Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Navy											Date: February 2015	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602123N *I Force Protection Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	168.311	163.660	154.963	-	154.963	146.800	129.755	120.871	121.476	Continuing	Continuing
0000: *Force Protection Applied Res*	0.000	143.311	139.460	154.963	-	154.963	146.800	129.755	120.871	121.476	Continuing	Continuing
9999: *Congressional Adds*	0.000	25.000	24.200	-	-	-	-	-	-	-	-	49.200

A. Mission Description and Budget Item Justification

The efforts described in this program element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Sep 2011). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability. This is accomplished by improvements in platform offensive performance, stealth, and self-defense.

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

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	170.288	139.496	128.363	-	128.363
Current President's Budget	168.311	163.660	154.963	-	154.963
Total Adjustments	-1.977	24.164	26.600	-	26.600
• Congressional General Reductions	-	-0.036			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	24.200			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.957	-			
• SBIR/STTR Transfer	-0.020	-			
• Program Adjustments	-	-	26.600	-	26.600

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Congressional Add Details ($ in Millions, and Includes General Reductions)

	FY 2014	FY 2015
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	-	4.200
Congressional Add: *Alternative Energy Research*	25.000	20.000
Congressional Add Subtotals for Project: 9999	25.000	24.200
Congressional Add Totals for all Projects	25.000	24.200

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy			Date: February 2015
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602123N / *Force Protection Applied Res*	Project (Number/Name) 0000 / *Force Protection Applied Res*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
0000: *Force Protection Applied Res*	-	143.311	139.460	154.963	-	154.963	146.800	129.755	120.871	121.476	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability by virtue of improvements in platform offensive performance, stealth, and self-defense.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Title: AIRCRAFT TECHNOLOGY	59.830	53.048	68.537	-	68.537
Description: The Aircraft Technology activity develops technologies for reduced observables technology and enhanced capability of naval aviation aircraft platforms in terms of mission effectiveness, platform range, responsiveness, survivability, observability, readiness, safety and life cycle cost. It also develops new Naval air vehicle concepts and high impact, saleable naval air vehicle technologies, such as - autonomous air vehicle command and control, helicopter and tilt rotorsystems, aerodynamics, propulsion systems, materials, structures and flight controls for future and legacy air vehicles. This activity directly supports the Naval Aviation Enterprise Science and Technology Objectives and the Naval Science and Technology Strategic Plan, principally in the Autonomy and Unmanned Systems, Platform Design and Survivability, Power and Energy and Total Ownership Cost Focus Areas, Sea-Based Aviation was designated as a National Naval Responsibility (SBA NNR) in FY 2011 and will refocus investments beginning in FY 2014 in areas that are Naval unique or dominated by Naval requirements. Variable Cycle Advanced Technology (VCAT) will identify and mature critical, relevant variable/adaptive cycle propulsion system technologies for the next generation carrier-based TACAIR/ISR systems. Autonomous Aerial Cargo/Utility System (AACUS) will develop advanced autonomous capabilities to enable rapid resupply of distributed forces in the short term. The SBA NNR Structures and Materials program will develop the next generation structural capability and material response science for aircraft technology in fixed and rotary wing, manned and unmanned airframe technology to achieve reduced weight, increased durability, strength, streamlined manufacturability, reduced life-cycle cost and maintenance/readiness gaps improvements.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602123N / *Force Protection Applied Res*	**Project (Number/Name)** 0000 / *Force Protection Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Program payoffs include increased availability/readiness, reduced sustainment requirements, fatigue/loads life enhancement, reduced weight and improved range, and advanced prognostics design tools. Beginning in FY 2014, applied research efforts began under the Sea-Based Aviation National Naval Responsibility (SBA NNR) Propulsion thrust area. These efforts addresses unique attributes to propulsion and power technologies for Naval Aviation, as well as those having higher importance to Naval Aviation and some that are more pervasive to all of military aviation. Related basic research efforts are addressed under 0601153N. The funding decrease from FY 2014 to FY 2015 is due to the completion of a portion of the INP-Advanced Autonomous Cargo Utility System (AACUS) effort. The funding increase from FY 2015 to FY 2016 is due to the initiation of the joint Tern program and an increase in AACUS activities as the program enters phase 3. ***FY 2014 Accomplishments:*** - Continued development of rotorcraft/VTOL systems automated launch and recovery technology. - Continued mixed-mode mechanical/environmental failure prediction research. - Continued advanced composite durability technology. - Continued material degradation risk prediction and operational environment-driven materials selection methods. - Continued demonstration of initial core software, sensor, air vehicle, and capability applications for Autonomous Aerial Cargo/Utility System (AACUS). - Continued the advanced technology demonstration portion of the Variable Cycle Advanced Technology (VCAT) Program. Critical technology development efforts will begin with major engine manufactures and system contractors to develop/mature the highest priority, long-lead propulsion system technologies, including variable/ adaptive cycle engine components, for next generation carrier-based TACAIR/ISR systems. - Completed the majority of Phase I variable cycle engine/propulsion subsystem technology development efforts. - Completed experiments on user interaction methods/decision tools for future deck operations with mixed manned and autonomous air systems. - Completed efforts on autonomy for low-altitude persistence by small UAVs. - Completed effort to demonstrate the solution processing of an inorganic nanowire based photovoltaic device that operates in the infrared region.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Initiated new efforts on high confidence/Safe Autonomous Control in naval environments and on supervisory control of decentralized heterogeneous UAS. - Initiated SBA NNR related projects in Virtual Ship/Aircraft Dynamic Interface, Manned/Unmanned Handling Qualities and Control, Automated Deck Operations, High Lift Aerodynamics and Vertical/Short Takeoff and Landing (V/STOL) Operations. - Initiated applied research efforts under the Sea-Based Aviation National Naval Responsibility Propulsion thrust area. ***FY 2015 Plans:*** - Continue all efforts of FY 2014, less those noted as completed above. - Continue VCAT Phase I variable cycle engine/propulsion subsystem technology development efforts through completion. - Continue to explore and evaluate future aircraft concepts and their associated enabling technologies. - Continue development of survivability/reduced observables technology. Metrics are classified. - Initiate new efforts on safe-perception based autonomous control in complex naval environments and on autonomy to support combined unmanned and manned air systems/units. - Initiate airplane launch and recovery component and subsystem technology developments to enable medium size long endurance, long range UAVs to be launched and recovered on short deck ships. ***FY 2016 Base Plans:*** - Continue all efforts of FY 2015. ***FY 2016 OCO Plans:*** N/A					
Title: FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS ***Description:*** Fleet Force Protection and Defense against Undersea Threats efforts include applied research for complementary sensor and processing technologies for platform protection. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against air, surface, and asymmetric threats. A goal of this activity is to provide these platforms with effective self-protection. The technology areas specific to platform protection will develop individual, multispectral electro-optical (EO), infrared (IR), radio frequency (RF), electro-magnetic (EM), visual and acoustic or chemical sensors/ biosensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multispectral detection and distribution of specific threat information.	1.389	1.627	2.532	-	2.532

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
The funding increases from FY 2015 to FY 2016 are due to re-prioritization of the S&T investments. ***FY 2014 Accomplishments:*** Sensors & Associated Processing - Continued efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms. - Continued efforts in biomimetic signal processing: panoramic periscope for submarines and temporal pattern recognition for Systems for Security Breaching Noise Detection. - Continued efforts in bioinspired quiet, efficient and maneuverable self-propelled line array using high-lift propulsors based on insect biomechanics. - Continued studies to develop catalytic activity profile of bioactive coatings against chemical agents. - Continued design and initiated fabrication of coatings to degrade both, chemical and biological agents. - Continued efforts to design microfabricated system for 3-color fluorescence measurements using integrated waveguides. - Continued effort to develop new, highly selective, preferential oxidation catalysts for the generation of power from the reformate gas purification process. - Continued effort to develop aspheric gradient index optics. - Initiated Electrochemical sensors for the distributed, remote detection of explosives ***FY 2015 Plans:*** Sensors & Associated Processing: - Continue all efforts of FY 2014. - Complete development of distributed environmental microsensors for analyte dectection. ***FY 2016 Base Plans:*** Sensors & Associated Processing: - Continue all efforts of FY 2015, less those noted as completed above. ***FY 2016 OCO Plans:*** N/A					
Title: MISSILE DEFENSE (MD) ***Description:*** This activity describes Missile Defense S&T projects.	1.170	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
The funding decrease from FY 2014 to FY 2015 is due to re-scoping/re-phasing of various efforts in this R-2 Activity. This re-scoping was done to re-prioritize S&T investments. ***FY 2014 Accomplishments:*** - Completed missile defense related efforts. ***FY 2015 Plans:*** N/A ***FY 2016 Base Plans:*** N/A ***FY 2016 OCO Plans:*** N/A					
Title: ADVANCED ENERGETICS ***Description:*** Advanced Energetics efforts address technology development to provide substantial improvements in energetic material systems and subsystems, primarily in terms of performance, but also addressing safety, reliability, and affordability concerns. Goals include: advanced energetic materials for warheads, propellants, and reactive material based subsystems for both defensive and offensive applications. Efforts include: development of new fuels, oxidizers, explosive ingredients and formulations; and reliable simulation tools and diagnostics to develop and design superior-performance, and/or reduced-vulnerability systems tailored to specific warfighter missions. ***FY 2014 Accomplishments:*** - Continued processing optimization studies for MTX-1 (1-[(2E)-3-(1H-tetrazol-5-yl)triaz-2-en-1-ylidene] methanediamine), an additive to percussion primers. - Continued the processing optimization design of material compositions for Reactive Material explosive fragment applications. - Continued optimization and refinement studies of Poly NitratoOxetane (3-PNO) process for solid rocket motor propellants. - Continued the development of a reliable chemical scale-up and material specification process techniques. - Continued ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, letality models, and experiments).	4.131	5.052	5.408	-	5.408

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Continued Advanced Energetics research in development and evaluation of advanced explosive/propellant/ reactive ingredients and formulations for the next generation higher performing systems. - Continued proof-of-concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. - Continued Advanced Energetics research in development and diagnostics of novel energy conversion concepts. - Continued non-traditional energy conversion studies with columbic and cluster material investigations. - Continued Advanced Energetics research in technology development for the next generation reactive material warhead concepts (formulations, material properties, target interaction, lethality models, and experiments) for highly reactive materials, high density reactive materials and novel reactive structural materials. - Continued Advanced Energetics research in development of advanced directed hydro-reactive material warhead concepts to enhance performance of undersea warheads. - Continued proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. This work involves development of high quality, small particle energetic ingredients, novel processing techniques, and advanced energy conversion concepts; and involves both theoretical and experimental efforts. - Continued Advanced Energetics research in advanced multiphase blast concepts employing dense metalized explosives to enhance performance of air and underwater blast warheads. - Continued Advanced Energetics research in development and diagnostics of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target for air, surface, and underwater warhead application - Continued research in technology development for the next generation reactive material warhead concepts formulations, material properties, and energy release experiments for highly reactive materials, high density reactive materials and novel reactive structural materials. Transition application specific target interaction, lethality modeling and ordnance specific experiments and demonstrations to Electromagnetic Rail Gun, PE 0603114N. - Continued development of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target. Limit efforts to analytical and laboratory scale proof of concept experimental efforts. - Continued development and evaluation of energetic ingredients and formulations for next generation higher performance applications. Concluded scale-up development and testing. - Continued the processing optimization design of material compositions for Reactive Material explosive fragment applications.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Continued optimization and refinement studies of Poly NitratoOxetane (3-PNO) process for solid rocket motor propellants. - Continued the development of a reliable chemical scale-up and material specification process techniques. - Continued ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, letality models, and experiments). - Completed Studies on Poly NitratoOxetane (3-PNO). - Initiated process research and development of Ammonium Nitrotetrazolate-2N-oxide (AONT). - Initiated process optimization of Ammonium Tetrakis (3,5-Dinitro-1,2,4-Triazolyl)Borate (ATDTB). ***FY 2015 Plans:*** - Continue all efforts of FY 2014, less those noted as complete above. - Complete Studies on MTX-1 (1-[(2E)-3-(1H-tetrazol-5-yl)triaz-2-en-1-ylidene] methanediamine), an additive to percussion primers. - Complete Advanced Energetics research in development of advanced directed hydro-reactive material warhead concepts to enhance performance of undersea warheads. - Complete process optimization of Ammonium Tetrakis (3,5-Dinitro-1,2,4-Triazolyl)Borate (ATDTB). - Initiate research on new caged nitramines - Initiate process research and development of 1,1'-Diamino4,4',5'5'-Tetranitro-2,2'-Biimidiazole (DATNBI) - Initiate process research and development of 1-Fluoro-4,5-Dinitroimidazole. ***FY 2016 Base Plans:*** - Continue all efforts of FY 2015, less those noted as complete above. ***FY 2016 OCO Plans:*** N/A					
Title: SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E) ***Description:*** Efforts include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability (includes damage control), and advanced naval power systems. Signature reduction addresses electromagnetic, infrared, and acoustic signature tailoring, both topside and underwater.	72.522	75.266	73.935	-	73.935

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Hydromechanics addresses hydrodynamic technologies, including the signature aspects of the hull-propulsor interaction and maneuvering. Distributed intelligence for automated survivability addresses both the basic technology of automating machinery control systems, as well as, distributed control of systems utilizing autonomy for mission context based reconfiguration. Unmanned Sea Surface Vehicle applied research includes short-term motion forecasting for recovery of USSVs on a host ship in higher sea states and determination of slamming loads on high-speed planing hulls for structural weight reduction. Advanced naval power systems efforts address electrical and auxiliary system and component technology to provide improvement in energy and power density, operating efficiency and recoverability from casualties. Advanced Naval Power efforts include: developing technologies to improve warfighting capability with more energy efficient systems; reducing the time & cost to certify alternative fuels, and mitigate adverse alternative fuel impacts on Naval platforms and equipment; developing sustainable biomass models to support alternative fuel availability to Naval forces; utilizing the Electric Ship Research and Development Consortium (ESRDC) efforts to develop modeling and simulation tools to provide critical design & operational capabilities for the all-electric ship program, accelerate development and demonstration of technologies, reduce risk of new technology insertion and address the national shortage of electrical power engineers. Efforts for ONR Science Advisors are also funded in this R-2 Activity. Long Endurance UUV technologies will deliver to the Office of Naval Research modular fuel cell systems for UUVs, including practical systems demonstrations, and a path forward for future developments. It will also keep the US Navy at the forefront of advanced electric propulsion technologies. The funding increase from FY 2014 to FY 2015 is due to the increase in the Applied Research Challenge and an increase in Counter-IED effort. The funding decrease from FY 2015 to FY 2016 is due to the completion of the INP - Advanced UUV Power & Energy effort. ***FY 2014 Accomplishments:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Survivable Platforms - Reduced Signatures: - Continued advanced numerical acoustic codes (and gridding methods for those codes) for submarines. - Continued mmWave Signatures measurement to identify key signature characteristics. - Continued Alternating Current (AC) propagation experiments. - Continued the next generation Infrared Electro-Optic Visual (IR/EO/VIS) model for surface ships by development of mitigation strategy supporting low observable infrared platforms, development of supporting physics, and prototype measurement techniques. - Continued development of quiet control surface design tool based on control surface flow noise studies. - Continued IR and radar detectability prediction capability. - Continued surface ship super-conductive degaussing with laboratory demonstration loop for Electromagnetic (EM) field accuracy measurements and control methods. - Continued testing on Advanced Electric Ship Demonstrator (AESD) to assess energy propagation and acoustic radiation mechanisms and to develop mitigation concepts for surface ships. - Continued IR assessment of two advanced treatments. - Continued first of a series of IR validation experiments and critical sensitivity analysis. - Continued Improved Corrosion Related Magnetic (CRM) Field Prediction Model to design compensation systems to reduce ship's CRM signature. - Continued assessment of ship biostatic Radar Cross Section (RCS). - Continued large-scale tests on AESD to develop signature prediction and design tools for surface ship incorporating a variety of propulsion technologies including external podded propulsion. - Continued experimental effort to characterize electric drive motor signature mechanisms and verify modeling and simulation approaches for signature prediction. - Continued development of modeling methods and noise control concepts for modular/reconfigurable submarine architectures. - Continued investigation into hull treatment concepts for acoustic signature/vibration control for surface ships. - Continued development of advanced RF metamaterials for platform signature control. - Continued development of signature modeling approaches for electric actuation and alternate electric drive system architectures. - Continued development of Low probability Intercept (LPI) technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems. - Continued advanced EM modeling tools development and validation. - Continued next generation deckhouse integration technology development. - Continued modeling of hydroacoustics of turbulence-propulsor interaction.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Continued joint effort with UK/MoD on adhesively joined aluminum in lieu of welding of marine structures and thus reduce cost. - Continued joint effort with NLRN on adhesive joined composite to metals in lieu of bolting of marine structures and thus reduce cost for topside structures. - Continued efforts on shock mitigation and shock diversion for ship hulls to reduce cost of machinery mounts and equipment, based on successful results from the ERC helmets for protection against TBI Survivable Platforms - Hull Life Assurance: - Continued efforts on combinations of highly rate-sensitive materials through experiment and modeling for extreme hyper velocity threat conditions. - Continued development of global surface wave measurement capability for ship models. - Continued Dynamic Behavior of Composite Ship Structures (DYCOSS) (joint effort with Dutch Navy). - Continued development of structural analysis codes describing failure mechanism of sandwich composites. - Continued Explosion Resistant Coatings (ERC) effort, providing US input to trilateral agreement with UK and Australia. - Continued composite and composite-metal hull performance characterization and testing including structural loading, thermal stress and signatures. - Continued effort on an advanced class of polymers as a follow-on to current ERC for application against advanced threats. - Continued Payload Implosion and Platform Damage Avoidance efforts. - Continued development of advanced analytical, numerical and experimental methods in support of platform signature reduction. - Continued effort on exploitation of polymers for the deflection and dissipation of shock wave impact on ship and submarine hull structures. - Completed development of reliability-based recoverability methods for assessing damaged ship structures. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continued development of modeling and simulation methods for robust design and virtual testing of integration of shipboard auxiliary systems including their control systems. - Continued research into advanced HM&E system reconfiguration approaches, including agent-based control systems and algorithms, and model-based reasoning. - Continued demonstration of Genetic Algorithm(s) for determining optimal distributed system control strategy. - Continued development of Survivability Analysis Algorithms Operable on a Total Ship Modeling Environment.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Continued the transition of the small scale hardware-in-the-loop demonstrator to the academic community for challenge problem formulation. - Continued demonstration of the developed model based reasoning control algorithms on full scale hardware test beds. Advanced Platforms - Advanced Platform Concepts and Designs: - Continued validation of asymmetric hull forms with experimental data. - Continued development of analytical models to further define submarine modular hull concepts. - Continued development of reliability based design and structural analysis code development. - Continued development design tools for integrated antenna and composite topside. - Continued circulation control analysis for three-dimensional flow effects. - Continued aperstructures microwave communication system. - Continued concept for Ultra High Frequency (UHF)/Very High Frequency (VHF) aperstructures opportunistic array (Advanced Hull-form Inshore Demonstrator - AHFID). - Continued development of methods for determining reliability and vulnerability of aluminum ship structures. - Continued large scale demonstration efforts of advanced mitigation technologies. Advanced Platforms - Hydromechanics: - Continued experimental database/computational tools development for extreme submarine maneuvers (e.g., crashback). - Continued the validation of circulation control and advanced control surfaces with experiments. - Continued to investigate improved maneuvering simulation capability for submarines. - Continued validation of Reynolds Average Navier-Stokes (RANS) code for advanced waterjet propulsor performance predictions. - Continued development of two-phase flow waterjet concept, Detached Eddy Simulation (DES) method for crashback prediction and numerical prediction method(s) of waterjet cavitation. - Continued modeling of turbulent flow interaction with propeller Leading Edge (LE) and Trailing Edge (TE) and modeling and simulation of rough-wall boundary layer noise. - Continued development of podded propulsor design/analysis tools. - Continued prediction and validation of damaged stability and capsize. - Continued non-body-of-revolution tool development for advanced submarine configurations. - Continued the multi-platform interaction analysis and tool development. - Continued modeling of performance of composite propellers in extreme maneuvers.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Advanced Naval Power Systems: - Continued effort to integrate front-and back diamond with high current GaN power switches for advanced thermal managment. - Continued SIC GTO thyristor designs and testing apparatus to increase the turn-on di/dt and reliability for pulsed power. - Continued demonstration of dynamic stability of an advanced intelligent, reconfigurable, solid-state-based, zonal-electrical power system that reconfigures within 10 milliseconds. - Continued designing software for the system manager for the Universal Control Architecture (UCA). - Continued development of thermal management technology for shipboard power distribution. - Continued investigation of potential applications of silicon-carbide in future high voltage and high power applications. - Continued improvements in electrical component and device technology allowing a reduction in motor propulsion and motor controllers weight and volume. - Continued development of technologies to support dynamic reconfiguration of shipboard systems under conditions of stressing scenarios and/or system degradation. - Continued studies of alternative cooling systems for future shipboard radar systems. - Continued control surface actuator project focused on the technologies needed to define the design space for control surface actuators supporting submarines. - Continued development of automated HVAC system architectures for future Naval platforms. - Continued ship service fuel cell development. - Continued program to develop and demonstrate 3 - 50 kW class solid oxide fuel cell onboard mobile power generation capabilities having compatibility with future logistics fuels to enable rapid recharge of batteries and direct power for C4ISR equipment. - Continued analytical model and reduced scale component development of power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers focusing on closing technology gaps associated with Alternative Integrated Power System (IPS) Architectures. - Continued studies of advanced heating, ventilation, and air-conditioning architectures, including studies of alternative (nonvapor-compression) refrigeration systems and concepts for waste heat reuse, to enhance ship cooling and provide thermal energy storage. - Continued research into the development of fuel chemistries, materials, and energy conversion technologies for optimal performance in Naval power systems.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Continued energy programs in support of SECNAV Energy Goals including biofuels, ship energy efficiencies and unmanned vehicle power systems. - Continued development of robotic Hull BUG and coating technologies to reduce hull biofouling over current Navy operating conditions which will reduce drag and provide significant power/fuel/cost savings. - Continued development of fuel cell components needed to make robust, compact, lightweight fuel cell systems for use in unmanned vehicles - Continued development of low cost, light weight, flexible solar cells - Completed effort to develop energy storage and conversion devices (e.g., batteries, capacitors, fuel cells) that are critical to many military missions. - Completed effort to develop SIC power device with fast switching and ability to parallel devices for higher current. - Completed development of common universal stator design to accommodate varying rotor topologies to improve affordability of motor design and development. Surface Ship & Submarine HM&E Applied Research: - Continued to increase emphasis of the Science Advisor engagement within the joint S&T community across DOD, which will focus on addressing the operational and strategic needs of the Fleet. - Continued applied research into short-term motion forecasting for recovery in higher sea states. - Continued applied research into determination of slamming loads on high-speed planing hulls for structural weight reduction. - Initiated efforts to implement the results from hybrid composite blisters /appendages and their effect on ship drag resistance and fuel saving performance, motion and stability in ship models to verify computations and adapt shapes of appendages. - Initiated the ONR Applied Research Challenge (ARC) to stimulate new, high-risk applied research projects in areas not currently addressed by the current ONR core applied research programs. Advanced ASW Surveillance: -Initiated development of Long Endurance UUV technologies. Counter Improvised Explosive Devices: - Continued efforts to expand counter-improvised explosive devices (C-IED) enhancement to support urgent operational needs. - Continued research to analyze and understand enemy threat organizations and networks (both cultural networks and IT networks)					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Continued research in directed energy weapons with the goal of reducing size, weight, and power requirements for systems in the detection and neutralization of IEDs. - Continued research in the mitigation of CIED effects (blast, blunt trauma, ballistics) on personnel. - Initiated research in Route Reconnaissance and Clearance methodologies to provide standoff detection, neutralization, and marking of buried and surface laid, on and off route, pressure plate, command wire and radio frequency initiated explosive obstacles using directed energy and mechanical means on autonomous or semi autonomous platforms.					
FY 2015 Plans: Survivable Platforms - Reduced Signatures: - Continue all efforts of FY 2014. - Continue utilization of condition-based maintenance systems for platform underwater signature assessment. - Continue development of a prediction and monitoring of a surface ship propulsion system for underwater acoustic signatures. - Continue development of global optimization of damped structures. Survivable Platforms - Hull Life Assurance: - Continue all efforts of FY 2014, less those noted as completed above. - Continue development of lightweight low-cost protection system for specific platforms for protection against specific large threats for the Explosion Resistant Coatings (ERC). - Continue development of lightweight protection system for vehicles (MTVR) for protection against specific small arms and IEDs for the Explosion Resistant Coatings (ERC) program. - Continue Ship modifications using blisters for application to DDG51 Flight III to gain larger displacement for AMDR and at the same time achieve higher fuel efficiency. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continue all efforts of FY 2014. Advanced Platforms - Advanced Platform Concepts and Designs: - Continue all efforts of FY 2014. Advanced Platforms - Hydromechanics: - Continue all efforts of FY 2014.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Complete waterjet efforts, including two-phase waterjet development and RANS code development and validation efforts. - Initiate cavitation erosion modeling on compliant surface. Advanced Naval Power Systems: - Continue all efforts of FY 2014, less those noted as completed above. Surface Ship & Submarine HM&E Applied Research: - Continue all efforts of FY 2014. Counter Improvised Explosive Devices: - Continue all other efforts of FY 2014. - Complete effort to develop transparent armor using flawless glass. - Complete effort on the studies of antennas for high powered microwaves and radio frequency applications.					
FY 2016 Base Plans: Survivable Platforms - Reduced Signatures: - Continue all efforts of FY 2015. Survivable Platforms - Hull Life Assurance: - Continue all efforts of FY 2015. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continue all efforts of FY 2015. Advanced Platforms - Advanced Platform Concepts and Designs: - Continue all efforts of FY 2015. - Initiate activities in understanding platform modification for greater access in polar environments. Advanced Platforms - Hydromechanics: - Continue all efforts of FY 2015, less those noted as completed above. - Initiate efforts to model platform performance and stability as well as propulsor performance in ice environments.					

Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Advanced Naval Power Systems: - Continue all efforts of FY 2015. - Complete effort to integrate front- and back-side diamond with high current GaN power switches for advanced thermal management. - Complete SiC GTO thyristor designs and testing apparatus to increase the turn-on dI/dt and reliability of SiC GTOs for pulsed power. Surface Ship & Submarine HM&E Applied Research: - Continue all efforts of FY 2015. Counter Improvised Explosive Devices: - Continue all other efforts of FY 2015, less those noted as completed above. - Complete efforts to expand counter-improvised explosive devices (C-IED) enhancement to support urgent operational needs. - Complete research to analyze and understand enemy threat organizations and networks (both cultural networks and IT networks) - Initiate research on sciences required to develop a Modular Explosive Hazard Defeat System to defeat IEDs and other explosive hazards from various platforms found in expeditionary forces. Applied Research Challenge (ARC): - Continue all base program efforts initiated in FY2015 including network information sciences, long-range high-resolution imaging, ocean surface scatter in RF propagation, wake measurement technologies, thermal management systems, high power control modules for ship application, decision support / uncertainty analysis for operational environments, and reactive composite materials. ***FY 2016 OCO Plans:*** N/A					
Title: NAVAL RESEARCH ENTERPRISE ***Description:*** The Naval Research Enterprise (NRE) encompasses the Independent Applied Research (IAR) efforts focused on solving a wide range of Naval Science and Technology (S&T) fleet issues utilizing unique Naval Warfare Center (WC) laboratory capabilities. Efforts under this activity address the full spectrum of the DON S&T Strategic Plan technology using focus areas which engage Naval aviation, sea surface, undersea,	4.269	4.467	4.551	-	4.551

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
space, weapons, communication, information, and human systems. The IAR Program provides participating WCs with in-house funding for applied research to support the execution of their assigned missions by: -Developing and maintaining a cadre of active researchers who can distill and extend results from worldwide research and apply them to solve Naval problems. -Promoting the hiring and development of talented new scientists and engineers (S&E) with the insurance of proper mentoring with senior personnel. -Encouraging collaboration with universities, private industry, and other Navy and Department of Defense laboratories. Funded projects are chosen through rigorous internal competition by each WC's selection committee and typically last two to three years. IAR projects are generally designed to promote investment in high-risk/high-payoff research and also allow young S&Es to manage Navy relevant research projects. A limited number of successful efforts developed under the In-House Laboratory Independent Research (ILIR) basic research Program Element 0601152N are matured and further developed under the IAR program with the goal of transitioning these technologies to the warfighter. The IAR R2 activity was stood up in FY 2013 as the Naval Research Enterprise (NRE) to consolidate all NRE related IAR investments. Projects funded in this R2 Activity are intended to be approximately 2-3 years in length. Based on historical trends approximately 30% of these projects will turn over each year. ***FY 2014 Accomplishments:*** - Completed research for Unmanned Sensor Network Concepts for Counter-Surveillance and Explosive Hazard Detection by investigating autonomy with imperfect perception, sensor and signal processing techniques supporting autonomy and battlefield sensing missions, and Human-Machine Interaction (HMI). - Completed research for Advanced Search and Tracking routines through the utilization and modification of advanced algorithms such as Maximum Likelihood Probabilistic Data Association Tracker (ML-PDA) and Moving-Source Matched Field Processing (MFP). - Completed research for sensors and ultra-low/self-powered sensors for remote applications addressing sub-threshold hydrophones, undersea wireless networks, and communication networks. - Completed research for advanced energetic materials with significantly enhanced explosive yields (over HMX) while improving insensitivity characteristics such as shock and thermal stabilities.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Completed research for reduced drag on surface ship hull designs utilizing advanced computational analysis and hydrodynamic model testing addressing scaling effects due to non-dimensional parameters such as the Froude number. - Initiated FY 2014 ILIR projects. ***FY 2015 Plans:*** - Continue all efforts of FY 2014, less those noted as completed above. - Continue research for the repair and repair process of Navy aircraft and ship alloys such as titanium, high-strength low-alloy steels, composites, and metamaterials. - Continue research for highly accurate autonomous unmanned undersea vehicles (UUV) communication and navigation. - Complete research for the repair and repair process of Navy aircraft and ship alloys such as titanium and high-strength low-alloy steels. - Complete research for warfighter performance predictions utilizing cognitive information and other human factors to enhance training experience and outcome. - Complete research for highly accurate autonomous unmanned undersea vehicles (UUV) communication and navigation. - Complete research on the effects of CMAS (Sand Dust) in Ceramic Matrix Composites (CMCs) to characterize CMAS and CMAS/salt effects in gas-turbine grade engine environments. - Complete research on the development and characterization of exploding ink. - Complete research on advanced submarine air purification. - Complete research on large-eddy simulations of advanced propulsion technology for UAV weapon systems. - Complete research on a metamaterial-based buoyant cable antenna with non-uniform loading. - Complete research of a bioluminescence system for submerged vehicles. - Inititate FY 2015 projects. ***FY 2016 Base Plans:*** - Continue all efforts of 2015, less those noted as completed above. - Complete all two year efforts started in FY 2015 and three year efforts started in FY 2014. Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE: - Complete research on Bio-inspired Broadband Sonar System for High-resolution Acoustic Imaging Applications. - Complete research on Advanced Infrared Suppressor.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
- Complete Determining R-45M Prepolymer Characteristics that Optimize Propellant Cure and Mechanical Properties. - Complete Development of Novel Propellants and Explosives Using Resonant Acoustic Mixing (RAM) Technology. - Complete study of the Electromagnetic Probability-of-effect Assessment Tool (EMPAT) for High-Power HERO/ EMV Test and Evaluation . - Complete Examination of Human Performance Characteristics using Eye-tracking and 3D Motion Capture Gaze Supported Gestures. - Complete research on Extended Object Tracking in Clutter with Exploitation of Doppler Measurements and Multi-Scan Detection Clustering. - Complete Research on Geospatial and Temporal Anomaly Detection using Scalable Cloud-Based Algorithms - Complete Improving Damage Tolerance Thresholds and Energy Absorption Capacities in Laminated Woven Composites using Crimp Imbalance and Crimp Imbalance Gradients - Complete Nondestructive Evaluation (NDE) Enhanced Accelerated Life Testing (ALT). - Complete Synthesis and Characterization of Novel Reactive Materials by Mechanical Alloying. - Complete Smoothed Particle Applied Mechanics research. - Initiate FY 2016 projects. ***FY 2016 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	143.311	139.460	154.963	-	154.963

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

This PE supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. Each PE Activity has unique goals and metrics, some of which include classified quantitative measurements. Overall metric goals are focused on achieving sufficient improvement in component or system capability such that the 6.2 applied research projects meet the need of or produce a demand for inclusion in advanced technology

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that may lead to incorporation into acquisition programs or industry products available to acquisition programs. Efforts funded in this PE also include energy programs in support of SECNAV energy goals and efforts in support of the Ohio Replacement program.

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COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
9999: *Congressional Adds*	-	25.000	24.200	-	-	-	-	-	-	-	-	49.200

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015
Congressional Add: Program Increase ***FY 2014 Accomplishments:*** N/A ***FY 2015 Plans:*** - ONR will pursue research in lithium-ion battery safety as well as opportunities for innovations in power generation and other energy storage technologies. Efforts may include advancing on-going lithium-ion battery projects forward for particular naval applications, to include providing battery test modules.	-	4.200
Congressional Add: Alternative Energy Research ***FY 2014 Accomplishments:*** - Demonstrated successful three-day flight of Ion Tiger with a liquid-hydrogen powered fuel cell constructed at NRL using 3D laser-sintering fabrication of a titanium bipolar plate and gas manifold assembly. - Initiated microgrid analyses at Naval Facilities in Hawaii to increase energy security for critical infrastructure and to determine capabilities needed for effective base-to-utility interconnect under conditions of high-penetration of renewables. - Continued evaluation of General Motors Equinox Fuel Cell Electric Vehicles (FCEVs) for non-tactical vehicle use at Naval Facilities in Hawaii and commissioned a new hydrogen fueling station at Marine Corp Base Hawaii (MCBH). - Continued heat exchanger material corrosion evaluation and process control evaluations for Ocean Thermal Energy Conversion (OTEC) systems. - Provided Naval Facilities with sea-water air condition (SWAC) cost and performance analysis using new modeling tools. - Continued development of sophisticated hydrodynamic tools for design of high performance, high efficiency hull forms for naval ships and craft - Continued evaluation of grid frequency control techniques using grid frequency response and battery state-of-charge algorithms for lithium-titanate battery system, demonstrating 40% reduction in frequency variability on grid with high-penetration of wind power, and initiated similar battery approaches at grid locations with high-penetration of photovoltaics.	25.000	20.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015
- Continued evaluation of external power operations using General Motors Equinox Fuel Cell Electric Vehicles (FCEVs) with off-board power (OBP) capability at Camp Pendleton. - Completed successful evaluation of plasma flow control to improve wind turbine efficiency. ***FY 2015 Plans:*** - Continued microgrid analyses at Naval Facilities in Hawaii to increase energy security for critical infrastructure and to determine capabilities needed for effective base-to-utility interconnect under conditions of high-penetration of renewables. - Continued evaluation of General Motors Equinox Fuel Cell Electric Vehicles (FCEVs) for non-tactical vehicle use at Naval Facilities in Hawaii and commissioned a new hydrogen fueling station at Marine Corp Base Hawaii (MCBH). - Continued heat exchanger material corrosion evaluation and process control evaluations for Ocean Thermal Energy Conversion (OTEC) systems. - Provided Naval Facilities with sea-water air condition (SWAC) cost and performance analysis using new modeling tools. - Continued development of sophisticated hydrodynamic tools for design of high performance, high efficiency hull forms for naval ships and craft - Continued evaluation of grid frequency control techniques using grid frequency response and battery state-of-charge algorithms for lithium-titanate battery system, demonstrating 40% reduction in frequency variability on grid with high-penetration of wind power, and initiated similar battery approaches at grid locations with high-penetration of photovoltaics. - Continued evaluation of external power operations using General Motors Equinox Fuel Cell Electric Vehicles (FCEVs) with off-board power (OBP) capability at Camp Pendleton.		
Congressional Adds Subtotals	25.000	24.200

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Interest Items not included in other Projects.