfluoroalkyl Substances (PFAS) Modeling	7.000	-

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	FY 2020	FY 2021
FY 2020 Accomplishments: Development of Novel Modeling Approaches for Rapid Risk Characterization of PFAS and PFAS alternatives ($4.000 million): - Completed initial artificial intelligence model for identification of PFAS surrogate chemicals. - Identified computational models for human uptake, distribution and metabolism of PFASs. - Completed molecular calculation of physical properties of PFAS and fluorine-free alternatives. - Completed initial computational models for fish tissue concentrations of PFASs and potential adverse effects. - Complete artificial intelligence computer vision models for developmental toxicity endpoints. - Complete Human Risk model to predict PFAS effects using non-animal testing data. - Complete Fish Ecological risk model to predict PFAS effects using non-animal test data. - Complete integration of Models into Rapid PFAS Risk Decision Tool. Degradation, destruction and removal of PFAS guided through advanced computational modeling and simulation approaches and artificial intelligence (AI)/machine learning (ML) algorithms ($3.000 million): - Completed initial database of PFAS physical and chemical properties. - Developed primary thermal degradation reactions of PFAS compounds. - Completed initial computational model for PFAS absorbents. - Identified potential microbes for PFAS degradation. - Create a PFAS database using AI/ML. - Create computational models to predict thermal degradation kinetics. - Use models to predict PFAS isolation and removal efficiency of adsorbents. - Use computational models to predict chemical degradation kinetics. - Deliver microbial degradation model for PFAS.		
Congressional Adds Subtotals	7.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A