Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Navy												Date: March 2023
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602114N *I Power Proj Applied Research*							
COST ($ in Millions)	**Prior Years**	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	41.760	27.953	23.982	-	23.982	23.880	24.358	24.845	25.341	Continuing	Continuing
0000: *Power Proj Applied Research*	0.000	22.453	22.953	23.982	-	23.982	23.880	24.358	24.845	25.341	Continuing	Continuing
9999: *Congressional Adds*	0.000	19.307	5.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	24.307

A. Mission Description and Budget Item Justification

In an Artificial Intelligence (AI) enabled maritime battlespace, the ability to fight at the speed of light will determine the outcome. The effective defense against threats increasingly beyond human speed, will enable U.S. naval forces to outthink, outmaneuver and outfight adversaries. This Program Element (PE) supports both advanced technology research and near to mid-term transition opportunities. The advanced research focus is primarily on directed energy, high speed weapon propulsion, Electro-Optic/Infrared (EO/IR) sensor technologies, and Naval Precision Strike Operations. The goal of this research is to develop technologies and capabilities that enable Directed Energy (DE) weapons as well as defense against adversary DE systems; the development of vehicle and propulsion technology for high-speed weapons operating from Mach 3 to Mach 8 and beyond; investment in the areas of Electro Optic/Infrared devices and advanced sensors; and technologies that provide the navy of the future the ability to quickly locate, target, and strike critical targets ashore.

Today's Sailors and Marines are enabled by naval Science and Technology (S&T). Since 1946, the Office of Naval Research (ONR) has fostered scientific research related to the maintenance of maritime superiority and national defense. ONR manages the Department of the Navy's (DON) portfolio of naval Basic and Applied research, and Advanced Technology Development investments to ensure naval forces can effectively deter conflict, but when called upon, fight, win and come home safe. Current investments hedge against uncertainty, providing solutions to commanders today, and options for the future. The Naval S&T budget supports higher guidance defined by the National Defense Strategy, and responds to requirements identified by the Secretary of the Navy through research priorities set by the Chief of Naval Research, coordinated across the Naval Research Enterprise (NRE), and outlined in the Naval R&D Framework.

This Program Element (PE) funds Applied Research, which is the systematic study to understand the means to meet a recognized and specific need. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments).

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Navy	Date: March 2023
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602114N *I Power Proj Applied Research*

B. Program Change Summary ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	43.013	22.953	27.166	-	27.166
Current President's Budget	41.760	27.953	23.982	-	23.982
Total Adjustments	-1.253	5.000	-3.184	-	-3.184
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	5.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.253	0.000			
• Program Adjustments	0.000	0.000	-3.184	-	-3.184
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Project: 9999: *Congressional Adds*		
Congressional Add: *Miniaturization of Lasers*	3.861	0.000
Congressional Add: *Manufacturing of high temperature hypersonic materials*	7.723	0.000
Congressional Add: *Multi-mission UAV-borne electronic attack*	7.723	0.000
Congressional Add: *Meta material broadband coatings*	0.000	5.000
Congressional Add Subtotals for Project: 9999	19.307	5.000
Congressional Add Totals for all Projects	19.307	5.000

Change Summary Explanation

Funding: $3.184M S&T reduction to comply with Defense Planning Guidance

Technical: No significant change.

Schedule: No significant change

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602114N / *Power Proj Applied Research*	Project (Number/Name) 0000 / *Power Proj Applied Research*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
0000: *Power Proj Applied Research*	0.000	22.453	22.953	23.982	-	23.982	23.880	24.358	24.845	25.341	Continuing	Continuing

A. Mission Description and Budget Item Justification

In an Artificial Intelligence (AI)enabled maritime battlespace, the ability to fight at the speed of light will determine the outcome. The effective defense against threats increasingly beyond human speed, will enable U.S. naval forces to outthink, outmaneuver and outfight adversaries. This Project supports both advanced technology research and near to mid-term transition opportunities. The advanced research focus is primarily on directed energy, high speed weapon propulsion, electro-optic/ infrared (EO/IR) sensor technologies, and Naval Precision Strike Operations. The goal of this research is to develop technologies and capabilities that enable Directed Energy (DE) weapons as well as defense against adversary DE systems; the development of vehicle and propulsion technology for high-speed weapons operating from Mach 3 to Mach 8 and beyond; investment in the areas of Electro Optic/Infrared devises and advanced sensors; and technologies that provide the navy of the future the ability to quickly locate, target, and strike critical targets ashore.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Title: Directed Energy	7.484	7.139	6.191	0.000	6.191
Description: The goal of this activity is to develop technologies and capabilities that enable Directed Energy (DE) weapons for naval applications as well as defense against adversary DE systems. The advanced research focus is in Naval Ship Defense, Naval Air Defense, and Naval Precision Strike Operations. The scope of this activity includes systems, sub-systems and their associated technologies. These technologies provide naval forces the ability to quickly engage critical and emerging targets, in cost effective means, while minimizing potential collateral damage, as well as the ability to defend against and counter adversarial modes of attack. ***FY 2023 Plans:*** Conduct exploratory research and develop component technologies that enables higher power, more lethal High Energy Laser (HEL), High Power Microwave (HPM) and Ultra Short Pulse Laser (USPL) weapons. Continuing Efforts - Development of novel laser and beam-director architectures - Improved sensor and illuminator technologies - Improved HEL electrical-to-optical efficiency - Improved laser sources with enhanced spectrum control - Reduced system jitter and improved precision aim-point maintenance - Improved characterization of atmosphere and associated modeling tools - Improved understanding of blooming and laser/material/target interactions					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Development of novel laser sources in Mid Wave Infrared (MWIR) and Long Wave Infrared (LWIR) - Development of Counter-capabilities, including the understanding of HEL Weapons risks to US naval forces - Improved understanding of USPL propagation mechanisms and effects - Development of understanding of HPM use in Electromagnetic (EM) Maneuver Warfare and Integrated Defense of US naval forces - Improved understanding of HPM effects and lethality - Effort to develop and apply innovative S&T in plasmas, pulsed power, electromagnetic acceleration, particle beams, high-energy & ultra-short-pulse lasers (USPL), and non-linear optics to support current and future Navy and DoD needs. Continue to focus on areas of high power fiber laser efforts. Initiating Efforts - Engineering USPL sub-component maturation for prototype sub systems - USPL component integration for prototype system of systems (SOS) experimentation - New effort for novel Counter-HEL capability -Preparation for range testing of HPM engagement systems -Performing system level performance analysis and mission level modeling relative to threats. -Applied research to further the State-of-the-Art Advancement for HPM source, antenna, pulsed power, and high voltage power supplies to support prototype development. -Explore HPM source and related component development around open architecture principles, to explore hardware options for achieving effective system CONEMPS -Developing self-contained HPM prototype development with integrated sensor and C2 capabilities that will provide a response to UAS swarm attack. ***FY 2024 Base Plans:*** Conduct exploratory research and develop component technologies that enables more capable and more lethal High Energy Laser (HEL), High Power Microwave (HPM) and Ultra Short Pulse Laser (USPL) weapons technologies aligned to warfighter requirements and capabilities to counter adversary DE weapons through Counter Directed Energy Weapons (CDEW). Continuing Efforts - Development of novel laser and beam-director architectures - Improved sensor and illuminator technologies - Reduced system jitter and improved precision aim-point maintenance					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Improved characterization of atmosphere and associated modeling tools - Improved understanding of blooming and laser/material/target interactions - Development of novel laser sources in Mid Wave Infrared (MWIR) and Long Wave Infrared (LWIR) - Improved understanding of USPL propagation mechanisms and effects - Development of understanding of HPM use in Electromagnetic (EM) Maneuver Warfare and Integrated Defense of US naval forces - Improved understanding of HPM effects and lethality through RF coupling, device interaction physics and component level effects - Engineering USPL sub-component maturation for prototype sub systems - USPL component integration for prototype system of systems (SOS) experimentation - The effort for novel Counter-HEL capability - Range testing of HPM engagement systems - Performing system level performance analysis and mission level modeling relative to threats. - Applied research to further the State-of-the-Art Advancement for HPM capable low profile steerable antennas; high energy density capacitors, solid-state high voltage switches; high voltage power supplies, power electronics switches, and hardened controls to support prototype development. - Explore HPM source and related component development around open architecture principles, to explore hardware options for achieving effective system CONEMPS - Developing self-contained HPM prototype development with integrated sensor and C2 capabilities that will provide a response to UAS swarm attack in both ground and air platform applications -Applied research in Solid-state and vacuum electronic based HPM sources capable of flexible waveforms for cross EM spectrum applications - Effort to develop and apply innovative S&T in plasmas, pulsed power, electromagnetic acceleration, particle beams, high-energy & ultra-short-pulse lasers (USPL), and non-linear optics to support current and future Navy and DoD needs. Completing Efforts - Improved laser sources with enhanced spectrum control - Improved HEL electrical-to-optical efficiency - Development of Counter-capabilities, including the understanding of HEL Weapons risks to US naval forces Initiating Efforts - Enhancement of HEL efficiency based on improved diode & fiber laser technologies					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Improvements in fiber laser doped illuminating lasers at unique "eye-safer" wavelengths - Improvements in laser light detection and testing sensors - Requirement's analysis to relate USPL functional requirements to operational needs - Functional analysis and design in order to identify USPL performance issues - Building and test of prototypes of USPL critical components - Validation of the maturity of USPL critical components - Conduct USPL precision dynamic engagements, against multiple maneuvering targets, with various effects (hard kill, sensing, non-lethal) - Explore the use of Artificial Intelligence for HEL & HPM systems to increase lethality in complex maritime operational environments - Applied research in HPM capable wide-bandwidth high-power frequency agile amplifiers - Initiate efforts into hollow core multiband fibers for laser power transmission. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The decrease in funding from FY23 to FY24 is due to efforts completing and reduced investment in Counter Directed Energy Weapons and Ultra Short Pulse Laser research.					
Title: High Speed Propulsion and Advanced Weapon Technologies	12.235	13.773	15.000	0.000	15.000
Description: This activity is focused on applied research to support the development of vehicle and propulsion technology for high-speed weapons operating from Mach 3 to Mach 8 and beyond. The goal is to develop computational, experimental and flight testing capabilities along with the workforce needed to support the development of hypersonic weapons. Research includes: Objectives: - Prediction and control of hypersonic boundary-layers and shock-wave boundary-layer interactions - Development of hypersonic ground test facilities, instrumentation and nonintrusive diagnostics - Prediction of interactions between materials and the high-speed flight environment such as flight through weather and oxidation of thermal protection systems - Development of improved modeling tools to predict the aerothermal and aerodynamic performance of hypersonic weapons over a wide range of velocities and altitudes					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Development of ultra-high temperature materials, cooling strategies and thermal protection systems that can survive the launch and flight environment - Development high-speed propulsion technologies such as solid fuel ramjets ***FY 2023 Plans:*** Conduct applied research for high-speed propulsion technologies such as solid-fuel ramjets/scramjets and dual mode ramjet/scramjet (DMRJ) to extend the range of hypersonic missiles; external aerodynamic technologies such as laminar flow control to enable high-performance hypersonic missiles; and improved modeling tools to predict the aerothermal, aerodynamic and propulsion performance of hypersonic weapons over a wide range of velocities and altitudes. Continuing Efforts - Experimental and numerical investigation on the combustion characteristics of solid fuels in supersonic combustors - Development of physics based computational structural analysis tools for prediction of impact damage in weapon structures due to atmospheric encounters under high-speed flow conditions. Completing Efforts - Assessment of advanced high-fidelity modeling and simulation tools for the prediction of boundary layer transition on relevant weapon geometries Initiating Efforts - Development and testing of new aeroshell material technology to extend laminar flow - High-fidelity computations, ground test techniques and flow diagnostics to characterize neutral and ionized gas species - Experimental and computational studies to extend the flight envelope of solid fuel ramjets to higher speeds and altitudes and to improve throttle-ability - Applied research for Nuclear Aircraft Carrier (CVN) compliant hypersonic air-breathing weapons to increase performance & operability - Development of reduced orders models for rapid prediction of aerothermal and aerodynamic performance using data driven approaches such as machine learning, high-fidelity simulations and experiments as training data ***FY 2024 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Conduct applied research for high-speed propulsion technologies such as solid-fuel ramjets/scramjets and dual mode ramjet/scramjet (DMRJ) to extend the range of hypersonic missiles; external aerodynamic technologies such as laminar flow control to enable high-performance hypersonic missiles; improved modeling tools to predict the aerothermal, aerodynamic and propulsion performance of hypersonic weapons over a wide range of velocities and altitudes; ultra-high temperature metamaterials and structures to enable sensing, flow control, power generation, and improved aero-thermo-mechanical performance of aeroshells and high-speed propulsion systems. Continuing Efforts - Experimental and numerical investigation on the combustion characteristics of solid fuels in supersonic combustors - Development of physics based computational structural analysis tools for prediction of impact damage in weapon structures due to atmospheric encounters under high-speed flow conditions - Development and testing of new aeroshell material technology to extend laminar flow - High-fidelity computations, ground test techniques and flow diagnostics to characterize neutral and ionized gas species - Experimental and computational studies to extend the flight envelope of solid fuel ramjets to higher speeds and altitudes and to improve throttle-ability - Applied research for Nuclear Aircraft Carrier (CVN) compliant hypersonic air-breathing weapons to increase performance & operability - Development of reduced orders models for rapid prediction of aerothermal and aerodynamic performance using data driven approaches such as machine learning, high-fidelity simulations and experiments as training data Initiating Efforts - Development and characterization of ultra-high temperature metamaterials and structures to enable, sensing, flow control, power generation, and improved aero-thermo-mechanical performance of aeroshells and high-speed propulsion systems - Development of efficient, predictive computational tools for high-speed, air-breathing propulsion systems to enable robust digital-engineering methodologies					
FY 2024 OCO Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase in funding from FY23 to FY24 is due to expanded investment in technology supporting hypersonic weapons in addition to initiating propulsion research.					
Title: Navigation, Electro Optic/Infrared (EO/IR), and Sensor Technologies ***Description:*** This activity describes Navy Science and Technology investments in the areas of Electro Optic/ Infrared (EO/IR) devices and advanced sensors and includes investment/performance in the technology areas of EO/IR, Electronic Warfare (EW), Electromagnetic Warfare, and Communications. ***FY 2023 Plans:*** - Initiate research and develop technologies that will protect surface platforms against imaging infrared seekers. Further efforts into development of inexpensive photodetectors operating at room temperature with higher detectivity than state-of-the-art cooled detectors. ***FY 2024 Base Plans:*** Continuing Efforts - Continue to research and develop technologies that will protect surface platforms against imaging infrared seekers. - Continue efforts into development of inexpensive photodetectors operating at room temperature with higher detectivity than state-of-the-art cooled detectors. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The increase from FY23 to FY24 is due to increased investment in the ability to counter the capability of an adversary to target and detect U.S. forces.	0.810	0.605	2.107	0.000	2.107
Title: Strike and Littoral Combat Technologies ***Description:*** The focus of this activity is on those technologies that will support Naval Precision Strike Operations and provide the Navy of the future the ability to quickly locate, target, and strike critical targets ashore. ***FY 2023 Plans:***	1.924	1.436	0.684	0.000	0.684

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602114N / *Power Proj Applied Research*	**Project (Number/Name)** 0000 / *Power Proj Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
-Continue efforts for machine-learning-based resource management for distributed radar system operation. This will support search and track requirements while minimizing emissions to degrade, defeat, and delay counter targeting. -Initiate projects which aim to develop technology and techniques to provide the Navy of the future the ability to quickly locate, target, and strike critical targets ashore. ***FY 2024 Base Plans:*** Continuing Efforts - Continue projects that aim to develop technology and techniques to provide the Navy of the future the ability to quickly locate, target, and strike critical targets ashore. Completing Efforts - Complete efforts for machine-learning-based resource management for distributed radar system operation. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The decrease from FY23 to FY24 is due to completing efforts for machine-learning-based resource management for distributed radar system operation.					
Accomplishments/Planned Programs Subtotals	22.453	22.953	23.982	0.000	23.982

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602114N / *Power Proj Applied Research*	Project (Number/Name) 9999 / *Congressional Adds*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	19.307	5.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	24.307

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
Congressional Add: Miniaturization of Lasers ***FY 2022 Accomplishments:*** Conduct applied research in miniaturization of lasers. ***FY 2023 Plans:*** N/A	3.861	0.000
Congressional Add: Manufacturing of high temperature hypersonic materials ***FY 2022 Accomplishments:*** Conduct applied research in manufacturing of high temperature hypersonic materials ***FY 2023 Plans:*** N/A	7.723	0.000
Congressional Add: Multi-mission UAV-borne electronic attack ***FY 2022 Accomplishments:*** Conduct applied research supporting multi-mission UAV-borne electronic attack ***FY 2023 Plans:*** N/A	7.723	0.000
Congressional Add: Meta material broadband coatings ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Conduct research in Meta material broadband coatings	0.000	5.000
Congressional Adds Subtotals	19.307	5.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A