Exhibit R-2, PB 2010 Navy RDT&E Budget Item Justification									DATE: May 2009	
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 2 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602123N FORCE PROTECTION APPLIED RESEARCH					
COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	183.654	186.750	91.400						Continuing	Continuing
0000: FORCE PROTECTION APPLIED RESEARCH	183.654	186.750	91.400						Continuing	Continuing

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 (Jan 2007). 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. This PE supports the Future Naval Capabilities (FNC) Program in the areas of Sea Shield, Sea Strike, Cross Pillar Enablers and Enterprise and Platform Enablers (EPE).

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

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B. Program Change Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011
Previous President's Budget	194.477	131.310	103.940	
Current BES/President's Budget	183.654	186.750	91.400	
Total Adjustments	-10.823	55.440	-12.540	
Congressional Program Reductions		-0.540		
Congressional Rescissions				
Total Congressional Increases		56.100		
Total Reprogrammings	-9.009			
SBIR/STTR Transfer	-1.814			
Program Adjustments			-11.568	
Rate/Misc Adjustments		-0.120	-0.972	

Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **ADVANCED SIMULATION TOOLS FOR AIRCRAFT STRUCTURES MADE OF COMPOSITE MATERIALS**	1.942	1.197
Project: 9999, **ALTERNATIVE ENERGY RESEARCH**	15.497	19.945
Project: 9999, **DEPUTEE-HIGH POWERED MICROWAVE NON-LETHAL VEHICLE/VESSEL ENGINE DISABLING**	0.000	1.596
Project: 9999, **FORCE PROTECTION APPLIED RESEARCH**	1.946	0.000
Project: 9999, **HARBOR SHIELD-HOMELAND DEFENSE PORT SECURITY INITIATIVE**	0.000	3.490
Project: 9999, **HIGH POWER DENSITY PROPULSION AND POWER FOR USSVS**	0.000	1.596
Project: 9999, **HIGH SPEED ACRC & COMPOSITES SEA LION CRAFT DEVELOPMENT**	0.000	1.995
Project: 9999, **HIGH STRENGTH WELDED STRUCTURES**	0.000	0.798
Project: 9999, **HIGH TEMPERATURE SUPER CONDUCTING MAGNETIC ENERGY STORAGE**	0.397	0.000
Project: 9999, **HIGH TOUGHNESS ALUMINUM STRUCTURES**	1.160	0.000
Project: 9999, **INTEGRATION OF ELECTRO-KINETIC WEAPONS INTO NEXT GENERATION OF NAVY SHIPS**	0.000	4.487
Project: 9999, **LITHIUM BATTERIES**	0.000	1.596
Project: 9999, **LITHIUM-ION CELL DEVELOPMENT WITH ELECTRO NANO MATERIALS**	2.901	3.988

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Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **LITHIUM-SULFUR CHEMISTRY VALIDATION FOR SONOBUOY APPLICATION**	0.000	1.596
Project: 9999, **MAGNETIC REFRIGERATION TECHNOLOGY**	3.088	2.394
Project: 9999, **MK V.1 MAKO FOR IMPROVED SIGNATURE AND WEIGHT PERFORMANCE**	0.967	1.995
Project: 9999, **NAVAL AVIATION TECHNOLOGY EXPLORATION INITIATIVE**	0.776	0.000
Project: 9999, **NAVAL SPECIAL WARFARE 11M RIB REPLACEMENT CRAFT DESIGN**	0.000	0.798
Project: 9999, **OPTICAL RECOGNITION PROTOCOL FOR BIOLOGICS DETECTION**	0.773	0.000
Project: 9999, **PLANAR SOLID OXIDE FUEL CELL SYSTEM DEMONSTRATION AT UTC SIMCENTER**	3.379	3.490
Project: 9999, **PMRF FORCE PROTECTION LAB**	1.946	1.995
Project: 9999, **SHIPBOARD PRODUCTION OF SYNTHETIC AVIATION FUEL**	1.547	0.997
Project: 9999, **SOLID OXIDE FUEL CELL**	0.000	0.798
Project: 9999, **STABLIZED LASER DESIGNATION CAPABILITY**	0.969	0.000
Project: 9999, **STANDOFF EXPLOSIVE DETECTION SYSTEM (SEDS)**	0.000	1.197
Project: 9999, **UNDERSEA PERIMETER SECURITY INTEGRATED DEFENSE ENVIRONMENT**	2.706	0.000

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

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COST ($ in Millions)	**FY 2008 Actual**	**FY 2009 Estimate**	**FY 2010 Estimate**	**FY 2011 Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
0000: FORCE PROTECTION APPLIED RESEARCH	183.654	186.750	91.400						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. This effort supports the FNC in the areas of Sea Shield, Cross Pillar Enablers, and Enterprise and Platform Enablers (EPE).

This project reflects the alignment of Future Naval Capability (FNC)program investments for the following Enabling Capabilities (ECs): Fortified Position Security, Over-the-Horizon Missile Defense, Anti-Ship Missile Defense Technologies, Two-Torpedo Salvo Defense, Defense of Harbor and Near-Shore Naval Infrastructure Against Asymmetric Threats, Sea Based Missile Defense of Ships & Littoral Installations, Aircraft Integrated Self-Protection Suites, Advanced Threat Aircraft Countermeasures, Helicopter Low-Level Operation, Four Torpedo Salvo Defense, Shipboard Force Protection in Port and Restricted Waters - Detection and Classification, Underwater Total Ship Survivability, Compact Power Conversion Technologies, Affordable Submarine Propulsion and Control Actuation, and Advanced Electronic Sensor Systems for Missile Defense.

FY 2008 reflects the initiation of the Large Vessel Stopping Program in response to the Chief of Naval Operations' Navy Strategic Plan which specified that the Navy must combat Weapons of Mass Destruction (WMD) at sea and ashore. FY 2009 reflects the transfer of power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers from PE 0602236N/Cost Reduction Technologies.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
ADVANCED ENERGETICS	15.747	4.156	2.081	
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,				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
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. Decreased funding in FY 2009 is due to the conclusion and transition of Advanced Energetics efforts in the areas of enhanced performance formulations, insensitive explosives, detonation merging techniques, and reactive materials. Remaining funding will be used to complete transition efforts and to develop next generation concepts as described below. *FY 2008 Accomplishments:* - 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 and evaluation of advanced explosive/ propellant/reactive ingredients and formulations for next generation higher performing systems. - 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.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
FY 2009 Plans: - Continue 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 Electro-magnetic Rail Gun, PE 0603114N. - Continue 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. - Continue development and evaluation of energetic ingredients and formulations for next generation higher performance applications. Conclude scale-up development and testing. Transition to Integrated High Payoff Rocket Propellant Program, PE 0602114N. - Complete proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. Transition to Future Naval Capabilities Program. - Complete development of and transition directed hydro-reactive material warhead concepts to Undersea Warheads Program, PE 0602747N. - Complete research in advanced multiphase blast concepts employing dense metalized explosives to enhance performance of air and underwater blast warheads. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as completed above.					
AIRCRAFT TECHNOLOGY The Aircraft Technology activity develops technologies for survivability and reduced observability, metrics are classified. It also develops new Naval air vehicle concepts and high impact, scaleable naval air vehicle technologies, such as - autonomous air vehicle command and control, helicopter and tiltrotor rotor and drive systems, aerodynamics, structures and flight controls for future and legacy air vehicles, which significantly increase the naval warfighter's capabilities, effectiveness, readiness, and safety, while reducing life cycle cost. This activity directly supports the Naval Aviation Enterprise Science and		16.241	15.639	12.749	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Technology Objectives and the Naval Science and Technology Strategic Plan, principally in the Platform Mobility Focus Area. The FY 2009 to FY 2010 decrease is due to the reduced level of investment. *FY 2008 Accomplishments:* - Continued development of survivability/reduced observables technology. Metrics are classified. - Continued development of flight control, intelligent autonomy, command & control, and multi-vehicle cooperation technologies for UAV. - Continued development of a Computational Fluid Dynamics (CFD) based integration system to maximize operational capability of autonomous aircraft by choosing optimal flight pattern for any environmental condition including low speed operations and brownout. - Continued vertical lift technology investments. - Completed demonstration of system integration of a shaped memory alloy into a Reconfigurable Rotor Blade system for improved range and lifting capacity in a tilt rotor aircraft. - Completed development effort to control flow and thermal dynamics in particle coating process and densification dynamics of large windows. *FY 2009 Plans:* - Continue all efforts of FY 2008, less those noted as completed above. - Initiate research in fixed wing aircraft/vertical lift/rotorcraft technology areas such as aeromechanics, propulsion, active rotor control for enhanced ship board operations, structural concepts compatible with shipboard operations, autonomous operations in the shipboard and austere environment, and innovative vehicle concepts for naval application. *FY 2010 Plans:* - Continue all efforts of FY 2009. - Initiate research in vertical lift aircraft /rotorcraft technology areas such as aeromechanics, propulsion, active rotor control for enhanced ship board operations, structural concepts compatible with shipboard				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
operations, autonomous operations in the shipboard and austere environment, and innovative vehicle concepts for naval application.					
FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS Fleet Force Protection and Defense against Undersea Threats efforts include applied research for complementary sensor and processing technologies for platform protection and shipboard technologies to increase the survivability of surface ship and submarine platforms against torpedo threats and to develop the capability to interdict underwater asymmetric threats to ships and infrastructure in harbors. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against air, surface, and asymmetric threats. (Asymmetric threat efforts are co-funded by PE 0602131M.) 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 (EO, IR, RF, 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. Another goal of this activity is to develop a torpedo defense capability to fill Sea Shield Warfighting Capability Gap/Enabling Capability: Platform Defense against Undersea Threats, including Four Torpedo Salvo Defense. This provides a capability to prevent any of the torpedoes, in up to four-torpedo salvos fired at high value units, from hitting those units. This activity supports the Fleet and Force Protection FNC and includes support to Sea Shield and Sea Strike Pillars and FNC Enabling Capabilities for: Aircraft Integrated Self-protection Suite; Fortified Position Security; Advanced Electronic Sensor Systems for Missile Defense; and Shipboard Force Protection in Port and Restricted Waters - Detection and Classification. Budget Activity 2 sensor efforts are co-funded by PEs 0602235N and 0602271N. *FY 2008 Accomplishments:* Sensors & Associated Processing		13.514	13.297	12.095	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms. - Continued design and fabrication of microfluidic nucleic acid extraction and enrichment methods and obtained funding for technology transfer. - 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 the development of low-cost, lightweight radar absorbing material (RAM) based on metallized cellulose in the form of fibers, fabric and paper. - Continued design and testing of on-chip nucleic acid amplification and transfer technology. - Continued studies to develop catalytic activity profile of bioactive coatings against chemical agents. Designed and initiated fabrication of coatings to degrade both, chemical and biological agents. - Continued advanced concept development to integrate object recognition and tracking algorithms, machine vision, multiple networked video streams into different classes of EO/IR sensors within the Intelligent Video Surveillance FNC product (transferred from PE 0602131M). - Continued design and fabrication of self-reporting coatings for system failure detection. - Completed the End User Terminal (EUT) effort by developing a prototype 2-way amplifier for the Secure Net (SECNET) 11 card that will increase by a factor of 9 the secure transmit/receive range between Dismounted-Data Automated Communications Terminals (D-DACT) in an urban environment. - Completed the Integrated EO/IR Self Protect Suite for Rotary Wing Aircraft by conducting a laboratory demonstration of the integrated Missile Warning Sensor (MWS) and multi-band fiber coupled laser jammer. - Completed development of solid projectile coilgun design, consumable casing material and improved railgun efficiency and developed method of reducing muzzle flash and surface wear of the rails. - Completed the design and development of integrated laser ground based, aircraft protection design to protect large aircraft from Infrared SAMs upon ingress and egress to an airport. - Completed the Intelligent Video Surveillance project including integration of object recognition and tracking algorithms, machine vision, and multiple networked video streams into different classes of EO/IR sensors.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed development of compact sensor systems in support of responsive Intelligence, Surveillance, and Reconnaissance (ISR). - Completed efforts on Antibodies for biowarfare agents to be synthetically modified with enzymes and studied via surface plasmon resonance to gain a better understanding of the impact tagging these recognition sites have on molecular recognition (kinetics and selectivity) for sensor applications. - Completed design and development of large (1.5m dia.) telescopes with associated adaptive optics for the Naval Prototype Optical Interferometer (NPOI). - Completed development of a portable detection system for defense against small arms fire and rocket propelled grenades (RPG) using Field Programmable Gate Arrays (FPGAs), infrared focal plane arrays (IRFPA), and filtering algorithms. - Completed integration of DNA and antibody array analysis and demonstrated capability for rapid screening and pathogen species confirmation. - Transferred biomimetic signal processing efforts, including panoramic periscope and temporal pattern recognition for security breaching noise detection to PE 0602236N. - Transferred efforts in bioinspired quiet, and maneuverable self-propelled line array using high-lift propulsors based on insect biomechanics to PE 0602236N. - Transferred efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms to PE 0602236N. - Initiated new FNC EC Shipboard Force Protection in Port and Restricted Waters - Detection and Classification. This project will develop mission specific electro-optic/infrared sensors to detect, classify, and determine the intent of potential terrorist and special operations force threats to ships and craft inport and transiting restricted waters. Underwater Platform Self-Defense - Completed the scalable low frequency continuous wave acoustic weapon for use against underwater asymmetric threats. - Initiated development of low-cost, light weight swimmer detection and localization technologies. - Initiated development of optimized microfluidic components suitable for explosive, chemical, and biological sensing applications, and initiate the development of models required to apply existing automated design tools to components with more complex physics and more general geometries.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
FY 2009 Plans: Sensors & Associated Processing - Continue all efforts of FY 2008, less those noted as completed above. - Complete the development of low-cost, lightweight RAM based on metallized cellulose in the form of fibers, fabric and paper. - Initiate the Countermeasures for Advanced Imaging Infrared (IIR) Guided Missiles FNC effort by initiating IIR threat model development. - Initiate the Countermeasures for Millimeter Wave Guided Missiles FNC effort by initiating requirements analysis. - Initiate the Multifunction Capabilities for Missile Warning Sensors FNC effort by commencing data collection and analysis. - Initiate efforts to design microfabricated system for 3-color fluorescence measurements using integrated waveguides. - Initiate effort to develop new, highly selective, preferential oxidation catalysts for the generation of power from the reformate gas purification process. - Initiate effort to develop aspheric gradient index optics. - Initiate the Helicopter Laser-Based Landing Aids FNC effort by commencing experimentation, data collection and analysis. Underwater Platform Self-Defense - Continue all efforts of FY 2008, less those noted as completed above. - Continue development of low-cost, light weight swimmer detection and localization technologies. - Initiate development of software encoded algorithms for the Anti-Torpedo Torpedo (ATT) sensor and controller that will enable ATT's to successfully engage torpedo salvoes of up to four attacking units. *FY 2010 Plans:* Sensors & Associated Processing - Continue all efforts of FY 2009, less those noted as completed above. Underwater Platform Self-Defense				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue all efforts of FY 2009.					
MISSILE DEFENSE (MD) This activity describes Missile Defense S&T projects of the Sea Shield FNC program, and non-FNC-related Navy research. - Advanced Area Defense Interceptor (AADI) S&T planning effort for Navy - Marine Corps Air Directed Surface to Air Missile (ADSAM) live firing demonstration at White Sands Missile Range. To be completed in FY 2009 with funding in PE 0603123N, the metric for AADI is execution of an ADSAM demonstration by the Navy and Marine Corps that establishes the basis for further development of an operational Naval Integrated Fire Control/Counter-Air (NIFC-CA) capability. - Naval Interceptor Improvements (NII) technology upgrades for STANDARD Missile (SM) future fleet air defense missile. Metrics will be to achieve SM performance requirements in specified tactical rain environments and achieve SM performance requirements in all specified electronic countermeasures environments. - Extended Distributed Weapons Coordination (EDWC) algorithms to extend DWC ABMA functionality to include coordination of passive defense measures (emission control, use of decoys, maneuvering). Metric will be improved probability of negation (Pneg) against advanced ballistic & cruise missile anti-ship threats that may be susceptible to decoys and jamming. - Positive Control of Naval Weapons (PCNW) - additional technology upgrades for SM to enable forward relay, remote launch & potentially forward pass engagements. Metrics are classified. - Midcourse and Terminal Algorithms (MTA) for interceptor and associated weapon system enhancements to defeat anti-ship ballistic missile (ASBM) threats with high confidence while retaining or improving baseline capability against advanced anti-ship cruise missiles (ASCM). Specific metrics are classified. - Enhanced Lethality Guidance Algorithms (ELGA) to increase probability of kill versus an expanded threat set including ASBMs and advanced ASCMs. Metrics for this project will be classified. - Enhanced Maneuverability Missile Airframe (EMMA) technology for Navy shipboard missile systems to intercept highly agile maneuvering ASCMs and ASBMs. Metrics for this project will be classified. - Emerging technologies that support delivery of Navy approved FNC enabling capabilities (EC) structured to address operational capability gaps in air and missile defense.		14.280	13.100	11.103	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Non-FNC-related investigation of effects of charged particle layers on UHF to S-Band radars used to track space vehicles and initiate development of advanced electromagnetic decoy launchers and payloads. The FY 2008 - FY 2009 decrease represents the phased movement of EDWC, PCNW, and NII projects from Applied Research (6.2) to Advanced (6.3) Research as the technologies mature and prepare for acquisition. *FY 2008 Accomplishments:* - Continued program to investigate effects of charged particle layers on UHF to S-Band radars used to track space vehicles. - Completed additional AADI S&T planning and coordination for the FY 2009 Navy ADSAM live-fire demonstration taking place under PE 0603123N. - Continued NII project. - Initiated EDWC and PCNW efforts. *FY 2009 Plans:* - Continue all efforts, less those noted as completed above. - Initiate MTA project efforts. - Initiate development of advanced electromagnetic decoy launchers and payloads. (NRL) *FY 2010 Plans:* - Continue all efforts of FY 2009. - Complete EDWC, NII and PCNW development efforts that will be tested/demonstrated. - Initiate ELGA and EMMA project efforts.					
STOPPAGE OF LARGE SURFACE VESSELS AT SEA The Chief of Naval Operations (CNO) in the Navy Strategic Plan (NSP) has specified that the Navy must combat Weapons of Mass Destruction (WMD) at sea and ashore. To support this requirement, the Navy must be able to temporarily stop ships that are suspected of carrying WMDs or their component materials. This activity addresses the development of key technologies that will enable the Navy to use non-lethal		5.780	7.560	9.521	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
methods for temporarily stopping and delaying non-cooperative large, greater than 20 meters or 300 gross tons, vessels at sea that will not comply with voice commands or warning devices. The technologies will be deployable by ship or aircraft and should be capable of disabling the vessel at safe distances from high-valued assets and infrastructures. Funding increase from FY 2008 to FY 2009 is due to the natural growth of the program as technology development efforts increase. Funding increase from FY 2009 - FY 2010 is due to large-scale demonstrations of various systems. *FY 2008 Accomplishments:* - Initiated evaluation of potential propeller entanglement device materials. - Initiated propulsion drive-train damage predictions. - Initiated assessment of delivery options for a large linear propeller entanglement device. - Initiated a component level proof of concept demonstration for externally inhibiting seawater cooling flow to ship propulsion equipment. - Initiated the identification and assessment of potential commercial maritime vessel electronic vulnerabilities within representative propulsion and maneuvering control systems. - Initiated a scaled component level proof of concept demonstration for a large vessel momentum reduction concept and determine the feasibility of seaborne or airborne delivery of a prototype system. *FY 2009 Plans:* - Continue all efforts of FY 2008. - Complete evaluation of potential propeller entanglement device materials. - Complete propulsion drive-train damage predictions. - Complete assessment of delivery options for a large linear propeller entanglement device. - Complete component level proof-of-concept demonstration for externally inhibiting seawater cooling flow to ship propulsion equipment. - Complete the identification and assessment of potential commercial maritime vessel electronic vulnerabilities within representative propulsion and maneuvering control systems.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Complete scaled component level proof-of-concept testing for large vessel momentum reduction concept. - Initiate prototype development and fabrication for a full-scale propeller entanglement device. - Initiate design and fabrication of device and emplacement system to externally inhibit seawater cooling flow to ship propulsion equipment. - Initiate the evaluation of technologies capable of remotely exploiting the electronic vulnerabilities identified within critical propulsion and steering systems. - Initiate the design and evaluation of a full-scale large vessel momentum reduction device and delivery system. - Initiate tactical system engineering and define the operational parameters for a large vessel momentum reduction device. - Initiate analysis and modeling of hydrodynamic forces generated between a large vessel and much smaller intercept craft or Unmanned Surface Vehicle (USV). *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as completed above. - Complete prototype development and fabrication for a full-scale propeller entanglement device. - Complete design and fabrication of device and emplacement system to externally inhibit seawater cooling flow to ship propulsion equipment. - Complete the evaluation of technologies capable of remotely exploiting the electronic vulnerabilities identified within critical propulsion and steering systems. - Complete the design and evaluation of a full-scale large vessel momentum reduction device and delivery system. - Complete tactical system engineering and define the operational parameters for a large vessel momentum reduction device. - Initiate full-scale demonstration of propeller entanglement prototype. - Initiate development of a USV delivery capability for a device emplacement package to externally inhibit seawater cooling flow to ship propulsion equipment. - Initiate development of an autonomous delivery and deployment capability for a device emplacement package to externally inhibit seawater cooling flow to ship propulsion equipment.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate test and evaluation of delivery systems for technologies capable of remotely exploiting the electronic vulnerabilities identified within critical propulsion and steering systems. - Initiate design and fabrication of a full-scale system capable of remotely exploiting the electronic vulnerabilities identified within critical propulsion and steering systems. - Initiate fabrication of a full-scale demonstration system for a large vessel momentum reduction device.					
SURFACE SHIP & SUBMARINE HULL MECHANIC & ELECTRICAL (HM&E) Efforts include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability (includes damage control), and advanced electrical power systems. Signature reduction addresses electromagnetic, infrared, and acoustic signature tailoring, both topside and underwater. 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 interface and maneuvering. Distributed intelligence for automated survivability addresses both the basic technology of automating damage control systems, as well as, distributed control of systems utilizing self-healing capability. Advanced electrical 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: Compact Power Conversion Technologies that reduce the cost of high power conversion equipment required to enable more-electric and all-electric ships. This activity also supports Global War on Terror (GWOT) Counter IED – Extramural activity which supports applied research for force protection of Naval platforms. Technologies are being developed that focus on prediction, prevention, detection, neutralization, and mitigation of improvised explosive devices in the maritime/littoral environment. The funding decrease from FY 2009 to FY 2010 is due to the current completion of the following Energy and Power efforts: Distribution/Control and Alternative Energy efforts, Energy Storage and Power Generation efforts and the Medium Voltage Direct Current (MVDC) architecture efforts in support of the Next Generation Integrated Power System (NGIPS) Roadmap efforts. The decrease also represents the phased movement of Future Naval Capability Enabling Capabilities Compact Power Conversion		78.098	77.050	43.851	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Technologies from Applied (6.2) to Advanced (6.3) Research as the technologies mature and prepare for transition to acquisition. *FY 2008 Accomplishments:* 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 bistatic 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. - Completed hull machinery noise measurements. - Completed development of test vessel and technology to evaluate performance and signature associated with electrically driven waterjets (AWJ-21) and Rim-drive motor (RIMJET).				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed modeling of electric warship components and system electromagnetic signatures with electric motor source control through motor configuration, off ship EM field control through compensation and investigation of other sources of EM fields. - Initiated development of modeling methods and noise control concepts for modular/reconfigurable submarine architectures. - Initiated investigation into hull treatment concepts for acoustic signature/vibration control for surface ships. - Initiated development of advanced RF metamaterials for platform signature control. - Initiated development of LPI technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems. Survivable Platforms - Hull Life Assurance - 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 Joint US/Japan Advanced Hull Materials & Structures Technology (AHM&ST) addressing hybrid hull concept and hybrid (steel/composite) joints in ship construction. - 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 (GWOT). - Initiated Payload Implosion and Platform Damage Avoidance efforts. - Initiated 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.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued research into advanced HM&E system reconfiguration approaches, including agent-based control systems and algorithms, and model-based reasoning. 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). - Initiated development of methods for determining reliability and vulnerability of aluminum ship structures. 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. - Completed prediction and validation of constrained capsize motions using advanced codes. - Completed prediction and validation of unconstrained capsize using advanced codes. - Initiated prediction and validation of damaged stability and capsize. - Initiated non-body-of-revolution tool development for advanced submarine configurations.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated the multi-platform interaction analysis and tool development. Advanced Naval Power Systems - 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 multi-year program to directly convert thermal energy to electricity. Such a capability would allow elimination of the steam cycle on an electric warship. - Continued studies of alternative cooling systems for future shipboard radar systems. - Continued development of structural macroscopic 3-dimensional battery. - Continued development of pulsed power technologies to include pulsed alternators and capacitors. - Continued electromechanical actuator noise source characterization activities. - Continued torque measurements on reduced scale models in support of electromechanical actuators. - 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 development of common universal stator design to accommodate varying rotor topologies to improve affordability of motor design and development. - Continued ship service fuel cell development. - Completed studies of the thermal performance and reliability of two-phase pumped cooling loops. - Completed research into high power controller and generator applications by using mixed winding, high-phase-order induction machines actuated with multi-phase and multi-level inverters and rectifiers. - Initiated development of shipboard waste heat driven chiller systems.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated 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. Surface Ship & Submarine HM&E Applied Research - Continued technology development for alternate approaches to high voltage fast turn off switches. - Continued development of heterojunction power switching devices. - Completed Biofilms on Scaffolds and Characterize Spatial Distribution and Chemistries. - Completed High Surface Area Conducting Electrodes for use as Biofilm Scaffolds. - Completed technology development for wafer bonded high voltage power switches. - Completed efforts to synthesize new metal sulfides as catalysts for fuel cells and evaluate their electrochemical performance. - Completed technology development for alternate approaches to high voltage fast turn off switches. - Initiated the computational design, synthesis and evaluation of new, high capacity, high-rate anode materials for Li-ion batteries. *FY 2009 Plans:* Survivable Platforms - Reduced Signatures - Continue all efforts of FY 2008, less those noted as completed above. - Complete testing on AESD to assess energy propagation and acoustic radiation mechanisms and to develop hull treatment concepts for surface ships. - Complete experimental effort to characterize electric drive motor signature mechanisms and verify modeling and simulation approaches for signature prediction. - Complete CRM Field Prediction Model with final validation by measurement of full scale ship to verify CRM Field Prediction against actual Impressed Current Cathodic Protection (ICCP) system layout for measured ship and magnetic/electric fields measured at Navy Magnetic Silencing Range Facility. - Initiate development of signature modeling approaches for electric actuation and alternate electric drive system architectures. - Initiate development of Low probability Intercept (LPI) technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Survivable Platforms - Hull Life Assurance - Continue all efforts of FY 2008. Survivable Platforms - Distributed Intelligence for Automated Survivability - Continue all efforts of FY 2008. - Initiate Second Generation distributed systems model development. - Initiate demonstration of real-time modeling of multiple distributed systems – utilizing small scale demonstrator. - Initiate demonstration of Genetic Algorithm(s) for determining optimal distributed system control strategy. - Initiate development of a hardware in-the-loop small scale demonstrator for fluid/thermal/electrical distributed systems. - Initiate development of Survivability Analysis Algorithms Operable on a Total Ship Modeling Environment. Advanced Platforms - Advanced Platform Concepts and Designs - Continue all efforts of FY 2008. Advanced Platforms - Hydromechanics - Continue all efforts of FY 2008, less those noted as completed above. - Complete development of two-phase flow waterjet concept. - Complete prediction and validation of unconstrained capsize using advanced codes. Advanced Naval Power Systems - Continue all efforts of FY 2008, less those noted as completed above. - Continue 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. (Transitioned from PE 0602236N/Cost Reduction Technologies)				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Complete demonstrations of improvements in electrical component and device enabling technology allowing a reduction in motor propulsion and motor controllers weight and volume. - Complete demonstration of Ship and Submarine Electric Actuator basic technology. - Complete studies of alternative cooling systems for future shipboard radar systems. - Complete multi-year program to directly convert thermal energy to electricity. - Complete development of structural macroscopic 3-dimensional battery. - Complete development of pulsed power technologies to include pulsed alternators and capacitors. - Complete energy storage, thermal management, electromechanical machines program under the Energy-Power Technology Initiative. - Initiate preliminary designs of control surface actuator systems. - Initiate studies of advanced heating, ventilation, and air-conditioning architectures, including studies of alternative (non-vapor-compression) refrigeration systems and concepts for waste heat reuse, to enhance ship cooling and provide thermal energy storage. - Initiate research into the development of fuel chemistries, materials, and energy conversion technologies for optimal performance in Naval power systems. Surface Ship & Submarine HM&E Applied Research - Continue all efforts of FY 2008, less those noted as completed above. *FY 2010 Plans:* Survivable Platforms - Reduced Signatures - Continue all efforts of FY 2009, less those noted as completed above. - Complete mmWave Signatures assessments to identify key signature characteristics. - Complete IR validation experiments and critical sensitivity analysis. - Complete testing on AESD to develop hull treatment coverage prediction capability for surface ships. - Initiate development of advanced special materials for hemispherical signature control. - Initiate scientific study of advanced passive EM signature control technologies. - Initiate development of next generation of evolving threat sensor systems. Survivable Platforms - Hull Life Assurance				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continue all efforts of FY 2009. Survivable Platforms - Distributed Intelligence for Automated Survivability - Continue all efforts of FY 2009. - Complete development of a hardware in-the-loop small scale demonstrator for fluid/thermal/electrical distributed systems. Advanced Platforms - Advanced Platform Concepts and Designs - Continue all efforts of FY 2009. Advanced Platforms - Hydromechanics - Continue all efforts of FY 2009, less those noted as completed above. - Initiate full-scale circulation control bow planes design and construction for at-sea test. - Initiate prediction and validation of damaged stability and capsize for advanced hulls and codes. Advanced Naval Power Systems - Continue all efforts of FY 2009, less those noted as completed above. - Complete preliminary designs of control surface actuator systems. - Complete common universal stator design to accommodate varying rotor topologies to improve affordability of motor design and development. - Initiate detailed design and breadboard demonstration of control surface actuator systems. Surface Ship & Submarine HM&E Applied Research - Continue all efforts of FY 2009. - Complete development of heterojunction power switching devices. - Complete the computational design, synthesis and evaluation of new, high capacity, high-rate anode materials for Li-ion batteries.				

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C. Other Program Funding Summary ($ in Millions)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	Cost To Complete	Total Cost
PE 0204152N/E-2 Squadrons									Continuing	Continuing
PE 0205601N/HARM Improvement									Continuing	Continuing
PE 0601153N/Defense Research Sciences									Continuing	Continuing
PE 0602000D8Z/Joint Munitions Technology									Continuing	Continuing
PE 0602114N/Power Projection Applied Research									Continuing	Continuing
PE 0602131M/Marine Corps Landing Force Technology									Continuing	Continuing
PE 0602204F/Aerospace Sensors									Continuing	Continuing
PE 0602235N/Common Picture Applied Research									Continuing	Continuing
PE 0602270A/Electronic Warfare Technology									Continuing	Continuing
PE 0602271N/ Electromagnetic Systems Applied Research									Continuing	Continuing
PE 0602747N/Undersea Warfare Applied Research									Continuing	Continuing
PE 0603114N/Power Projection Advanced Technology									Continuing	Continuing

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PE 0603123N/Force Protection Advanced Technology		Continuing	Continuing
PE 0603235N/Common Picture Advanced Technology		Continuing	Continuing
PE 0603271N/ Electromagnetic Systems Advanced Technology		Continuing	Continuing
PE 0603502N/Surface and Shallow Water Mine Countermeasures		Continuing	Continuing
PE 0603513N/Shipboard System Component Development		Continuing	Continuing
PE 0603553N/Surface ASW		Continuing	Continuing
PE 0603561N/Advanced Submarine System Development		Continuing	Continuing
PE 0603609N/ Conventional Munitions		Continuing	Continuing
PE 0603640M/USMC Advanced Technology Demonstration (ATD)		Continuing	Continuing
PE 0604307N/Surface Combatant Combat System Engineering		Continuing	Continuing
PE 0604518N/Combat Information Center Conversion		Continuing	Continuing
		Continuing	Continuing

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PE 0604558N/New Design SSN		
PE 0604561N/SSN-21 Developments	Continuing	Continuing

D. Acquisition Strategy

Not applicable.

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 that may lead to incorporation into acquisition programs or industry products available to acquisition programs.

Specific examples of metrics under this PE include:
- Provide improvements in electrical component and device technology as to allow a 50% reduction in motor propulsion and motor controllers weight and volume by FY 2009.
- Increase the hydrodynamic efficiency of current hull designs by 5% by FY 2010.
- Reduce electromagnetic vulnerability of ship hulls by 50% by FY 2011.
- Torpedo defense thresholds will be validated by modeling and simulation to satisfy the overall system performance specification of a Probability of Survival (PS) of the US Navy platform as specified in the draft Capabilities Development Document (CDD) for Surface Ship Torpedo Defense.
- Additional metrics are included within the Missile Defense Activity description.

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