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Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Navy **Date:** April 2022

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy / BA 4: Advanced Component Development & Prototypes (ACD&P)</i>	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>
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COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	354.653	39.144	76.922	176.600	-	176.600	150.880	150.484	91.545	74.868	Continuing	Continuing
2471: <i>Integrated Power Systems (IPS)</i>	290.015	22.261	64.922	176.600	-	176.600	150.880	150.484	91.545	74.868	Continuing	Continuing
9999: <i>Congressional Adds</i>	64.638	16.883	12.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	93.521

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 HM&E cyber security. 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 hull agnostic Integrated Power and Energy System Test Facility (ITF) is being transitioned into the DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS). This approach capitalizes on past Navy investments in modeling and simulation, hardware procurement, integration, and lessons learned. 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.

B. Program Change Summary (\$ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	40.510	78.122	0.000	-	0.000
Current President's Budget	39.144	76.922	176.600	-	176.600
Total Adjustments	-1.366	-1.200	176.600	-	176.600
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-13.200			
• Congressional Rescissions	-	-			
• Congressional Adds	-	12.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.366	0.000			
• Program Adjustments	0.000	0.000	0.000	-	0.000
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Adjustments to Budget Year	-	-	176.600	-	176.600

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Congressional Add Details (\$ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: 9999: <i>Congressional Adds</i>		
Congressional Add: <i>Silicon Carbide Power Modules</i>	9.647	10.000
Congressional Add: <i>Advanced power electronics integration</i>	2.412	0.000
Congressional Add: <i>Small Boat Electric Propulsion</i>	4.824	0.000
Congressional Add: <i>Solid state circuit breaker development</i>	0.000	2.000
Congressional Add Subtotals for Project: 9999		
	16.883	12.000
Congressional Add Totals for all Projects		
	16.883	12.000

Change Summary Explanation

FY 2021 decrease of \$1.366 million is due to SBIR/STTR Reductions.

FY 2022 Congressional mark of (-\$12.7M) to the DDG(X) Power and Propulsion Risk Mitigation and Demonstration sub-project impacts hardware procurement shifting award of main gas turbine from FY 2022 to FY 2023.

FY 2022 to FY 2023 increase is due primarily to DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS) modifications, hardware procurements and test site infrastructure refurbishments.

FY 2023 funding increase reflects the fact that the FY 2022 President's Budget request did not include out-year funding.

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Appropriation/Budget Activity 1319 / 4					R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>				Project (Number/Name) 2471 / <i>Integrated Power Systems (IPS)</i>			
COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
2471: <i>Integrated Power Systems (IPS)</i>	290.015	22.261	64.922	176.600	-	176.600	150.880	150.484	91.545	74.868	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:

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 ship agnostic Integrated Power and Energy System Test Facility (ITF) is being transitioned into the DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS). This approach capitalizes on past Navy investments in modeling and simulation, hardware procurement, integration, and lessons learned. 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. IPS test findings will be incorporated in final 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 sub-project 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

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IPS. Phases 2 and 3 are being conducted primarily by Naval Surface Warfare Center Philadelphia Division (NSWCPD) in tightly coupled coordination with Florida State University Center for Advanced Power Systems (FSU CAPS) digital engineering efforts.

- Phase 4 (Shipboard Test & Activation), funded by future DDG(X) Ship Construction 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.

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.

HM&E Cyber security develops and tests various cyber security hardware that monitors the HM&E network and system communications to detect and deter potential cyber attacks. HM&E cyber security hardware will transition to appropriate back-fit and forward fit ship installations, as appropriate, once development and testing completes. The Cyber funding also supports using cyber analysis tools to identify potential vulnerabilities in HM&E enclave architectures, hardware components, and software for applicable surface ships. HM&E cyber security and analysis was previously referred to as Situational Awareness, Boundary Enforcement & Response (SABER) and is being renamed to more clearly identify the specific work scope within this PE which includes both SABER prototype HW development and HM&E cyber analyses.

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Title: DDG (X) Power & Propulsion Risk Mitigation & Demonstration	0.000	29.400	145.758	0.000	145.758
Articles:	-	-	-	-	-
FY 2022 Plans:					
DDG(X) IPS development activities in FY 2022 include: Initiate Phase 1 (IPS Modeling & Simulation (M&S)) and Phase 2 (Land Based Test Site) activities and begin planning for Phase 3 (Land Based Engineering Site).					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>- Phase 1: Develop and execute critical system risk reduction activities for the DDG(X) by providing representative, validated digital environments of ship power systems running in real time at FSU CAPS. Commence virtually prototype and characterize the electrical system performance characteristics, interfaces, controls, and component interactions within the DDG(X) IPS system context to include high energy weapons and sensors in addition to power, energy and propulsion system components to learn failure modes and power quality issues. Commence the interoperability and integration of digital engineering toolsets to enable integration of the power and propulsion aspects of the design with the other ship design domains. Develop prototyping and test/analysis plans for DDG(X)critical power, propulsion and propulsion system technologies. Refine and operationalize digital component models of ITF in order to integrate DDG(X) power and propulsion system with the other engineering domains within the government product model. Provide performance feedback to and accept performance feedback from the ship Design and Analysis efforts, executed under PE 0603564N / PU 0411, to refine the power and propulsion system design and demonstrate interfaces for future energy storage and advanced controls capabilities that are required to support future mission system capabilities such as directed energy weapons and advanced sensors.</p> <p>- Phase 2: Develop test capability using surrogate equipment. Initiate procurement of a propulsion load machine, and mission system simulators; continue refurbishment of the General Electric (GE) Advanced Induction Motor (AIM) main propulsion motor and drives; initiate ITF Concept of Operations (CONOPS) and controls development to inform testing development needs for DDG(X); Continue robust engagement with industry to keep bidirectional dialog open and refine planning and risk reduction efforts for DDG(X) power system design through industry informed decision making.</p> <p>- Initiate analysis of acquisition strategies for DDG(X) power system development as part of the overall ship acquisition strategy development. Continue close information exchange activities with United Kingdom (UK) Royal Navy and other international partners for evaluation and incorporation of their lessons from experience into plans for DDG(X). Initiate study to support DDG(X) LBES scope and location to support Phase 3, Land Based Engineering Site.</p> <p>FY 2023 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:</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>Phase 1 (IPS M&S): Continue risk reduction activities for the DDG(X) IPS by utilizing ship power systems simulation at FSU CAPS & NSWCPCD 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. Continue to gather and/or generate models to support DDG(X) IPS design decisions, known risk mitigations, and a digital model of IPS.</p> <p>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.</p> <p>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.</p> <p>FY 2023 OCO Plans: N/A</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: FY 2022 to FY 2023 increase is due primarily to DDG(X) IPS Land Based Test Site (LBTS) modifications, hardware procurements and test site infrastructure refurbishments including a propulsion motor & drive, primary & auxiliary power generators, electrical distribution, IPS controls and related auxiliary systems. In addition, commence procurement of LBTS facility long lead equipment including a propulsion load machine, load banks, and other hardware needed to host full scale ship IPS.</p>					
<p>Title: Power and Energy Systems</p> <p align="right">Articles:</p> <p>FY 2022 Plans:</p>	15.514 -	25.620 -	21.883 -	0.000 -	21.883 -

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>The 2019 Naval Power and Energy Systems (NPES) Technology Development Roadmap (TDR) identified land based testing of power systems as a Navy best practice for reducing and managing warship development risk. Navy's investment across the Future Years Defense Program (FYDP) in this land based testing effort for DDG(X), formerly Large Surface Combatant, is implementing that best practice to reduce critical risks prior to Detail Design. Using FY 2020 Congressional Add funds placed in PE 0603573N/2471 the Navy began refurbishment of the former DDG 1000 land based test site, referred to as the Integrated Power and Energy System Test Facility (ITF), at the Naval Surface Warfare Center Philadelphia Division and commenced digital engineering efforts of power and energy systems at Florida State University (FSU) Center for Advanced Power Systems (CAPS). ITF is being designed and built to be a flexible and adaptable suite of land based interconnected hardware and software that will provide, in a sequence of phased builds, equivalent functionality and capability of a shipboard system. This flexibility will enable realistic testing and demonstration at the element, sub-system, and system level for the DDG(X) IPS system to reduce critical risks prior to detail design. ITF will utilize robust component-level prototyping of potential new critical systems, including those related to propulsion, energy storage, electrical distribution, and advanced controls with demonstration and testing to validate digital models and the ITF digital twin, energy storage integration with the ship power system and Tactical Energy Management.</p> <p>Integrated Power and Energy System (IPES): An IPES is described in the Naval Power and Energy Systems Technology Development Roadmap (NPES TDR) as an advanced power architecture that incorporates multi-use distributed energy storage as well as advanced controls and energy management. IPES is an evolution of an Integrated Power System (IPS), and fully integrates all generated and stored electrical energy in the ship platform so that it is available to all electrical users, including high power weapons, advanced sensors, and electric propulsion, as mission scenarios dictate. IPES removes the need for individual Uninterruptible Power Supplies (UPS) battery units now proliferating on ships. IPES breaks this paradigm of stove piped energy storage and allows all users to benefit from common, shared sources of energy whether that be for mission systems or providing ride through power for mission critical systems or ship systems. Ship power systems today, including integrated power systems such as that on DDG 1000, do not have the capability to share energy resources.</p> <p>In FY 2022, this PE will continue to conduct feasibility studies, cost based assessments, computer real time simulations, and develop technical and performance specifications for an Integrated Power & Energy System (IPES) in support of notional future surface warship power and energy requirements. Identify shared energy storage and advanced controls requirements enabling an affordable, scalable and flexible power system to</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>meet current and future needs. Initiate 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 implements necessary functionality to enable Tactical Energy Management as described in the NPES TDR. Continue refining IPES notional architectures and risk assessments through studies and industry engagement. Draft performance specifications for IPES system, equipment and components. Continue to engage in robust component-level prototyping of potential new critical systems, including those related to propulsion and electrical distribution in support of future surface warships to the maximum extent possible. Execute computer component models and system level modeling and simulation efforts. Continue to plan for land based testing activities focused on testing prototypes, validating specifications and standards and interfaces, and functionality of advanced controls to demonstrate applicability and capability gain for the DDG(X).</p> <p>This PE has pursued an evolutionary energy storage development strategy for surface ships. Prior to FY 2021, this PE has designed, built, and tested at the Center for Advanced Power System at Florida State University (FSU CAPS) the Energy Storage Module (ESM) prototype, the Energy Magazine Bread Board (to test active front end technology to enable peak shaving) and multiple other energy storage devices designed and built outside of this PE. These include the United Kingdom (UK) Flywheel Energy Storage System, the Johns Hopkins University Adaptable Power Supply, and the Northrop Grumman Energy Storage System. This testing has de-risked the Energy Magazine technical specification and increased Navy expertise in the use of advanced energy storage technologies. Energy Storage is a key enabler for high-powered directed energy weapons.</p> <p>Energy Magazine-Prototype (EM-P): Complete build, conduct Test Readiness Reviews (TRR) and factory tests. Continue preparation of test plans and procedures and test site modifications for independent government testing including test in a Power Hardware in the Loop environment against representative naval warship electrical architectures and relevant directed energy weapons systems loads at FSU CAPS and Navy test facilities to confirm performance requirements and validate digital models of system. Continue to confirm safety of lithium-battery energy storage system design through rigorous safety and characterization testing. Continue</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>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.</p> <p>Energy Magazine (EM): Award contract and conduct kickoff meeting. Commence EM Preliminary Design (PD), plan and prepare for characterization for storage media (Lithium Batteries / Flywheel), begin ordering Long Lead Time Material (LLTM), and preparations to build the prototype units. Continue development of EM models to de-risk electrical design and support control software development. Continue conducting system simulations that focus on EM performance, generate and validate detailed interface requirements, test scenarios and sequences, and incorporate in Power Hardware In the Loop (PHIL) demonstration(s).</p> <p>Advanced Power Conversion Module (APCM): Continue to conduct feasibility studies, Cost Based Assessments, and developing performance and technical specifications for next generation compact high power Advanced Power Conversion Module (APCM) incorporating high band gap materials such as silicon carbide. Continue to develop computer component models and system level modeling and simulation efforts. In FY 2022, complete performance testing and digital model validation of the FY 2021 transitioned ONR FNC project "High Power State Circuit Protection for Power Distribution and Energy Storage" (SW-FY14-02) developed by Eaton Electric. Integrate data package into plans for future Medium Voltage DC (MVDC) distribution architectures and preserve hardware for future land based test and evaluation to reduce risk of integration of MVDC for surface ships.</p> <p>Advanced Power Generation Modules (APGM): Continue to define performance requirements, explore trade space in next generation compact high power Advanced Power Generation Modules (APGM), continue to develop characterization data used to conduct ship design studies and to establish a benchmark for performance comparison, continue to develop a standalone technical description document which describes performance characteristics, continue to evaluate the effect of large pulse loads from future electric weapons on the cycle life of gas turbine engines, and engine capability to respond to such pulse loads without an unacceptable reduction in time between overhaul. In FY 2022, this PE will take delivery of and transition into APGM the ONR Future Naval Capabilities (FNC) product, Shipboard Gas Turbine (GT)Modernization Package for Higher Temperature, Higher Pressure Operation" (SW-FY-19-03) developed by Rolls Royce. Planned FY 2022 focus areas include evaluation of ONR sponsored 264-hr 501-K34 engine endurance test.</p> <p>FY 2023 Base Plans:</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>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), consists of power electronics, energy storage media, and controls. 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.</p> <p>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 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, OPNAV, and ONR laser testing and planning activities. Evaluate performance of the EM prototype and, as applicable, incorporate lessons learned in EM.</p> <p>Energy Magazine (EM): Complete the preliminary design and material ordering. Commence detail design, characterization for Lithium Ion (Li) Batteries / Flywheel, build of prototype energy storage units, conduct Test Readiness Reviews and start testing required by. Update EM models and continue to 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.</p> <p>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 implements necessary functionality to enable Tactical Energy Management to ultimately be used in</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>an Integrated Power & Energy system (IPES). 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 is an evolution of an Integrated Power System (IPS), and 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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <ul style="list-style-type: none"> - 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 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. 					

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 2471 / <i>Integrated Power Systems (IPS)</i>

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
<p>- 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.</p> <p>FY 2023 OCO Plans: N/A</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement: The FY 2022 to FY 2023 decrease is due to completing Energy Magazine Prototype and taking delivery of the prototype unit.</p>					
<p>Title: HM&E Cybersecurity - Hardware Development / Prototyping & Cyber Analysis</p> <p align="right">Articles:</p> <p>FY 2022 Plans: Continue build of HM&E cybersecurity computing hardware Lab units for NSWC Philadelphia Division, Philadelphia PA for ship integration testing to support installations in FY 2023 and FY 2024. Continue design and development of second generation SABER Computing Hardware. Continue development and testing of additional WeaselBoard variants and cybersecurity capabilities.</p> <p>Continue development and testing of additional WeaselBoard variants for additional ship classes.</p> <p>Complete Environmental Qualification test (EQT) and lab testing and integration plans of Copper Tap & Aggregator Units for ship installations.</p> <p>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.</p> <p>FY 2023 Base 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. Continue 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.</p>	6.137	8.798	8.959	0.000	8.959
	-	-	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy				Date: April 2022	
Appropriation/Budget Activity 1319 / 4		R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>		Project (Number/Name) 2471 / <i>Integrated Power Systems (IPS)</i>	
B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)					
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 2023 OCO Plans: N/A					
FY 2022 to FY 2023 Increase/Decrease Statement: The increase from FY 2022 to FY 2023 is due to cost increases of prototype HM&E cybersecurity hardware on existing contracts					
Title: Naval Power Technology Development / Platform Integration & Transition					
Articles:					
FY 2022 Plans: Continue to execute the Advanced Electric Power and Propulsion Systems Development Project (short title is AEP3), Project Arrangement (PA) ref DoD-MOD-N-12-0001 which is an agreement between the 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 the needs of both Navies. Scope of AEP3 PA was modified in FY19 via amendment 2 to include development and testing of advanced cooling methods and distributed thermal management systems, and to jointly develop advanced control methods, technologies, and hardware for management of advanced shipboard power and energy systems. Thermal management of shipboard power and energy systems has lagged behind the rapid development of shipboard electrical power systems and high power pulsed mission systems, like Directed Energy (DE) weapons. Both nations seek to apply innovative cooling methods derived from academia, industry, and mission systems communities to electric power conversion and distribution. Advanced controls are required to support the rapid power and energy system reconfiguration needed on future surface ships. The benefits to both Participants will be the ability to power revolutionary Directed Energy Weapons on existing ships and field future shipboard electrical architectures with performance thresholds that exceed current thermal management and controls limits. Continue to execute international agreements with the 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 develop power and propulsion system configurations in support of future surface ship acquisition programs. Develop alternative power and propulsion solutions for future surface combatants and amphibious					
	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
	0.610	1.104	0.000	0.000	0.000
	-	-	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 2471 / <i>Integrated Power Systems (IPS)</i>

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
ships. Continue to improve baseline power system performance by performing analysis, modeling and simulation, life cycle cost analysis, producibility studies, module development, and ship integration studies and planning. When ready, issue update of the Naval Power and Energy Systems (NPES) technology development roadmap (TDR)					
Support transition from ONR of Silicon Carbon (and other high bandgap semiconductor materials) based power electronic modules. High band gap semiconductor materials operate at high speeds and temperatures as compared with silicon based materials affording more compact, thermally tolerant power conversion equipment making them highly desirable for naval applications.					
<i>FY 2023 Base Plans:</i> Activities in this sub-project have been realigned into the Power and Energy Systems sub-project to more appropriately reflect Power & Energy System Naval Power Technology Developments and integration / transitions into existing and future platform.					
<i>FY 2023 OCO Plans:</i> N/A					
<i>FY 2022 to FY 2023 Increase/Decrease Statement:</i> Activities in this sub-project have been realigned into the Power and Energy Systems sub-project to more appropriately reflect Power & Energy System Naval Power Technology Developments and integration / transitions into existing and future platform.					
Accomplishments/Planned Programs Subtotals	22.261	64.922	176.600	0.000	176.600

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.

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Navy												Date: April 2022			
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)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 Total			
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Cost To Complete	Total Cost	Target Value of Contract
Product Development	SS/CPFF	Rolls Royce : Walpole, MA	37.983	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Product Development	TBD	EM TBD : EM TBD	0.000	0.500	Apr 2022	9.500	Apr 2022	10.850	Nov 2022	-		10.850	Continuing	Continuing	Continuing
Product Development	C/CPFF	DRS : DRS, Milwaukee WI	62.463	9.327	Oct 2020	5.695	Oct 2021	1.626	Nov 2022	-		1.626	Continuing	Continuing	Continuing
Product Development	C/CPFF	Industry : Various	55.107	2.576	Oct 2020	4.868	Nov 2021	4.292	Nov 2022	-		4.292	Continuing	Continuing	Continuing
Product Development	WR	NSWCPCD : Phila, PA	67.272	1.866	Oct 2020	2.961	Nov 2021	2.686	Nov 2022	-		2.686	Continuing	Continuing	Continuing
Product Development	WR	Other Government Organizations : Various	0.742	1.057	Oct 2020	2.155	Nov 2021	0.814	Nov 2022	-		0.814	Continuing	Continuing	Continuing
Cybersecurity	WR	NSWCPCD : Phila, PA	14.354	2.446	Nov 2020	3.146	Nov 2021	3.179	Nov 2022	-		3.179	Continuing	Continuing	Continuing
Cybersecurity	C/CPIF	Boeing : Huntington Beach, CA	1.500	0.250	May 2021	0.250	May 2022	0.250	May 2023	-		0.250	Continuing	Continuing	Continuing
Cybersecurity	C/FP	Various HM&E Equipment Vendors : Various	2.066	0.000		0.250	Apr 2022	0.250	Jan 2023	-		0.250	Continuing	Continuing	Continuing
Cybersecurity	C/CPIF	Industry : Various	4.690	0.089	Jan 2021	0.747	Apr 2022	0.863	Jan 2023	-		0.863	Continuing	Continuing	Continuing
Cybersecurity	C/CPFF	Hexagon US Federal : Huntsville, AL	1.200	0.174	May 2021	1.505	Apr 2022	1.530	Jan 2023	-		1.530	Continuing	Continuing	Continuing
Cybersecurity	C/CPFF	JHU APL : Laurel, MD	3.756	1.649	Nov 2020	1.800	Jan 2022	1.020	Nov 2022	-		1.020	Continuing	Continuing	Continuing
Cybersecurity	C/CPFF	Visionary Products Incorporated (VPI) Technologies : Draper, UT	1.402	0.269	Nov 2020	0.700	Apr 2022	0.408	Nov 2022	-		0.408	Continuing	Continuing	Continuing
Cybersecurity	MIPR	Sandia National Labs : Albuquerque, NM	3.954	1.259	Nov 2020	0.400	Nov 2021	1.157	Nov 2022	-		1.157	Continuing	Continuing	Continuing
DDG(X) Power & Prop Risk Mitigation & Demo	WR	Other Government Organizations : Various	0.000	0.000		2.003	Nov 2021	2.322	Nov 2022	-		2.322	Continuing	Continuing	Continuing

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Navy **Date:** April 2022

Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 2471 / <i>Integrated Power Systems (IPS)</i>
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Product Development (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
DDG(X) Power & Prop Risk Mitigation & Demo	Various	GE : Various	0.000	0.000		8.001	Feb 2022	19.598	Dec 2022	-		19.598	Continuing	Continuing	Continuing
DDG(X) Power & Prop Risk Mitigation & Demo	C/CPFF	Industry : Various	0.000	0.000		10.007	Nov 2021	35.015	Nov 2022	-		35.015	0.000	45.022	-
DDG(X) Power & Prop Risk Mitigation	WR	NSWCPD : Phila. PA	0.000	0.000		8.289	Dec 2021	15.065	Nov 2022	-		15.065	0.000	23.354	-
DDG(X) Power & Prop Risk Mitigation	Various	Shipbuilders (BIW/HII) : Various	0.000	0.000		1.100	Jan 2022	73.900	Nov 2022	-		73.900	0.000	75.000	-
Subtotal			256.489	21.462		63.377		174.825		-		174.825	Continuing	Continuing	N/A

Remarks

- FY 2022 to FY 2023 increase is due primarily to DDG(X) Integrated Power System (IPS) Land Based Test Site (LBTS) modifications, hardware procurements and test site infrastructure refurbishments.
- Rolls-Royce (RR) Walpole, MA FY 2022 cost of \$2.5M moved to Industry: Various due to use of a RR contract different than this contract with RR Walpole, MA.
- FY 2022 Award Date updates are due primarily to the elongated Continuing Resolution under which this PU received ~23% of its PB22 request necessitating prioritization of efforts and obligations to those efforts / performers with the biggest impact to schedule. All efforts / performers will execute FY22 in accordance with FY22 plans. EM TBD is in source selection with contract award in April 2022. Award delay resulted from COVID-19 and Industry requests for additional time for proposal generation.
- FY 2022 Product Development Cost updates are associated with Congressional mark of (-\$0.5M) and cost growth associated with COVID-19 supply chain and material shortages.
- FY 2022 Cybersecurity Cost updates are due to resolution of design and / or system interface issues discovered in FY 2021 during either the prototype development and testing phases or from at-sea testing of prototype hardware and deferral of non-critical work.
- FY 2022 DDG(X) Power & Propulsion Risk Mitigation & Demo cost updates are associated with: (1) separately identifying NSWCPD (previously within Other Government Organizations) and Shipbuilders (previously in Industry:Various); and, (2) (-\$12.7M) Congressional mark
- GE changes from PB22 include: Contract type from SS/BOA to various due to the multiple contracting vehicles to fund the various GE performers

Test and Evaluation (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Test and Evaluation	WR	NSWCCD-SSSES : 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

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Navy											Date: April 2022		
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Management Services (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Management	C/CPFF	Herren Associates : Alexandria, VA	8.572	0.799	Oct 2020	1.545	Oct 2021	1.775	Nov 2022	-		1.775	Continuing	Continuing	Continuing
Subtotal			8.572	0.799		1.545		1.775		-		1.775	Continuing	Continuing	N/A

Remarks
FY 2022 to FY 2023 increase of 15% in planned Cost is a result of the PU Controls increase from FY22 (\$64.9M)to FY23 (\$176.6M)

Project Cost Totals	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
	290.015	22.261	64.922	176.600	-	176.600	Continuing	Continuing	N/A

Remarks

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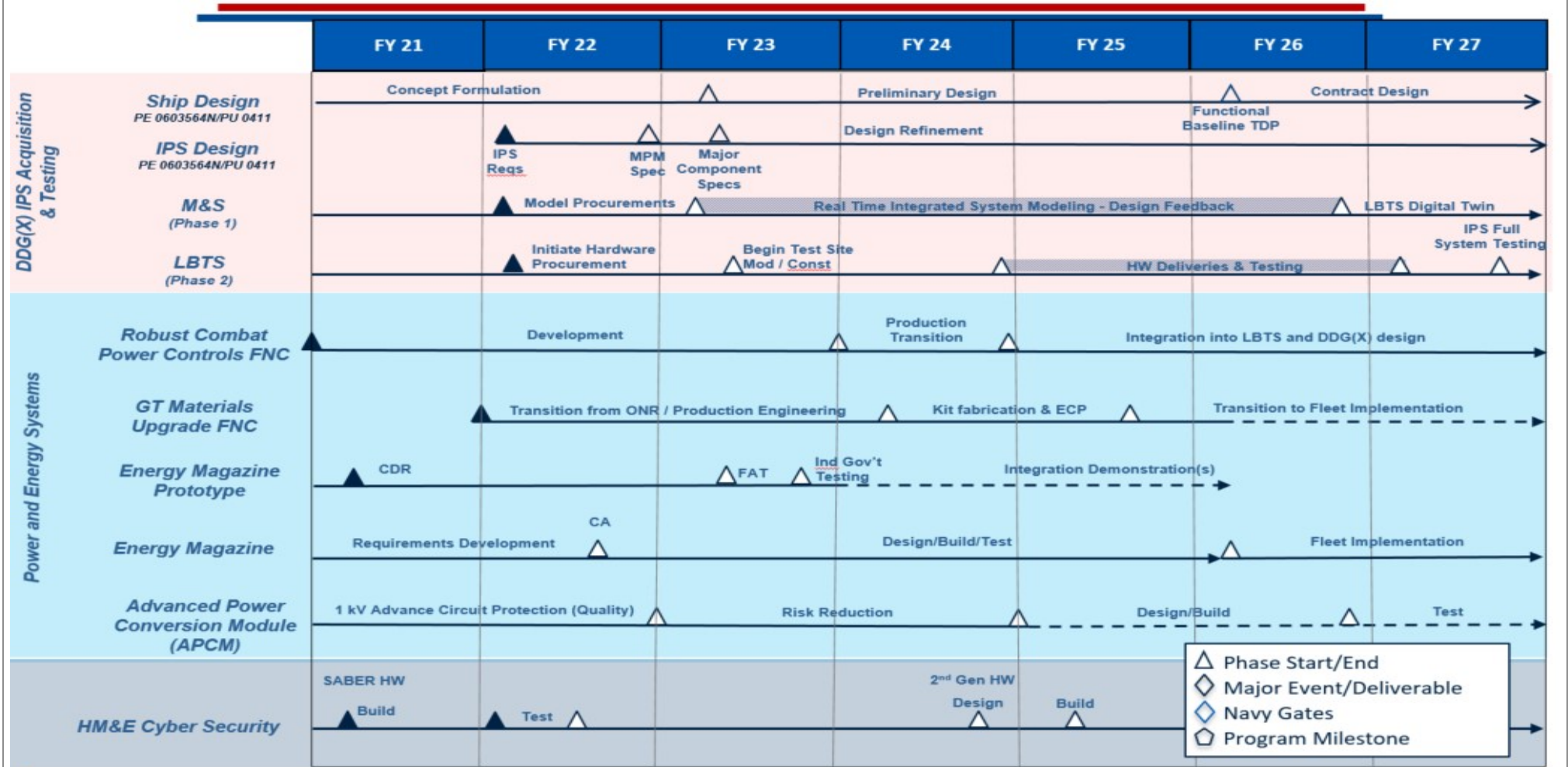
Exhibit R-4, RDT&E Schedule Profile: PB 2023 Navy

Date: April 2022

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)



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Exhibit R-4A, RDT&E Schedule Details: PB 2023 Navy		Date: April 2022
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 2471 / <i>Integrated Power Systems (IPS)</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Proj 2471				
DDG(X) Power & Propulsion Risk Mitigation & Demo / DDG(X) IPS ACQ & Testing	1	2022	4	2027
Power and Energy Systems	1	2021	4	2027
HM&E Cyber Ssecurity	1	2021	4	2027

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy **Date:** April 2022

Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>
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COST (\$ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
9999: <i>Congressional Adds</i>	64.638	16.883	12.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	93.521
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Congressional Adds:
 Silicon Carbide Power Modules (C447)
 Advanced Power Electronics Integration (C540)
 Surface Combatant Component-level Prototyping (C541)
 Small Boat Electric Propulsion (C639)

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

	FY 2021	FY 2022
Congressional Add: Silicon Carbide Power Modules FY 2021 Accomplishments: 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 2022 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	10.000
Congressional Add: Advanced power electronics integration FY 2021 Accomplishments: Design integration efforts for a new silicon carbide based power converter and continue power converter based distribution architecture modeling and simulation. FY 2022 Plans: FY2022 Plans continue FY2021 funded efforts to design integration efforts for a new silicon carbide based power converter and continue power converter based distribution architecture modeling and simulation.	2.412	0.000
Congressional Add: Small Boat Electric Propulsion FY 2021 Accomplishments: Developing contracting strategy and scope of effort associated with small boat electric propulsion FY 2022 Plans: Issue contract and execute scope of effort associated with small boat electric propulsion.	4.824	0.000
Congressional Add: Solid state circuit breaker development	0.000	2.000

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Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy	Date: April 2022
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Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022
<i>FY 2021 Accomplishments:</i> N/A		
<i>FY 2022 Plans:</i> Develop contracting strategy and scope of effort associated with Solid State Circuit Breaker Development		
Congressional Adds Subtotals	16.883	12.000

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

Remarks

D. Acquisition Strategy
N/A

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Navy **Date:** April 2022

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Product Development (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
SiC Power Modules	C/CPFF	RCT : Linthicum Heights MD	10.164	9.000	Jul 2021	9.000	Jun 2022	0.000		-		0.000	0.000	28.164	-
SiC Power Modules	Various	Various : Various	1.413	0.647	Feb 2021	1.000	Jun 2022	0.000		-		0.000	0.000	3.060	-
Adv. Power electronics Integration	Various	Various : Various	4.824	2.412	Apr 2021	0.000		0.000		-		0.000	0.000	7.236	-
Surface 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	0.000	4.824	Jun 2021	0.000		0.000		-		0.000	0.000	4.824	-
Solid State Circuit Breaker Development	C/BA	Not Specified : Not Specified	0.000	0.000		2.000	Aug 2022	0.000		-		0.000	0.000	2.000	-
Subtotal			64.638	16.883		12.000		0.000		-		0.000	0.000	93.521	N/A

	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	64.638	16.883	12.000	0.000	-	0.000	0.000	93.521	N/A

Remarks

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Exhibit R-4, RDT&E Schedule Profile: PB 2023 Navy **Date:** April 2022

Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>
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Proj 9999	FY 2021				FY 2022				FY 2023				FY 2024				FY 2025				FY 2026				FY 2027							
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q				
Component Level Prototyping																																
SiC Power Modules																																
Adv. Pwr Elec Integration																																
Small Boat Elec Propulsion																																
Solid State Circuit Breaker																																

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Exhibit R-4A, RDT&E Schedule Details: PB 2023 Navy		Date: April 2022
Appropriation/Budget Activity 1319 / 4	R-1 Program Element (Number/Name) PE 0603573N / <i>Advanced Surface Machinery Sys</i>	Project (Number/Name) 9999 / <i>Congressional Adds</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Proj 9999				
Surface Combatant Component Level Prototyping	1	2021	4	2021
SiC Power Modules	1	2021	4	2023
Advanced Power Electronics Integration	1	2021	4	2022
Small Boat Electric Propulsion	2	2021	4	2022
Solid State Circuit Breaker Development	1	2022	4	2023