Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Navy											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	270.426	84.227	40.510	78.122	-	78.122	-	-	-	-	-	-
2471: *Integrated Power Systems (IPS)*	265.602	24.413	23.010	78.122	-	78.122	-	-	-	-	-	-
9999: *Congressional Adds*	4.824	59.814	17.500	0.000	-	0.000	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The FY 2021 to FY 2022 increase is due to transferring Large Surface Combatant (now known as the DDG(X)) Power and Propulsion Risk Mitigation and Demonstration efforts, specifically the development of the Integrated Power and Energy System Test Facility (ITF) from Program Element(PE) 0603564N / Project Unit(PU) 0411 to PE 0603573N/PU 2471 to align component level prototyping and risk reduction activities with land based testing and demonstration. The ITF foundational elements are applicable to a variety of power and propulsion systems benefiting multiple ship classes over the long term, but the near term primary focus will be on critical system risk reduction efforts for the DDG(X) Integrated Power System (IPS). The ITF responds to, and will be used to satisfy the FY20 NDAA Section 131 requirements for land-based testing of propulsion systems in a realistic environment for the Navy's next class of large surface combatants while also providing test facility capabilities that can be focused broadly on future Navy power and propulsion technologies.

This Program Element (PE) includes the development of advanced surface ship Hull, Mechanical, and Electrical (HM&E) components and systems for all future ships and back-fit ships where appropriate as well as HM&E cyber security. This PE is managed by PMS 320, the Electric Ships Office, located organizationally within PEO SHIPS, responsible for developing Naval Power and Energy Systems that focus power system integration of Directed Energy (DE) and other high-powered mission systems as well as platform integration and improving energy efficiency of those components and systems. The mission of PMS 320 is to develop and provide smaller, simpler, more affordable and more capable electric power systems for all Navy platforms, focus Navy and industry investments, and reduce total ownership cost. PEO Ships, SHIPS Government Equipment Management (GEM) manages the Situational Boundary Enforcement & Response (SABER) hardware development effort and conducts HM&E cyber security analyses.

This PE also serves as the bridge between Science and Technology (S&T) and 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.

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B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	87.408	38.449	34.179	-	34.179
Current President's Budget	84.227	40.510	78.122	-	78.122
Total Adjustments	-3.181	2.061	43.943	-	43.943
• Congressional General Reductions	-	-0.171			
• Congressional Directed Reductions	-	-15.268			
• Congressional Rescissions	-	-			
• Congressional Adds	-	17.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.181	0.000			
• Program Adjustments	0.000	0.000	44.724	-	44.724
• Rate/Misc Adjustments	0.000	0.000	-0.781	-	-0.781

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: 9999: *Congressional Adds*		
Congressional Add: *Silicon Carbide Power Modules*	6.753	10.000
Congressional Add: *Advanced power electronics integration*	4.824	2.500
Congressional Add: *Surface combatant component-level prototyping*	48.237	0.000
Congressional Add: *Small Boat Electric Propulsion*	0.000	5.000
Congressional Add Subtotals for Project: 9999	59.814	17.500
Congressional Add Totals for all Projects	59.814	17.500

Change Summary Explanation

FY 2020 decrease due to SBIR/STTR Reductions

FY 2021 increase due to Congressional Adds of $17.5 million (for Silicon Carbide (SiC) Power Modules, Advanced Power Electronics Integration, and small boat electric propulsion) and decreases associated with power and energy system contract award delay ($15.268 million) and excess to need ($0.171 million).

FY 2022 increases by a total of $43.943 million due to: $42.100 million transfer of DDG(X), formerly Large Surface Combatant, Power and Propulsion Risk Mitigation and Demonstration specifically the development of the Integrated Power and Energy System Test Facility (ITF) from PE 0603564N / PU 0411 to align component level prototyping and risk reduction activities with land based testing and demonstration. The ITF foundational elements are applicable to a variety of power and propulsion systems benefiting multiple ship classes over the long term, but the near term primary focus will be on critical system risk reduction efforts

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for the DDG(X) Integrated Power System (IPS). The ITF will satisfy the FY20 NDAA Section 131 requirements for land-based testing of propulsion systems in a realistic environment for the Navy's next class of large surface combatants while also providing test facility capabilities that can be focused broadly on future Navy power and propulsion technologies; $2.624 million increase to begin transition and maturation of Office Of Naval Research (ONR) Future Naval Capabilities (FNC) gas turbine materials and coatings which are projected to improve capability and favorably impact performance and overhaul intervals for marine gas turbines, for both large propulsion and small ship service engines, for the next thirty years; and, ($0.781) million decrease due to other rate / miscellaneous rate adjustments.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy												Date: May 2021
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
2471: *Integrated Power Systems (IPS)*	265.602	24.413	23.010	78.122	-	78.122	-	-	-	-	-	-
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project supports the development and transition of Naval Power and Energy Systems 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). This 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). Component and system prototyping and demonstration integration methods employed include advanced digital engineering and modelling and simulation, through land based hardware testing at various Navy, Academic and industry facilities, and through at-sea demonstrations of technological readiness and fitness for service to pace and inform development of ship requirements.

The Navy's DDG(X) (formerly known as Large Surface Combatant) Program is the Navy's Future Guided Missile Destroyer ship acquisition program to follow the DDG 51 class that is essential to field capabilities required for the future fight as validated by the Future Surface Combatant Force (FSCF) Initial Capability Document (ICD), FSCF Analysis of Alternatives (AoA), and Future Naval Force Structure (FNFS). DDG(X) is initiating a phased systems engineering approach where risk is incrementally reduced to the necessary level to support performance of follow-on design and construction activities. This four-phased testing and risk reduction approach builds assurance that the IPS system can be installed and activated efficiently by the shipbuilder with performance characteristics that are well understood. Phase 1 (Digital Engineering) includes establishing a description of the components and system non-real-time models that are needed for the DDG(X) effort initiating the IPS digital engineering effort. This ensures requirements, specifications, and other important factors that determine intended use and performance bounds are defined. Persistent digital engineering efforts initiated as part of Phase 1 extend through the life of the DDG(X) program and have been conducted primarily at FSU CAPS. Phase 2 (Surrogate Testing) employs refined digital models and full-scale integrated surrogate components that functionally represent the intended DDG(X) power and propulsion system for testing at ITF. These models and surrogates support the build specification and guide the connection of equipment and interfaces at the ITF. Phase 3 (Tactical Hardware Testing) develop and transition ITF to the DDG(X) Land Based Engineering Site (LBES), builds a full-scale tactical representation of the shipboard power and propulsion system. Phase 4 (Shipboard Test & Activation) 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. 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.

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Project 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.

This project develops and transitions products that electrically integrate and provide power to mission systems, integrates those components and systems into ship platforms, increases energy efficiency, and provides cyber security capabilities for current in-service Hull, Mechanical and Electrical (HM&E) systems as well as future systems.

The 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 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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Title: Power and Energy Systems	15.776	15.513	26.120	0.000	26.120
Articles:	-	-	-	-	-
FY 2021 Plans: This PE has pursued an evolutionary energy storage development strategy for surface ships. Prior to FY 2021, this PE has designed, built, and then 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. The stored energy of the Energy Magazine is required to supplement typical ship service power so that large pulsed loads do not directly tie to the electrical power generator, which potentially damages the shipboard power system. The Energy Magazine consists of power electronics, energy storage media, and controls. The Energy					

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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Magazine is a common, modular, scalable intermediate power system that standardizes energy storage across multiple mission systems and ships classes, eliminating wasteful need for mission systems to each develop, build, test and qualify/certify 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. Additionally, approximately 30-40% of the cabinet components that support weapons and sensing systems are power conditioning; these can be functionally replaced by the Energy Magazine as a more universal power conditioning and energy storage unit that is ship power "reloadable" for multiple directed energy engagements. The Energy Magazine is designed for both new construction and back-fit applications where advanced combat systems loads are being deployed. Energy Magazine-Prototype (EM-P): Continue to execute the Energy Magazine - Prototype (EM-P) development. Specific FY21 efforts include: completing the design, ordering material, commencing the build and preparing for Test Readiness Reviews prior to testing the EM-P. Evaluate performance of the EM Prototype and, as applicable, incorporate lessons learned into EM procurement. Initiate preparation of test plans and procedures and test site modifications for independent government testing. Energy Magazine (EM): Following source selection, competitively award EM contracts to up to two (2) vendors. In FY 2021, selected vendor(s) will commence Preliminary Design (PD) of a modular, scalable, multi-application EM; an energy storage system that serves as the energy resource to enable the introduction of pulsed high power and energy weapons and sensor systems. EM simultaneously supports multiple pulsed loads such as laser, electronic warfare, radars, etc. When fully integrated, EM is expected to also reduce the number of Uninterruptable Power Supply (UPS) battery units on ships which decreases maintenance and costs. The EM aligns with PEO IWS plans for development and deployment of shipboard high power directed energy weapons and sensors. In FY 2021, this PE will take delivery of and complete transition of the ONR Future Naval Capabilities (FNC) product, Multi-Function High Density Shipboard Energy Storage" (SW-FY-15-02), developed by General Electric. MFESM will be tested in a Power Hardware in the Loop environment against representative naval warship electrical architectures and relevant directed energy weapons systems loads at FSU CAPS to confirm performance requirements and validate digital models of system. 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-					

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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
use distributed energy storage as well as advanced controls and energy management. IPES is an evolution of an Integrated Power System (IPS), specifically from that installed on DDG 1000. Other changes from IPS on DDG 1000 range from system level improvements such as variable speed prime movers, higher bus voltages, common intra-zone power conversion, improved electrical disconnects, advanced circuit protection, and cybersecurity to component and device improvements such as increased efficiency and performance leveraging industry's advancements in power conversion technology since DDG 1000 was designed. IPES is a system that 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) now proliferating on ships. An 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 do not have the capability to share energy resources. In FY21, IPES efforts include: 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 future surface warship power and energy requirements. Identify shared energy storage and advanced controls requirements enabling an affordable, scalable and flexible power system to meet current and future needs. Refine IPES notional architectures and risk assessments through studies and industry engagement. 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 combatants to the maximum extent possible. Execute computer component models and system level modeling and simulation efforts. Plan for land based testing activities focused on testing prototypes, validating specifications and standards and interfaces, and functionality of advanced controls. In order to obtain early insight into the effects of high power and energy mission systems on ships electric power systems, evaluate shipboard power and energy systems, and evaluate power system performance at lower cost than full-scale hardware system testing, simulated electrical system integration testing using power and energy system components will be conducted. This lower-cost approach to testing is referred to as Power Hardware In the Loop (PHIL). PHIL includes development of component computer models that simulate and emulate actual operating machinery components and shipboard power and energy systems. PHIL testing replaces component models with hardware once hardware development is complete. PHIL testing costs less than full-scale hardware system testing, shortens development time, and affords the opportunity to identify and mitigate risks in a deliberate fashion from specification development to computer model development to hardware development resulting in a more affordable and robust end product. PHIL testing reduces developmental risk,					

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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
and demonstrates performance potential prior to live hardware integration testing. Continue to conduct PHIL demonstrations. In FY 2021 PHIL demonstrations will focus on available propulsion and electrical distribution component prototypes to support design efforts. 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 2021, this PE will take delivery of and transition into APCM the ONR Future Naval Capabilities (FNC) product, High Power State Circuit Protection for Power Distribution and Energy Storage" (SW-FY14-02) developed by Eaton Electric. This unit will be tested in a Power Hardware in the Loop environment against representative naval warship electrical architectures at FSU CAPS and Navy test facilities to confirm performance requirements and validate digital models of system. 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. Continue scale generator physical modeling efforts at Sandia National Labs Small Scale Microgrid to determine the feasibility and operational characteristics of dual wound generators operating through active rectifiers to supply a scale medium voltage DC ships electrical bus with scale pulsed, high power weapons and sensors. Continue industry engagement in early trade and concept studies to determine the cost and feasibility of dual wound, variable speed gas turbine generators. Continue to support maturation and transition of ONR Future Naval Capabilities (FNC) products for advanced marine gas turbine engine materials and coatings for higher temperature, higher pressure operation. Planned FY21 focus areas include establishment of transition contract vehicle and execution of initial tasking to support selection of targeted application for transition of new materials for DDG 51 Class 501-K34 generator set engines. ***FY 2022 Base Plans:*** 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					

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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
risk. Navy's investment across the 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. 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. 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 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					

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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
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) as demonstrated at ITF. 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. The stored energy of the Energy Magazine is required to supplement typical ship service power so that large pulsed loads do not directly tie to the electrical power generator, which potentially damages the shipboard power system. The Energy Magazine consists of power electronics, energy storage media, and controls. The Energy Magazine is a common, modular, scalable intermediate power system that standardizes energy storage across multiple mission systems and ships classes, eliminating 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. Approximately 30-40% of the cabinet components that support weapons and sensing systems are power conditioning; these can be functionally replaced by the Energy Magazine as a more universal power conditioning and energy storage unit that is ship power "reloadable" for multiple directed energy engagements. The 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 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					

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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 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. Energy Magazine (EM): Complete EM Preliminary Design (PD), commence detailed design, plan and prepare for S9310-AQ-SAF-010 characterization for Li Batteries / Flywheel, order Long Lead Time Material (LLTM), and prepare to build the prototype units. Continue to conduct 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). In order to obtain early insight into the effects of high power and energy mission systems on ships electric power systems, evaluate shipboard power and energy systems, and evaluate power system performance at lower cost than full-scale hardware system testing, simulated electrical system integration testing using power and energy system components will be conducted. This lower-cost approach to testing is referred to as Power Hardware In the Loop (PHIL). PHIL includes development of component computer models that simulate and emulate actual operating machinery components and shipboard power and energy systems. PHIL testing replaces component models with hardware once hardware development is complete. PHIL testing costs less than full-scale hardware system testing, shortens development time, and affords the opportunity to identify and mitigate risks in a deliberate fashion from specification development to computer model development to hardware development resulting in a more affordable and robust end product. PHIL testing reduces developmental risk, and demonstrates performance potential prior to live hardware integration testing. In FY 2022 PHIL demonstrations will focus on available propulsion and electrical distribution component prototypes to support design efforts. 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.					

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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
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. 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. Continue scale generator physical modeling efforts at Sandia National Labs Small Scale Microgrid to determine the feasibility and operational characteristics of dual wound generators operating through active rectifiers to supply a scale medium voltage DC ships electrical bus with scale pulsed, high power weapons and sensors. Continue industry engagement in early trade and concept studies to determine the cost and feasibility of dual wound, variable speed gas turbine generators. In FY 2022, this PE will take delivery of and transition into APGM the ONR Future Naval Capabilities (FNC) product, Shipboard Gas Turbine 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 500-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. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** FY21 to FY22 increase includes commencing transition and maturation of Office Of Naval Research (ONR) Future Naval Capabilities (FNC) gas turbine materials and coatings which are projected to improve capability and favorably impact performance and overhaul intervals for marine gas turbines, for both large propulsion and small ship service engines, for the next thirty years; and, design and build of the modular scalable shipboard multi-application Energy Magazine (EM) which enables new pulsed, high power directed energy weapons (lasers) and sensors.					
Title: Naval Power Technology Development / Platform Integration & Transition	1.104	1.104	1.104	0.000	1.104
Articles:	-	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
FY 2021 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. Continued to execute international agreements with the German and Indian Navies. Executed a Data Exchange Agreement (N-20-JPH-4037) with the Japanese Navy. 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 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. Continue to analyze alternatives for supplying power to advanced radars, combat systems, and electric weapons power demands and potential interfaces to develop optimum alternative solutions. Continue assessments of Naval Power and Energy System alternate architectures to best meet emerging ship requirements. Continue to generate strategy, technology development plan and resource requirements for future surface warship integrated power and energy systems.					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Continued 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). 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. ***FY 2022 Base 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 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					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
and planning. Continue to analyze alternatives for supplying power to advanced radars, combat systems, and electric weapons power demands and potential interfaces to develop optimum alternative solutions. Continue assessments of Naval Power and Energy System alternate architectures to best meet emerging ship requirements. Continue to generate strategy, technology development plan and resource requirements for future surface combatant integrated power and energy systems. Continued to support maturation and transition of ONR Future Naval Capabilities (FNC) products to meet NPES TDR identified gaps. When ready, issue biennial 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. ***FY 2022 OCO Plans:*** N/A					
Title: DDG (X) Power & Propulsion Risk Mitigation & Demonstration ***Articles:*** ***FY 2021 Plans:*** N/A ***FY 2022 Base Plans:*** DDG(X) IPS development activities in FY 2022 include: Continue Phase 1 (Digital Engineering) and Phase 2 (Surrogate Testing) activities and begin planning for Phase 3 (Tactical Hardware Testing). - Phase 1: Continue to 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. 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. Continue testing 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	0.000 -	0.000 -	42.100 -	0.000 -	42.100 -

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
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 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. - Phase 2: Continue to develop test capability using surrogate equipment. Initiate procurement of a Main Turbine Generator (MTG), 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 CONOPS and controls development to inform testing development needs for DDG(X); Continue to develop interfaces and specifications of individual power and propulsion system components; 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. - 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 U.K. 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, Tactical Hardware Testing. ***FY 2022 OCO Plans:*** N/A ***FY 2021 to FY 2022 Increase/Decrease Statement:*** The FY 2021 to FY 2022 $42.1 million increase is due to transferring DDG(X), formerly Large Surface Combatant, Power and Propulsion Risk Mitigation and Demonstration specifically the development of the Integrated Power and Energy System Test Facility (ITF) at NSWCPD from PE063564N/PU 0411 to PE0603573N/PU 2471 to support surface ship component level prototyping, system integration testing and demonstration. The ITF foundational elements are applicable to a variety of power and propulsion systems benefiting multiple ship classes over the long term, but the near term primary focus will be on critical system risk reduction efforts for the DDG(X) Integrated Power System (IPS). The ITF responds to, and will be used to satisfy the FY20 NDAA Section 131 requirements for land-based testing of propulsion systems in a realistic environment for the Navy's next class of large surface combatants while also providing test facility capabilities that can be focused broadly on future Navy power and propulsion technologies.					
Title: HM&E Cybersecurity - Hardware Development / Prototyping & Cyber Analysis	7.533	6.393	8.798	0.000	8.798

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Articles:	-	-	-	-	-
FY 2021 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 2022 and FY 2023. Develop and test additional WeaselBoard variants. Complete design, First Article Test (FAT) unit fabrication, and Environmental Qualification Test (EQT) of the SABER sensor known as the Copper Tap & Aggregator unit. Complete build of a small Low Rate Initial Production (LRIP) quantity of Copper Tap & Aggregator Units for lab testing at NSWC Philadelphia Division, Philadelphia PA. 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 2022 Base 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. Continue development and testing of additional WeaselBoard variants for additional ship classes. Complete EQT and lab testing and integration plans of Copper Tap & Aggregator Units for ship installations. 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 2022 OCO Plans: N/A					
FY 2021 to FY 2022 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
The $2.405 million increase from FY 2021 to FY 2022 is to account for the design and development of second generation SABER Computing Hardware, the increase in Cyber Table Top type events and cyber vulnerability analyses planned, and the increase in Weaselboard variants under development and testing.					
Accomplishments/Planned Programs Subtotals	24.413	23.010	78.122	0.000	78.122

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

This program develops and transitions higher performance and more affordable electric power and propulsion systems to both new construction and back fit ship applications using an evolutionary acquisition approach. 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 2022 Navy			Date: May 2021
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 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Product Development	SS/CPIF	Rolls Royce : Walpole, MA	37.983	0.000		0.000		2.576	Nov 2021	-		2.576	-	-	-
Product Development	TBD	TBD : TBD	0.000	0.000		0.500	Aug 2021	10.000	Nov 2021	-		10.000	-	-	-
Product Development	C/FFP	DRS : DRS, Milwaukee WI	54.873	7.590	Oct 2019	9.327	Oct 2020	5.000	Oct 2021	-		5.000	-	-	-
Product Development	C/CPFF	Various : Various	50.704	4.403	Oct 2019	2.717	Oct 2020	2.901	Nov 2021	-		2.901	-	-	-
Product Development	WR	NSWCPD : Phila, PA	64.300	2.972	Oct 2019	2.066	Oct 2020	2.944	Nov 2021	-		2.944	-	-	-
Product Development	WR	Other Government Organizations : Various	0.000	0.742	Dec 2019	1.007	Oct 2020	2.140	Nov 2021	-		2.140	-	-	-
Cybersecurity	WR	NSWCPD : Phila, PA	11.474	2.880	Nov 2019	2.519	Nov 2020	3.146	Nov 2021	-		3.146	-	-	-
Cybersecurity	C/CPIF	Boeing : Huntington Beach, CA	1.250	0.250	May 2020	0.250	May 2021	0.250	May 2022	-		0.250	-	-	-
Cybersecurity	C/FP	Various HM&E Equipment Vendors : Various	1.998	0.068	Jan 2020	0.000		0.250	Jan 2022	-		0.250	-	-	-
Cybersecurity	C/CPIF	Various : Various	3.481	1.209	Jan 2020	0.561	Jan 2021	1.118	Jan 2022	-		1.118	-	-	-
Cybersecurity	C/CPFF	Hexagon US Federal : Huntsville, AL	1.200	0.000		0.180	May 2021	1.500	Jan 2022	-		1.500	-	-	-
Cybersecurity	C/CPFF	JHU APL : Laurel, MD	3.756	0.000		1.649	Nov 2020	1.000	Nov 2021	-		1.000	-	-	-
Cybersecurity	C/CPFF	Visionary Products Incorporated (VPI) Technologies : Draper, UT	0.000	1.402	Jul 2020	0.250	Nov 2020	0.400	Nov 2021	-		0.400	-	-	-
Cybersecurity	MIPR	Sandia National Labs : Albuquerque, NM	2.286	1.668	Nov 2019	0.984	Nov 2020	1.134	Nov 2021	-		1.134	-	-	-
DDG(X) Power & Prop Risk Mitigation & Demo	WR	Other Government Organizations : Various	0.000	0.000		0.000		10.935	Nov 2021	-		10.935	-	-	-

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy		Date: May 2021
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 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
DDG(X) Power & Prop Risk Mitigation & Demo	SS/BOA	GE : Various	0.000	0.000		0.000		11.520	Dec 2021	-		11.520	-	-	-
DDG(X) Power & Prop Risk Mitigation & Demo	C/CPFF	Various (incl SYs) : Various	0.000	0.000		0.000		19.645	Nov 2021	-		19.645	-	-	-
		Subtotal	233.305	23.184		22.010		76.459		-		76.459	-	-	N/A

Test and Evaluation ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Test and Evaluation	WR	NSWCCD-SSES : Phila, PA	24.954	0.000		0.000		0.000		-		0.000	-	-	-
		Subtotal	24.954	0.000		0.000		0.000		-		0.000	-	-	N/A

Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Management	C/CPFF	Herren Associates : Alexandria, VA	7.343	1.229	Oct 2019	1.000	Oct 2020	1.663	Oct 2021	-		1.663	-	-	-
		Subtotal	7.343	1.229		1.000		1.663		-		1.663	-	-	N/A

	Prior Years	FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	265.602	24.413		23.010		78.122		-		78.122	-	-	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Navy		Date: May 2021
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)*

PE 0603573N

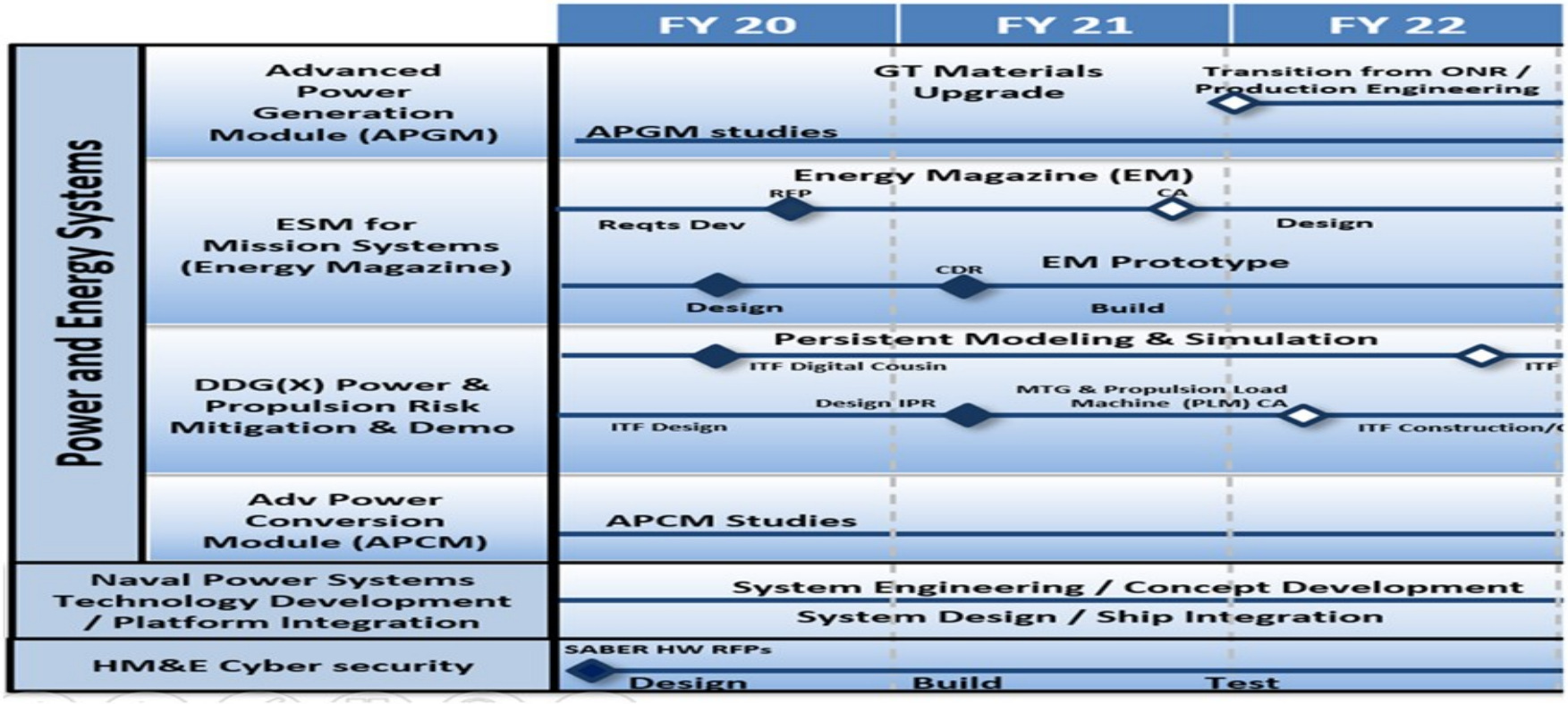

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Exhibit R-4A, RDT&E Schedule Details: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 2471 / *Integrated Power Systems (IPS)*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
Proj 2471				
Power and Energy Systems	1	2020	4	2022
Naval Power Technology Development / Platforms Integration & transition	1	2020	4	2022
Situational Awareness, Boundary Enforcement & Response (SABER) previously Cybersecurity BDC	1	2020	4	2022
DDG(X) Power & Propulsion Risk Mitigation & Demo	1	2022	4	2022

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
9999: *Congressional Adds*	4.824	59.814	17.500	0.000	-	0.000	-	-	-	-	-	-
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 2020	FY 2021
Congressional Add: Silicon Carbide Power Modules ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** 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.	6.753	10.000
Congressional Add: Advanced power electronics integration ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** Design integration efforts for a new silicon carbide based power converter and continue power converter based distribution architecture modeling and simulation.	4.824	2.500
Congressional Add: Surface combatant component-level prototyping ***FY 2020 Accomplishments:*** N/A ***FY 2021 Plans:*** FY2021 Plans continued FY20 funded design activities and build initiation of Integrated Power and Energy (IPES) Test Facility known as the "ITF" as a land based test facility at the Naval Surface Warfare Center (NSWC) Philadelphia Division (PD) by refurbishment and reuse of certain DDG1000 developmental power system components, and other prototype hardware to support advanced controls development and integration of distributed and federated energy storage into ship agnostic Tactical Energy Management for use on future surface ships.	48.237	0.000
Congressional Add: Small Boat Electric Propulsion	0.000	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2022 Navy		Date: May 2021
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2020 Accomplishments: N/A ***FY 2021 Plans:*** Developing contracting strategy and scope of effort associated with small boat electric propulsion		
Congressional Adds Subtotals	59.814	17.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Navy		Date: May 2021
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 2020 Cost	FY 2020 Award Date	FY 2021 Cost	FY 2021 Award Date	FY 2022 Base Cost	FY 2022 Base Award Date	FY 2022 OCO Cost	FY 2022 OCO Award Date	FY 2022 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
SiC Power Modules	C/CPFF	RCT : Linthicum Heights MD	4.000	6.164	May 2020	9.000	May 2021	0.000		-		0.000	-	-	-
SiC Power Modules	Various	Various : Various	0.824	0.589	May 2020	1.000	Feb 2021	0.000		-		0.000	-	-	-
Adv. Power electronics Integration	Various	Various : Various	0.000	4.824	Dec 2020	2.500	Apr 2021	0.000		-		0.000	-	-	-
Suface Combatant Component Level prototyping	Various	Various : Various	0.000	9.361	Mar 2020	0.000		0.000		-		0.000	-	-	-
Surface Combatant Component Level Prototyping	Various	General Electric : Various	0.000	17.818	Mar 2020	0.000		0.000		-		0.000	-	-	-
Surface Combatant Component Level Prototyping	Various	Rolls-Royce : Various	0.000	4.480	Mar 2020	0.000		0.000		-		0.000	-	-	-
Surface Combatant Component Level Prototyping	Various	FSU CAPS : Tallahassee, FL	0.000	10.800	Mar 2020	0.000		0.000		-		0.000	-	-	-
Surface Combatant Component Level Prototyping	WR	NSWCPD : Philadelphia,PA	0.000	5.778	Mar 2020	0.000		0.000		-		0.000	-	-	-
Small Boat Electric Propulsion	Various	Various : Various	0.000	0.000		5.000	Jun 2021	0.000		-		0.000	-	-	-
		Subtotal	4.824	59.814		17.500		0.000		-		0.000	-	-	N/A

	Prior Years	FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	4.824	59.814		17.500		0.000		-		0.000	-	-	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 9999 / *Congressional Adds*

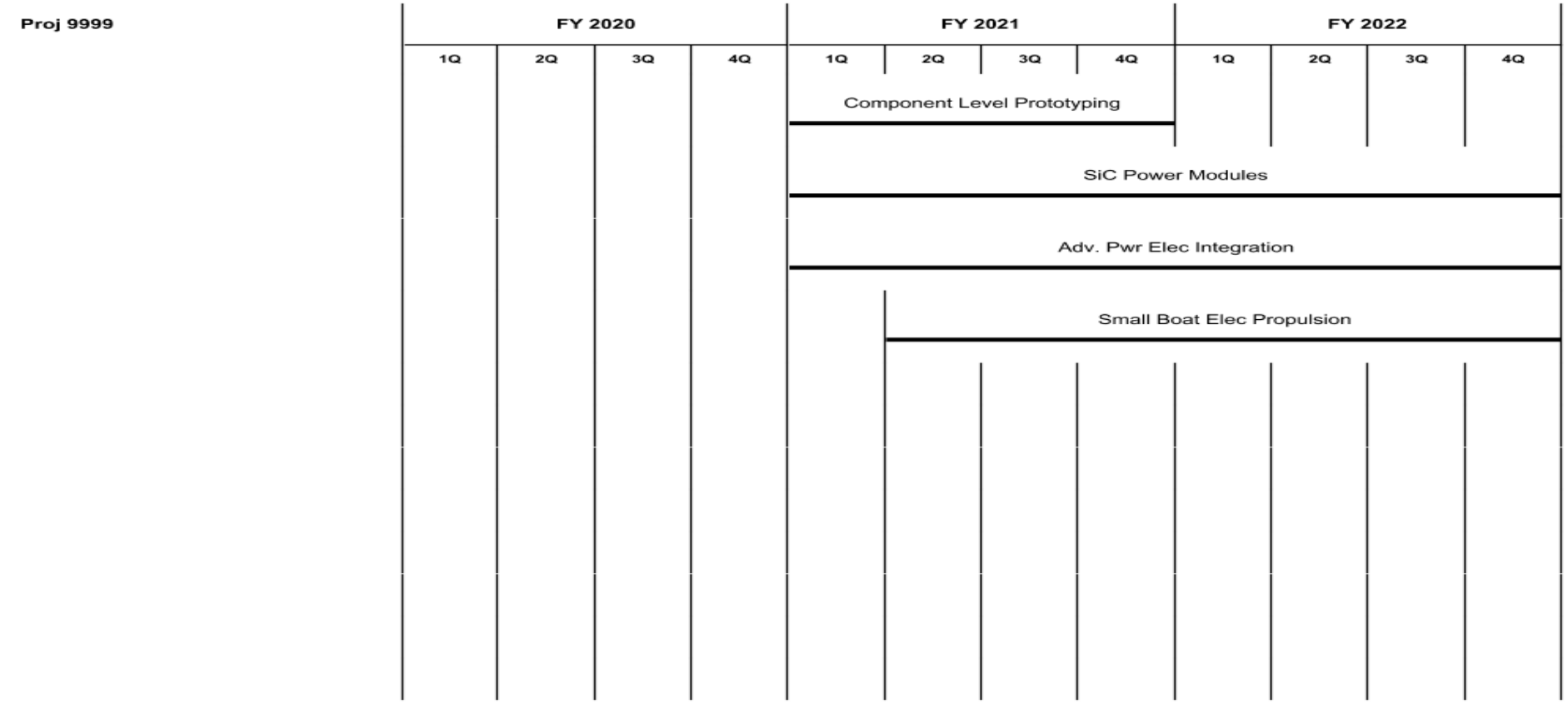

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Exhibit R-4A, RDT&E Schedule Details: PB 2022 Navy		Date: May 2021
Appropriation/Budget Activity 1319 / 4	**R-1 Program Element (Number/Name)** PE 0603573N / *Advanced Surface Machinery Sys*	**Project (Number/Name)** 9999 / *Congressional Adds*

Schedule Details

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