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 4: *Advanced Component Development & Prototypes (ACD&P)*					R-1 Program Element (Number/Name) PE 0603573N *I Advanced Surface Machinery Sys*							
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	393.797	74.439	207.000	133.911	-	133.911	151.324	90.035	68.769	70.172	Continuing	Continuing
2471: *Integrated Power Systems (IPS)*	312.276	62.863	176.600	133.911	-	133.911	151.324	90.035	68.769	70.172	Continuing	Continuing
9999: *Congressional Adds*	81.521	11.576	30.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	123.497

A. Mission Description and Budget Item Justification

This Program Element (PE) supports innovative research and development of advanced surface ship Hull, Mechanical, and Electrical (HM&E) components and systems, primarily power and energy systems, and the subsequent test, evaluation, and demonstration of those systems for future ships and back-fit ships, where appropriate. This PE provides resources for Ships HM&E cyber analysis. This PE also serves as the bridge for power and energy systems between Science and Technology (S&T), ship platform, and mission systems acquisition programs by identifying prospective applications for S&T research, advanced development, and performing additional product development and qualification when necessary to meet platform or mission system requirements. This PE includes risk mitigation efforts for the DDG(X) Integrated Power System (IPS) which will satisfy the FY20 National Defense Authorization Act (NDAA) Section 131 requirements for land-based testing of propulsion systems in a realistic environment and FY22 NDAA Section 221 requirement for a land based test program for the engineering plant prior to DDG(X) construction start. The IPS hardware development and procurement and Land Based Test Site (LBTS) integration and test efforts executed under this PE / PU are informed by DDG (X) Ship Design specifications developed under PE 0603564N / PU 0411.

Lower funding requirements in FY 2024 is due to completed procurements of lead-time hardware for DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS) and an increase in enacted funding levels in FY23.

B. Program Change Summary ($ in Millions)	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**
Previous President's Budget	76.922	176.600	150.880	-	150.880
Current President's Budget	74.439	207.000	133.911	-	133.911
Total Adjustments	-2.483	30.400	-16.969	-	-16.969
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	30.400			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.483	0.000			
• Program Adjustments	0.000	0.000	-17.948	-	-17.948
• Rate/Misc Adjustments	0.000	0.000	0.979	-	0.979

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 4: *Advanced Component Development & Prototypes (ACD&P)*	**R-1 Program Element (Number/Name)** PE 0603573N *I Advanced Surface Machinery Sys*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Project: 9999: *Congressional Adds*		
Congressional Add: *Silicon Carbide Power Modules*	9.647	0.000
Congressional Add: *Solid state circuit breaker development*	1.929	0.000
Congressional Add: *Silicon carbide flexible bus node*	0.000	21.400
Congressional Add: *Large format lithium ion batteries*	0.000	9.000
Congressional Add Subtotals for Project: 9999	11.576	30.400
Congressional Add Totals for all Projects	11.576	30.400

Change Summary Explanation

FY 2023 to FY 2024 decreased by (-73.089) million of which (-$30.400) million is due to FY23 Congressional Adds, as well as the following decreases to PU 2471/ Integrated Power Systems budget: (-$32.741M) due primarily to DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS) progressing through long lead time hardware procurements; (-$3.638M) is associated with delivery of the EM-P unit in FY23 and completion of government testing in FY24 and; (-$ 6.310M) due to realignment of SABER development funds to the SABER program office PE 0603563N project 3244.

R-4 Schedule update for HM&E Cyber Analysis. Efforts that remain in this PE are as needed Tabletop exercises that do not have specific milestones.

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / *Advanced Surface Machinery Sys*	Project (Number/Name) 2471 / *Integrated Power Systems (IPS)*	

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
2471: *Integrated Power Systems (IPS)*	312.276	62.863	176.600	133.911	-	133.911	151.324	90.035	68.769	70.172	Continuing	Continuing
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This Project Unit includes the development and risk reduction of advanced surface ship Hull, Mechanical, and Electrical (HM&E) components and systems, primarily power and energy systems, for all future ships and back-fit ships where appropriate as well as HM&E cyber security. Specific sub-projects include:
The DDG(X) power and propulsion risk mitigation demonstration sub-project will be used to de-risk the DDG(X) Integrated Power System (IPS) and satisfy the FY 2020 National Defense Authorization Act (NDAA) Section 131 requirements for land-based testing of propulsion systems in a realistic environment and FY 2022 NDAA Section 221 requirement for a land based test program for the engineering plant prior to DDG(X) construction start. In an IPS, all engines generate electric power, which can then be distributed to both the propulsion system and the ship's service electrical systems (radars and sensors, weapons systems, etc.). This flexibility allows the same propulsion and electric plant requirements to be met with fewer total engines. With an IPS, the most efficient combination of engines (diesel or gas turbine) can be placed online to supply the total electric power required for the combined propulsion and ship's service loads, which provides for greater fuel efficiency in comparison to a mechanically driven ship propulsion system. In comparison to a mechanically driven ship propulsion system (DDG 51), the DDG (X) IPS facilitates a 50% increase in range, 25% increase in fuel efficiency, and 120% increase in Time on Station. The DDG(X) IPS hardware development and procurement and Land Based Test Site (LBTS) integration and test efforts executed under this PE / PU are informed by DDG (X) Ship Design specifications developed under PE 0603564N / PU 0411. IPS test findings will inform decisions in baseline specifications and design products, developed under PE 0603564N / PU 0411, ensuring that the ship can accommodate the space, weight, power, cooling (SWAP-C) required by the IPS and that the IPS can meet DDG(X) power and energy requirements. The interdependency of DDG(X) design and IPS risk reduction is critical. This subproject will employ a four-phased testing and risk reduction approach (updated to align with FY 2020 and FY 2022 NDAA land based testing requirements) to build assurance that the DDG(X) IPS system can be installed and activated efficiently by the shipbuilder with performance characteristics that are well understood.
- Phase 1 (IPS Modeling & Simulation (M&S)), commenced in FY 2021, establishes a description of the components and system non-real-time models that are needed for the DDG(X) IPS digital engineering effort to provide performance feedback to DDG(X) IPS design and specification. Persistent digital engineering efforts initiated as part of Phase 1 extend through the life of the DDG(X) program.
- Phase 2 (Land Based Test Site), commenced in FY 2021, initially employs refined digital models and scaled integrated surrogate components that functionally represent the intended DDG(X) IPS and transitions to full scale testing by procurement, integration and test of DDG(X) specific major long lead hardware components.
- Phase 3 (Land Based Engineering Site) builds a tactical representation of the DDG(X) shipboard power and propulsion system based on the DDG(X) full scale hardware procured in phase 2. The LBES will be an enduring activity over the life of the ship and provides capability to perform performance & endurance testing of the IPS.
- Phase 4 (Shipboard Test & Activation), funded by future DDG(X) Shipbuilding and Conversion, Navy (SCN), conducts shipboard integration testing of the power and propulsion system with other ship systems to confirm performance as specified in the contract requirements and interoperability at the platform level.

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

Naval Power and Energy Systems developments and transitions including power generation, power conversion, power distribution, energy storage, power utilization and automation and control functions for fully integrated electric propulsion (such as T-AKE -1 class or DDG 1000 class), hybrid electric propulsion (such as LHD 8 and LHA(R) class), as well as legacy mechanical propulsion ships (such as DDG 51 class). Naval Power and Energy Systems sub-project supports optimized integration of naval warship power and energy systems to support Directed Energy (DE) and other high powered mission systems, ship power quality requirements including frequency and voltage control for AC systems, Directed Energy (DE) and other high powered mission systems, appropriate component and system controls, integration of components and systems into future and current ships, and providing power and energy system solution alternatives to new and existing platforms. Existing ships' power systems require optimized integration via energy storage and advanced controls techniques to withstand the effects of DE and other high powered mission systems and avoid negative impacts to power generating equipment (diesel/gas turbine engines and generators).
- Power & Energy System developments are aligned with the Navy's 30 year shipbuilding plan and the Chief of Naval Operations Surface Capability Evolution Plan via the Naval Power and Energy Systems Technology Development Roadmap (TDR), which outlines the way ahead for future developments and provides a basis for coordinated planning and investment by the Navy and private industry.
- The power and energy systems developed by this Project are the power and energy foundation of the ships kill chain, and are developed with efficiency requirements as part of total life cycle cost minimization. Efforts within Power and Energy Systems are to design, develop, test and integrate shipboard power systems to incorporate advanced sensors, directed energy and other advanced weapons. Design and testing includes modeling and simulation, as well as land based testing, to reduce risk and demonstrate readiness for shipboard use.

Ships HM&E Cyber analysis employs cyber analysis tools to identify potential vulnerabilities in ship-wide or HM&E enclave/system architectures, hardware components, and software for applicable surface ships; and, designs and tests cyber protections for applicable surface ship systems, enclaves, and platforms.

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Title: DDG (X) Power & Propulsion Risk Mitigation & Demonstration	28.213	145.758	113.325	0.000	113.325
Articles:	-	-	-	-	-
FY 2023 Plans: Continue DDG(X) power and propulsion risk reduction activities to meet intent of (NDAA) Section 131 and FY22 NDAA Section 221 requirements for land-based testing of propulsion systems in a realistic environment aligned with the DDG(X) IPS design efforts as part of DDG(X) Design Development efforts executed under PE 0603564N/0411. Specifically: - Phase 1 (IPS M&S): Continue risk reduction activities for the DDG(X) IPS by utilizing ship power systems simulation at Florida State University Center for Advanced Power Systems (FSU CAPS) & Naval Surface Warfare Center Philadelphia Division (NSWCPD) to support equipment and interface specification refinement. Conduct real-time integrated system modeling (including controls) assessing power & propulsion system performance. Provide DDG(X) IPS design performance feedback to the ship design (PE 0603564N / PU 0411) as part of preliminary design and refinement of the power and propulsion system design and specification.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Demonstrate interfaces for energy storage and advanced controls capabilities that are required to support future mission system capabilities such as directed energy weapons and advanced sensors. Continue to gather and/or generate models to support DDG(X) IPS design decisions, known risk mitigations, and a digital model of IPS. - Phase 2 (Land Based Test Site): Commence scaled risk reduction testing and begin test site modifications and construction for full scale hardware. Initiate Shipbuilder procurement of long lead (36+ month) full scale DDG(X) representative hardware for IPS components including a propulsion motor & drive, primary & auxiliary power generators, electrical distribution, IPS controls, auxiliary systems, etc. In addition, commence procurement of LBTS facility long lead equipment including a propulsion load machine, load banks, and other hardware need to host full scale ship IPS. Continue refinement of interfaces and specifications for individual power and propulsion system components and validation of Digital Engineering efforts. - Phase 3 (Land Based Engineering Site): Initiate design for the DDG(X) IPS LBES which transitions from the LBTS to tactical representation of the DDG(X) shipboard power and propulsion system.					
FY 2024 Base Plans: Continue DDG(X) power and propulsion risk reduction activities to meet intent of (NDAA) Section 131 and FY22 NDAA Section 221 requirements for land-based testing of propulsion systems in a realistic environment aligned with the DDG(X) IPS design efforts as part of DDG(X) Design Development efforts executed under PE 0603564N/0411. Specifically: - Phase 1 (IPS M&S): Continue risk reduction activities for the DDG(X) IPS by utilizing ship power systems simulation at Florida State University Center for Advanced Power Systems (FSU CAPS) & Naval Surface Warfare Center Philadelphia Division (NSWCPD) to support equipment and interface specification refinement. Conduct real-time integrated system modeling (including controls) assessing power & propulsion system performance. Provide DDG(X) IPS design performance feedback to the ship design (PE 0603564N / PU 0411) as part of preliminary design and refinement of the power and propulsion system design and specification. Demonstrate interfaces for energy storage and advanced controls capabilities that are required to support future mission system capabilities such as directed energy weapons and advanced sensors. - Phase 2 (Land Based Test Site): Continue risk reduction testing and test site modifications and construction for incorporation of DDG(X) IPS hardware. Continue Shipbuilder procurement of DDG(X) IPS hardware components including a propulsion motor & drive, primary & auxiliary power generators, electrical distribution, IPS controls, auxiliary systems, etc. Continue refinement of interfaces and specifications for individual power and propulsion system components and validation of Digital Engineering efforts.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
- Phase 3 (Land Based Engineering Site): Continue design for the DDG(X) IPS LBES which transitions from the LBTS to tactical representation of the DDG(X) shipboard power and propulsion system. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** FY 2023 to FY 2024 decrease of (-$32.741M) is due primarily to DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS) progressing through long lead time hardware procurements. LBTS infrastructure Refurbishments and IPS procurement activities continue in FY 2024.					
Title: Power and Energy Systems	25.852	21.883	17.937	0.000	17.937
Articles:	-	-	-	-	-
FY 2023 Plans: Energy storage, referred to as Energy Magazine, required to avoid negative impacts of Directed Energy (DE) weapons and other high powered mission systems on power generating equipment (diesel/gas turbine engines and generators) and ship electrical distribution systems. There are two (2) ongoing energy storage developments: Energy Magazine Prototype (EM-P) focused specifically on laser application, the most challenging power pulse to interface, and will result in a prototype demonstration unit. EM-P will inform the Energy Magazine which is a common, modular, scalable intermediate power system that standardizes energy storage across multiple mission systems (lasers, advanced radars, Surface Electronic Warfare Improvement Program (SEWIP), and other pulsed loads) and ships classes, and eliminates wasteful need for mission systems to each develop, build, test, qualify/certify and support their own unique energy storage systems. The Energy Magazine also provides stable backup power functionality and leads to reduction of uninterruptable power supplies (UPS) aboard ship. Energy Magazine is designed for both new construction and back-fit applications where advanced combat systems are being deployed. Energy Magazine-Prototype (EM-P): Complete preparation of test plans and procedures and test site modifications for independent government testing. Complete confirmation of safety of lithium-battery energy storage system design through rigorous safety and characterization testing. Complete factory testing and deliver, install, and test EM-P hardware in the FSU CAPS M&S environment against representative naval					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
warship electrical architectures and relevant directed energy weapon systems loads followed by installation and independent government testing to confirm performance requirements against representative Naval power system and validate digital models of the EM-P system. Continue to support PEO IWS, Office of the Chief of Naval Operations, (OPNAV), and Office of Naval Research (ONR) laser testing and planning activities. Evaluate performance of the EM prototype and, as applicable, incorporate lessons learned in EM. Energy Magazine (EM): Complete System and Software Requirements Review and initiate preliminary design. Complete preliminary design, hold Preliminary Design Review and commence detail design, characterization for Lithium Ion (Li) Batteries, build of prototype energy storage units, conduct Test Readiness Reviews and start energy storage testing required by NAVSEAINST 9310.1. Accept delivery of EM models and conduct component and system simulations that focus on EM software development and EM performance. Generate and validate detailed interface requirements, test plans and procedures for use in virtual environment demonstration(s) and independent government testing to confirm performance requirements. Continue transition of the Robust Combat Power Control (RCPC) Future Naval Capabilities (FNC), SW-FY-20-02, in accordance with the Technology Deployment Agreement with the Office of Naval Research. The RCPC FNC enables Tactical Energy Management by developing Integrated Power System (IPS) control algorithms facilitating flexible power distribution and management. This capability also gives an IPS the ability to readily incorporate energy storage (Energy Magazine) in the future becoming an Integrated Power & Energy system (IPS). An IPES as described in the Naval Power and Energy Systems Technology Development Roadmap (NPES TDR) is an advanced power architecture that incorporates multi-use distributed energy storage (Energy Magazine) and advanced controls (RCPC) to effect ship wide energy management. IPES fully integrates and controls all generated and stored electrical energy in the ship platform so that it is available to all electrical users, in the most fuel efficient manner possible, including high power weapons, advanced sensors, and electric propulsion, as mission scenarios dictate.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Advanced Power Conversion Module (APCM) required to develop power conversion equipment to support high powered future ship equipment requirements Continue to support ONR Silicon Carbon (and other high bandgap semiconductor materials) based power electronic modules that enable more compact, thermally tolerant power conversion equipment making them highly desirable for naval applications. Advanced Power Generation Modules (APGM) ongoing developments lower Total Ownership Cost (TOC) by developing advanced materials package capable of minimum 3X engine life over projected increases in Gas Turbine (GT) loads and temperatures: The transitioned ONR FNC SW-19-03 (GT Marinization Package), planned FY 2023 focus areas include evaluation of ONR sponsored 264-hr 501-K34 engine endurance test and post-test engine teardown and inspection to support prototype parts selection and integration into a Fleet engine asset for planned At-Sea evaluation. Initiate production engineering tasks including development of material and coating product specifications and casting and tooling manufacturing processes. The below tasks, previously executed within the Naval Power Technology Development / Platform Integration & Transition subprojects, are now included within the Power & Energy Systems subproject to better align tasks. - Continue to execute International Agreements with the United Kingdom, India, Germany, and Japan for power and propulsion. Specific agreements include: Project Arrangement (PA) ref DoD-MOD-N-12-0001 between the United States (US) and United Kingdom (UK) Governments to cooperate on a scope of work associated with characterizing, developing, modeling, and de-risking electrical power and propulsion system architectures and equipment for future surface and submarine platforms to meet the needs of both Navies. German (N-13-GY-4246), Indian (N-20-IND-6625) and Japanese (N-20-JPN-4037) Navies. Continue to execute In-Service agreement with United Kingdom on all matters related to naval warship power, energy and propulsion systems. - Continue to support maturation and transition of ONR Future Naval Capabilities (FNC) products to meet NPES TDR					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
identified gaps. Continue update of the Naval Power and Energy Systems (NPES) Technology Development Roadmap (TDR) and, when ready, issue update of the NPES TDR. ***FY 2024 Base Plans:*** Energy storage, referred to as Energy Magazine, is required to avoid negative impacts of Directed Energy (DE) weapons and other high powered mission systems on power generating equipment (diesel/gas turbine engines and generators) and ship electrical distribution systems. The Energy Magazine is a common, modular, scalable intermediate power system that standardizes energy storage across multiple mission systems (lasers, advanced radars, Surface Electronic Warfare Improvement Program (SEWIP), and other pulsed loads) and ships classes, and eliminates wasteful need for mission systems to each develop, build, test, qualify/certify and support their own unique energy storage systems. The Energy Magazine (EM) also provides stable backup power functionality and leads to reduction of uninterruptable power supplies (UPS) aboard ship. Energy Magazine is designed for both new construction and back-fit applications where advanced combat systems are being deployed. Energy Magazine-Prototype (EM-P): Conduct testing of EM-P hardware in the FSU CAPS M&S environment against representative naval warship electrical architectures and relevant directed energy weapon systems loads and independent government testing to confirm performance requirements against representative Naval power system and validate digital models of the EM-P system. Evaluate performance of the EM prototype and, as applicable, incorporate lessons learned in EM. EM-P activities are planned to complete in FY24. Continue to support PEO IWS, OPNAV, and ONR laser integration demonstration(s). Energy Magazine (EM): Complete the detail design, characterization for Lithium Ion (Li) Batteries, procurement of all material to fabricate and assemble EM first units, conduct Test Readiness Reviews and continue and complete testing. Continue to update EM models and conduct component and system simulations that focus on EM software development and EM performance. Generate and validate detailed interface requirements, test plans and procedures for use in virtual environment demonstration(s) and independent government testing to confirm performance requirements. Continue to support PEO IWS, Office of the Chief of Naval Operations, and Office of Naval Research laser testing and planning activities. Evaluate performance of the EM prototype and, as applicable, incorporate lessons learned in EM.					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Continue transition of the Robust Combat Power Control (RCPC) Future Naval Capabilities (FNC), SW-FY-20-02, in accordance with the Technology Deployment Agreement with the Office of Naval Research. The RCPC FNC enables Tactical Energy Management by developing Integrated Power System (IPS) control algorithms facilitating flexible power distribution and management. This capability also gives an IPS the ability to readily incorporate energy storage (Energy Magazine) in the future becoming an Integrated Power & Energy system (IPS). An IPES as described in the Naval Power and Energy Systems Technology Development Roadmap (NPES TDR) is an advanced power architecture that incorporates multi-use distributed energy storage (Energy Magazine) and advanced controls (RCPC) to effect ship wide energy management. IPES fully integrates and controls all generated and stored electrical energy in the ship platform so that it is available to all electrical users, in the most fuel-efficient manner possible, including high power weapons, advanced sensors, and electric propulsion, as mission scenarios dictate. Develop an Advanced Power Conversion Module (APCM) to convert ships power for use by high powered future ship equipment with different voltage requirements, such as radars, sensors, etc. Utilize Silicon Carbon (and other high bandgap semiconductor materials) power electronic modules that enable more compact, thermally tolerant power conversion equipment making them highly desirable for naval applications. FY24 will complete requirements definition begun in FY23, and develop solicitation products (RFP, selection plan, etc.) for development and procurement of an APCM. Advanced Power Generation Modules (APGM): Ongoing developments lower Total Ownership Cost (TOC) by developing advanced materials package capable of minimum 3X engine life over projected increases in Gas Turbine (GT) loads and temperatures: The transitioned ONR FNC SW-19-03 (GT Marinization Package), planned FY 2024 focus areas include completion of material/coating production specifications, completion of casting/coating manufacturing process development, initiation of parts fabrication for qualification testing, and monitoring condition of at-sea demonstration hardware. Naval Power Technology Development / Platform Integration & Transition: Continue to execute International Agreements with the United Kingdom, India, Germany, and Japan for power and propulsion. Specific agreements include: Project Arrangement (PA) ref DoD-MOD-N-12-0001 between the United States (US) and UK Governments to cooperate on a scope of work associated with characterizing, developing, modeling, and de-risking electrical power and propulsion system architectures and equipment for future surface and submarine platforms to meet					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
the needs of both Navies. German (N-13-GY-4246), Indian (N-20-IND-6625) and Japanese (N-20-JPN-4037) Navies. Continue to execute In-Service agreement with United Kingdom (UK) on all matters related to naval warship power, energy and propulsion systems. Continue to support maturation and transition of ONR Future Naval Capabilities (FNC) products to meet NPES TDR identified gaps. Continue update of the Naval Power and Energy Systems (NPES) Technology Development Roadmap (TDR) and, when ready, issue update of the NPES TDR. ***FY 2024 OCO Plans:*** N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Decrease of (-$3.638M) is associated with delivery of the EM-P unit in FY23 and completion of government testing in FY24					
Title: HM&E Cyber Analysis	8.798	8.959	2.649	0.000	2.649
Articles:	-	-	-	-	-
Description: Previous titled: HM&E Cybersecurity - Hardware Development / Prototyping & Cyber Analysis ***FY 2023 Plans:*** Continue build of Hull, Mechanical, and Electrical (HM&E) cybersecurity computing hardware Lab units for NSWC Philadelphia Division, Philadelphia PA for ship integration testing to support installations in FY 2024 and FY 2025. Begin design and development of second generation Situational Boundary Enforcement & Response (SABER) Computing Hardware. Continue development and testing of additional WeaselBoard variants as well as existing variants for additional ship classes. Complete verification and validation testing of Copper Tap & Aggregator HW unit. Conduct Cyber Table Top type events and cyber vulnerability analysis via Model Based Systems Engineering tools of HM&E systems/networks on additional ship classes. ***FY 2024 Base Plans:*** Conduct Cyber Table Top type events and cyber vulnerability analysis via Model Based Systems Engineering tools of HM&E systems/networks on additional ship classes. ***FY 2024 OCO Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
N/A ***FY 2023 to FY 2024 Increase/Decrease Statement:*** The decrease of ($-6.310M) from FY23 to FY24 is due to realignment of SABER development funds to the SABER program office PE 0603563N project 3244.					
Accomplishments/Planned Programs Subtotals	62.863	176.600	133.911	0.000	133.911

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

For new contract awards, full and open competition is utilized to the maximum extent possible to provide maximum benefit to the Navy at the lowest possible cost to the taxpayer. When able to meet Navy requirements, commercial technology is leveraged to further minimize cost to the Navy.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2022 Cost	FY 2022 Award Date	FY 2023 Cost	FY 2023 Award Date	FY 2024 Base Cost	FY 2024 Base Award Date	FY 2024 OCO Cost	FY 2024 OCO Award Date	FY 2024 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Power & Energy Sys	SS/CPFF	Rolls Royce : Walpole, MA	37.983	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Power & Energy Sys	C/CPIF	DRS : Milwaukee WI	0.500	10.200	Apr 2022	7.919	Nov 2022	7.023	Nov 2023	-		7.023	Continuing	Continuing	Continuing
Power & Energy Sys	C/CPFF	DRS : DRS, Milwaukee WI	71.790	6.733	Oct 2021	2.954	Nov 2022	0.065	Nov 2023	-		0.065	Continuing	Continuing	Continuing
Power & Energy Sys	C/CPFF	Industry : Various	57.683	2.717	Nov 2021	4.488	Nov 2022	4.388	Nov 2023	-		4.388	Continuing	Continuing	Continuing
Power & Energy Sys	WR	NSWCPD : Phila, PA	69.138	1.445	Nov 2021	2.514	Nov 2022	2.700	Nov 2023	-		2.700	Continuing	Continuing	Continuing
Power & Energy Sys	WR	Other Government Organizations : Various	1.799	2.288	Nov 2021	2.180	Nov 2022	2.194	Nov 2023	-		2.194	Continuing	Continuing	Continuing
Cyber analysis	WR	NSWCPD : Phila, PA	16.800	1.403	Nov 2021	2.182	Nov 2022	0.946	Nov 2023	-		0.946	Continuing	Continuing	Continuing
Cyber analysis	C/CPIF	Boeing : Huntington Beach, CA	1.750	0.250	May 2022	0.800	May 2023	0.000	May 2024	-		0.000	Continuing	Continuing	Continuing
Cyber analysis	C/FP	Various HM&E Equipment Vendors : Various	2.066	0.000	Apr 2022	1.633	Jan 2023	0.320	Jan 2024	-		0.320	Continuing	Continuing	Continuing
Cyber analysis	C/CPIF	Industry : Various	4.779	0.623	Apr 2022	0.309	Jan 2023	0.383	Jan 2024	-		0.383	Continuing	Continuing	Continuing
Cyber analysis	C/CPFF	Hexagon US Federal : Huntsville, AL	1.374	2.732	Apr 2022	1.082	Jan 2023	0.000	Jan 2024	-		0.000	Continuing	Continuing	Continuing
Cyber analysis	C/CPFF	JHU APL : Laurel, MD	5.405	1.800	Jan 2022	2.528	Nov 2022	1.000	Nov 2023	-		1.000	Continuing	Continuing	Continuing
Cyber analysis	C/CPFF	Visionary Products Incorporated (VPI) Technologies : Draper, UT	1.671	0.690	Jul 2022	0.075	Nov 2022	0.000		-		0.000	Continuing	Continuing	Continuing
Cyber analysis	MIPR	Sandia National Labs : Albuquerque, NM	5.213	1.300	Nov 2021	0.350	Nov 2022	0.000		-		0.000	Continuing	Continuing	Continuing
DDG(X) Power & Prop Risk Mitigation & Demo	WR	Other Government Organizations : Various	0.000	0.000	Mar 2022	0.914	Nov 2022	1.064	Nov 2023	-		1.064	Continuing	Continuing	Continuing

Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / *Advanced Surface Machinery Sys*	Project (Number/Name) 2471 / *Integrated Power Systems (IPS)*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2022 Cost	FY 2022 Award Date	FY 2023 Cost	FY 2023 Award Date	FY 2024 Base Cost	FY 2024 Base Award Date	FY 2024 OCO Cost	FY 2024 OCO Award Date	FY 2024 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
DDG(X) Power & Prop Risk Mitigation & Demo	Various	GE : Various	0.000	0.200	Feb 2022	16.539	Dec 2022	0.000		-		0.000	Continuing	Continuing	Continuing
DDG(X) Power & Prop Risk Mitigation & Demo	C/CPFF	Industry : Various	0.000	18.974	Nov 2021	66.373	Nov 2022	56.484	Nov 2023	-		56.484	0.000	141.831	-
DDG(X) Power & Prop Risk Mitigation	WR	NSWCPD : Phila. PA	0.000	6.324	Dec 2021	8.641	Nov 2022	8.740	Nov 2023	-		8.740	0.000	23.705	-
DDG(X) Power & Prop Risk Mitigation	Various	Shipbuilders (BIW/ HII) : Various	0.000	2.715	Jan 2022	53.291	Nov 2022	46.729	Nov 2023	-		46.729	0.000	102.735	-
		Subtotal	277.951	60.394		174.772		132.036		-		132.036	Continuing	Continuing	N/A

Remarks

FY 2023 to FY 2024 decrease in Product Development is due primarily to DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS) sequenced long lead time hardware procurements. LBTS infrastructure refurbishments and IPS procurement activities continue in FY 2024.

Test and Evaluation ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2022 Cost	FY 2022 Award Date	FY 2023 Cost	FY 2023 Award Date	FY 2024 Base Cost	FY 2024 Base Award Date	FY 2024 OCO Cost	FY 2024 OCO Award Date	FY 2024 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Prior Year Developmental Test & Evaluation Not Funded FYDP (PYDT&E)	WR	NSWCCD-SSES : Phila, PA	24.954	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
		Subtotal	24.954	0.000		0.000		0.000		-		0.000	Continuing	Continuing	N/A

Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2022 Cost	FY 2022 Award Date	FY 2023 Cost	FY 2023 Award Date	FY 2024 Base Cost	FY 2024 Base Award Date	FY 2024 OCO Cost	FY 2024 OCO Award Date	FY 2024 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Management	C/CPFF	Herren Associates : Alexandria, VA	9.371	2.469	Oct 2021	1.828	Nov 2022	1.875	Nov 2023	-		1.875	Continuing	Continuing	Continuing
		Subtotal	9.371	2.469		1.828		1.875		-		1.875	Continuing	Continuing	N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / *Advanced Surface Machinery Sys*	Project (Number/Name) 2471 / *Integrated Power Systems (IPS)*	

	Prior Years	FY 2022		FY 2023		FY 2024 Base		FY 2024 OCO		FY 2024 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	312.276	62.863		176.600		133.911		-		133.911	Continuing	Continuing	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

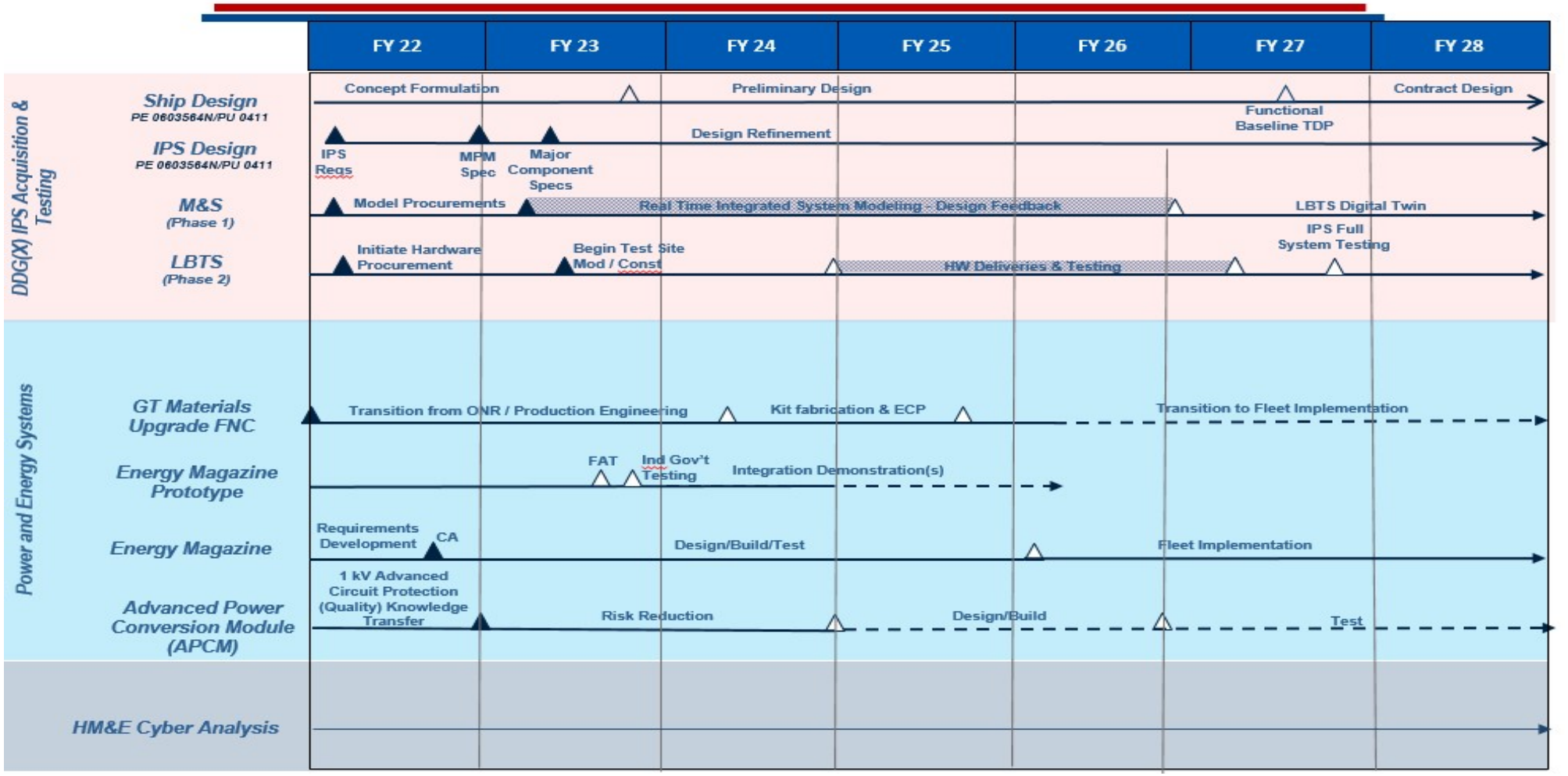

Exhibit R-4A, RDT&E Schedule Details: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Proj 2471				
DDG(X) Power & Propulsion Risk Mitigation & Demo / DDG(X) IPS ACQ & Testing	1	2022	4	2028
Power and Energy Systems	1	2022	4	2028
HM&E Cyber Security	1	2022	4	2028

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / *Advanced Surface Machinery Sys*	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*	81.521	11.576	30.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	123.497
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Congressional Adds:
Silicon Carbide Power Modules (C447)
Solid State Circuit Breaker Development (C755)

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
Congressional Add: Silicon Carbide Power Modules ***FY 2022 Accomplishments:*** Continue Silicon Carbide (SiC) power module efforts including development, qualification, and systems integration. Specific efforts include SiC semiconductor module refinement and validation, endurance test and prototype power converter development, modeling, prototype power converter testing, etc. ***FY 2023 Plans:*** Continue Silicon Carbide (SiC) power module efforts including development, qualification, and systems integration. Specific efforts include SiC semiconductor module refinement and validation, endurance test and prototype power converter development, modeling, prototype power converter testing, etc.	9.647	0.000
Congressional Add: Solid state circuit breaker development ***FY 2022 Accomplishments:*** Develop contracting strategy and scope of effort associated with Solid State Circuit Breaker Development ***FY 2023 Plans:*** Award contract and execute scope associated with Solid State Circuit Breaker Development	1.929	0.000
Congressional Add: Silicon carbide flexible bus node ***FY 2022 Accomplishments:*** N/A ***FY 2023 Plans:*** Develop contracting strategy and execute scope associated with Silicon carbide flexible bus node	0.000	21.400
Congressional Add: Large format lithium ion batteries	0.000	9.000

Exhibit R-2A, RDT&E Project Justification: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 9999 / *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2022 Accomplishments: N/A ***FY 2023 Plans:*** Develop contracting strategy and scope of effort associated with Large format lithium ion batteries		
Congressional Adds Subtotals	11.576	30.400

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / *Advanced Surface Machinery Sys*	Project (Number/Name) 9999 / *Congressional Adds*	

Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2022 Cost	FY 2022 Award Date	FY 2023 Cost	FY 2023 Award Date	FY 2024 Base Cost	FY 2024 Base Award Date	FY 2024 OCO Cost	FY 2024 OCO Award Date	FY 2024 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
SiC Power Modules	C/CPFF	RCT : Linthicum Heights MD	19.164	9.398	Sep 2022	0.000		0.000		-		0.000	0.000	28.562	-
SiC Power Modules	Various	Various : Various	2.060	0.250	Jun 2022	0.000		0.000		-		0.000	0.000	2.310	-
Adv. Power electronics Integration	Various	Various : Various	7.236	0.000		0.000		0.000		-		0.000	0.000	7.236	-
Suface Combatant Component Level prototyping	Various	Various : Various	9.361	0.000		0.000		0.000		-		0.000	0.000	9.361	-
Surface Combatant Component Level Prototyping	Various	General Electric : Various	17.818	0.000		0.000		0.000		-		0.000	0.000	17.818	-
Surface Combatant Component Level Prototyping	Various	Rolls-Royce : Various	4.480	0.000		0.000		0.000		-		0.000	0.000	4.480	-
Surface Combatant Component Level Prototyping	Various	FSU CAPS : Tallahassee, FL	10.800	0.000		0.000		0.000		-		0.000	0.000	10.800	-
Surface Combatant Component Level Prototyping	WR	NSWCPD : Philadelphia,PA	5.778	0.000		0.000		0.000		-		0.000	0.000	5.778	-
Small Boat Electric Propulsion	Various	Various : Various	4.824	0.000		0.000		0.000		-		0.000	0.000	4.824	-
Solid State Circuit Breaker Development	C/BA	Not Specified : Not Specified	0.000	1.928	Aug 2022	0.000		0.000		-		0.000	0.000	1.928	-
SiC FBN	C/BA	Not Specified : Not Specified	0.000	0.000		21.400	Jun 2023	0.000		-		0.000	0.000	21.400	-
Large Format Lithium ion battery	C/BA	Not Specified : Not Specified	0.000	0.000		9.000	Sep 2023	0.000		-		0.000	0.000	9.000	-
		Subtotal	81.521	11.576		30.400		0.000		-		0.000	0.000	123.497	N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Navy			Date: March 2023
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / *Advanced Surface Machinery Sys*	Project (Number/Name) 9999 / *Congressional Adds*	

	Prior Years	FY 2022		FY 2023		FY 2024 Base		FY 2024 OCO		FY 2024 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	81.521	11.576		30.400		0.000		-		0.000	0.000	123.497	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 9999 / *Congressional Adds*

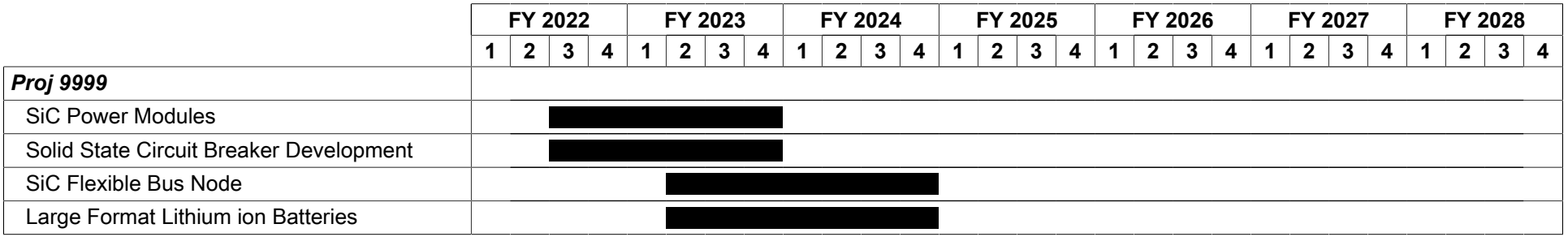

Exhibit R-4A, RDT&E Schedule Details: PB 2024 Navy		Date: March 2023
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 9999 / *Congressional Adds*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Proj 9999				
SiC Power Modules	3	2022	4	2023
Solid State Circuit Breaker Development	3	2022	4	2023
SiC Flexible Bus Node	2	2023	4	2024
Large Format Lithium ion Batteries	2	2023	4	2024