Exhibit R-2, PB 2010 Navy RDT&E Budget Item Justification								DATE: May 2009		
APPROPRIATION/BUDGET ACTIVITY 1319 - Research, Development, Test & Evaluation, Navy/BA 02 - Applied Research					R-1 ITEM NOMENCLATURE PE 0602747N UNDERSEA WARFARE 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	71.841	65.187	55.694						Continuing	Continuing
0000: UNDERSEA WARFARE APPLIED RESEARCH	71.841	65.187	55.694						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 funds applied research efforts in undersea target detection, classification, localization, tracking, and neutralization is funded through this PE. Technologies being developed within this PE are aimed at enabling Sea Shield, one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new Anti-Submarine Warfare (ASW) operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship, and air ASW assets. Research focused on understanding the impacts on marine mammals of manmade underwater sound is also conducted in the Program Element.

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	71.764	58.658	60.792	
Current BES/President's Budget	71.841	65.187	55.694	
Total Adjustments	0.077	6.529	-5.098	
Congressional Program Reductions		-0.217		
Congressional Rescissions				
Total Congressional Increases		6.800		
Total Reprogrammings	0.526			
SBIR/STTR Transfer	-0.412			
FTT Assessment	-0.037			
Program Adjustments			-5.105	
Rate/Misc Adjustments		-0.054	0.007	

Congressional Increase Details ($ in Millions)	FY 2008	FY 2009
Project: 9999, **ADVANCED HIGH ENERGY DENSITY SURVEILLANCE POWER MODULE**	0.775	2.394
Project: 9999, **AUTONOMOUS UNMANNED UNDERSEA VEHICLE (UUV) DELIVERY & COMMUNICATION (AUDAC) IMPLEMENTATION**	1.946	2.792
Project: 9999, **GALFENOL ENERGY HARVESTING**	1.543	1.596

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: UNDERSEA WARFARE APPLIED RESEARCH	71.841	65.187	55.694						Continuing	Continuing

A. Mission Description and Budget Item Justification

This PE funds applied research efforts in undersea target detection, classification, localization, tracking, and neutralization is funded through this project. Technologies being developed within this project are aimed at enabling Sea Shield which is one of the core operational concepts detailed in the Naval Transformational Roadmap. Associated efforts focus on new ASW operational concepts that promise to improve wide-area surveillance, detection, localization, tracking, and attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments. Related efforts are aimed at leveraging technologies that will protect the country's current capital investment in surveillance, submarine, surface ship, and air ASW assets.

B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
ANTI-SUBMARINE WARFARE (ASW) DISTRIBUTED SEARCH	0.000	0.000	14.124	
ASW Distributed Search focuses the development of technologies for the non-covert tactical search for undersea targets ranging from hours to weeks using automated sensor systems deployed around operating areas including along key transit routes to protect naval/maritime forces, around temporarily fixed sea base regions and naval force operating areas, or around fixed defensive regions and areas of interest such as key US/Allied ports. "Non-covert" implies availability of airborne assets for sensor deployment (although other means may also be used), and the ability to employ active sonar along with passive and non-acoustic methods. "Search" is conducted in concentrated areas, typically exploiting cues received from surveillance systems. The submarine target must be detected beyond its weapons release range. The objective is to develop rapidly deployable systems employing automated detection and classification capabilities for use in both shallow and deep water operating environments. Distributed Search supports the ASW protected passage Maritime Shield operational constructs. Related efforts include the development of distributed systems employing optimization as well as active acoustic sensing and processing techniques, navy-unique transduction and underwater networking technology. Efforts also include the development of Unmanned Undersea Vehicle-based and affordable off-board deployable sensing systems employing persistent detection concepts and components. These efforts provide an				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
extended reach of organic platform-based systems through the use of new sensor concepts, improved materials for advanced sensors, optimized deployment, employment, and automated operation of distributed sensor fields. The cornerstone of Distributed Search is the development of rapidly deployable, long-endurance active sensors with automated processing suitable for use in a wide variety of operational environments. The FY 2009-2010 funding increase is due to the realignment of the Wide Area ASW Surveillance and Battlegroup ASW Defense Activities into this new Activity. *FY 2010 Plans:* The following efforts transferred into this activity from the FY 2009 Wide Area ASW Surveillance activity: - Continue development of signal processing algorithms aimed at reducing clutter-generated false alerts. - Continue development/improvement of multi-static signal processing techniques for systems employing coherent sound sources. - Continue development of “intelligent” algorithms aimed at optimizing distributed multistatic sources/ receivers. - Continue a collaborative follow-on Joint Research Project for Next Generation Autonomous Sensing (NGAS). - Complete research effort to accomplish array shape estimation using fiber-optic interferometric methods. - Initiate research and development of feature-based tracking techniques to improve multi-sensor tracking of quiet submarines in littoral and deep-ocean environments. - Initiate research into the characterization and classification of deep-ocean clutter sources to improve active sonar system performance in Convergence Zone (CZ) and other deep-ocean propagation conditions. - Initiate development of Non-Traditional Transduction Methods (NTTM) which fundamentally departs from conventional ASW transduction techniques. - Initiate development of Non-Acoustic Fiber Optic Sensors (NA-FOS) for ASW applications. - Initiate research aimed at adaptive design and synthesis of networked distributed sensors.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate effort to demonstrate the effectiveness of structural acoustic-based classifier techniques to detect, localize and identify. The following efforts contribute to the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continue an applied research effort to improve distributed system processing techniques and capabilities. - Initiate development of high fidelity computer-based simulation training with linked architecture that supports ASW training from the operator-level to the ASW Commander-level applicable to both surface and air platforms. The following efforts transferred into this activity from the FY 2009 Battlegroup ASW Defense activity: - Continue development of signal processing improvements for coherent tactical active sonar systems aimed at improving Detection, Classification, and Localization of small, slow moving submarines in shallow water. - Continue development of improved techniques to distinguish submarine echoes from those produced by ocean bottom features. - Continue design and development of underwater projectors using structural magnetostrictive materials. - Continue dipole projector array design and development. - Continue compact low frequency projector developments. - Continue single crystal and hybrid projector design and development.					
ANTI-SUBMARINE WARFARE (ASW) PERFORMANCE ASSESSMENT The goal of this work is to integrate ocean and atmospheric environmental characteristics with sensor performance predictions in order to develop algorithms and Tactical Decision Aids (TDAs) that will accurately predict overall sensor performance in a given environment in near real-time for both present and future situations. The results of these research efforts in conjunction with embedded state-of-the-art command and operator-level training will facilitate the optimum employment of ASW sensor systems, thus increasing their effectiveness and potentially decreasing the number of sensors used to provide coverage in a given area. This work will provide operational commanders with sensor performance predictions which		0.000	0.000	4.036	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
allow them to accurately judge the performance of those sensors, as well as information with which to deploy them for the greatest operational effect. It will also provide information as to how the performance evolves over time due to effects such as the deformation of sensor locations by currents, sound velocity profile changes, geologic magnetic interference changes, or changes to the optical properties of the water, etc. The effort includes performance predictions for fields of sensors as well as individual sensors themselves and applies to both acoustic and non-acoustic sensors. Work includes development of ASW sensor and system performance models, and realistic simulations and measures of effectiveness that incorporate and exploit critical environmental knowledge. It includes efforts to couple ocean dynamics and acoustics, characterize ambient noise in the littorals, measure and model acoustic and optical propagation and scattering in complex environments, develop algorithms to extract environmental information from through-the-sensor measurements and quantification and prediction of uncertainty. This information is combined with the operating characteristics of particular sensors (or groups of sensors) to provide predictions of sensor performance in the environment at that particular time and in the future. The predictions will also include assessments of the prediction uncertainty due to environmental measurement and sensor performance uncertainties. This work aligns principally with the Assure Access and Hold at Risk S&T Focus Area in the Naval S&T Strategic Plan and contributes measurably to the Operational Environments S&T Focus Area strategic objectives. The FY 2009-2010 funding increase is due to the realignment of Wide Area ASW Surveillance activity into this new activity. *FY 2010 Plans:* The following efforts transferred to this activity from the FY 2009 Wide Area ASW Surveillance activity: - Complete development of models that accurately characterize short and long range forward scattering from the ocean boundaries for surveillance through tactical sonar frequencies.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
The following efforts contribute to the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continue research effort aimed at the ideal placement of acoustic sources and drifting sensor systems using in-situ environmental information and models. - Continue research effort focusing on distributed system in-situational environmental characterization and system monitoring. - Continue research effort to determine the placement of and follow-on control and pattern keeping of mobile sources and distributed sensor systems. - Initiate development of algorithms to extract environmental information from through-the-sensor measurements.				
ANTI-SUBMARINE WARFARE (ASW) PRECISION LOCALIZATION Precision Localization focuses on the development and demonstration of technologies which use information from surveillance or search systems to determine an area of uncertainty (AOU) relative to target range, bearing, and depth adequate to handoff to an attack system. Precision Localization employs non-acoustic techniques such as magnetic sensing and wake trailing to highly localize submerged threats. The objective is to increase magnetic sensor range and robustness, enable deployment on Unmanned Air Vehicles (UAVs), and increase wake trailing search rates. Efforts include the development of non-traditional tracking and advanced magnetic and electric field sensors and processing. These technologies will provide a decreased AOU size thus enabling the effective use of smaller, more versatile torpedoes as well as increased performance gain in detection, targeting, tracking/trailing, and homing via wake acquisition and covert prosecution. The FY 2009-2010 funding increase is due to the realignment of the Wide Area ASW Surveillance Activity into this new Activity.	0.000	0.000	3.656	

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
FY 2010 Plans: The following efforts were transferred to this new activity from the FY 2009 Wide Area ASW Surveillance activity: - Continue development of a non-traditional tracking system for deployment on undersea vehicles. - Continue testing of a non-traditional tracking system. - Continue development of alternative active optical sources and sensor devices for Non-Acoustic ASW systems. - Continue an effort to extend the technology base for blue laser sources for Undersea Warfare applications including underwater communications. - Continue an effort to extend the technology base for high performance electro-optic detectors suitable for Undersea Warfare applications including underwater communications. - Continue an effort to extend the technology base for high performance electro-optic filters suitable for Undersea Warfare applications including underwater communications. - Continue an effort to develop consistent and comprehensive modeling and simulation tools for photonic Undersea Warfare and underwater communications components and systems. - Continue an effort to develop optical signal processing and hybrid computing technology appropriate for Undersea Warfare and underwater communications systems. - Complete development of spin-dependent tunneling and coupled magnetostrictive/piezoelctric passive magnetometer device technologies. - Initiate development of ASW sensor technologies capable of being deployed by a gun or missile launcher.					
ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE ASW Surveillance focuses on dramatically improving detection, classification, and localization capabilities in large ocean areas relative to the capabilities of legacy ASW surveillance systems. The related technologies support the conduct of covert wide-area surveillance ranging from one day to six months. The objectives are to develop and demonstrate technologies that provide clandestine indications and warnings in far forward and contested operating areas and in complex operational environments against all submarine threats including new threats with unknown target signatures and tactics. Covertness implies		0.000	0.000	13.967	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
use of non-observable platforms and/or deployed automated sensors employing passive sonar or other non-detectable methods. The surveillance process includes initial detection and classification. Efforts include the development of Unmanned Undersea Vehicle-based and affordable off-board deployable sensing systems employing a wide variety of surveillance concepts and components. These efforts focus on alternative detection phenomena, vector/tensor sensors, automated acoustic processing, more compact and longer lasting power sources, and high bandwidth acoustic communications links. The FY 2009-2010 funding increase is due to the realignment of the Wide Area ASW Surveillance and Battlegroup ASW Defense activities into this new activity. *FY 2010 Plans:* The following efforts were transferred to this new activity from the FY 2009 Wide Area ASW Surveillance activity: - Continue development of new acoustic and magnetic sensors for autonomous, networked underwater threat monitoring over large spatial scales. - Continue an applied research effort to improve distributed system processing techniques and capabilities. - Complete design of a "Sea Star" undersea local area network to link peripheral sensors to a centralized node through high-bandwidth, short-haul acoustic communications. - Complete fiber optic technology development to support the next generation of submarine hull arrays including new transducers, optical multiplexing, and optical components. - Initiate development of Non-Acoustic Underwater Communications. - Initiate development of Advanced Imaging Methods (AIM) to provide expanded spatial, temporal and spectral imaging options. - Initiate an effort to research improved seawater electrodes for Underwater Electric Potential (UEP) sensing in ASW applications. - Initiate research the goal of which is to form underwater magnetic sensors into a virtual gradiometric array via non-cabled communications.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
The following Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area efforts were transferred to this new activity from the FY 2009 Wide Area ASW Surveillance activity: - Continue development of technologies to provide rapid localization of threat submarines for On-Demand Detection, Classification and Localization (On-Demand DCL). - Initiate development of a vector sensor towed array and associated signal processing with performance nominally equivalent to a "thin-line" (TB-29) twin-line towed array to be compatible with the existing TB-29 array handling system. The following efforts were transferred to this new activity from the FY 2009 Battlegroup ASW Defense activity: - Continue development of an acoustic/magnetic hybrid sensor. - Continue development of low cost, compact, combined acoustic sensor. - Continue electroactive polymer smart sensor development. - Continue research to improve detection of quiet diesel-electric submarines using passive sonar arrays in deep ocean environments. - Complete development of target classification algorithms that adapt to local shipping noise conditions, thereby reducing false alarm probability. - Complete development of environmentally adaptive target detection and classification algorithms for deep water operating environments. - Initiate research to predict performance of automated passive sonar detection and classification algorithms in shallow and deep ocean environments. - Initiate biomimetic and nano sensor development. - Initiate 'hockey puck' transducer/amplifier module development. - Initiate broadband, directional, high power array development.				
BATTLEGROUP ANTI-SUBMARINE WARFARE (ASW) DEFENSE Battlegroup ASW Defense technology focuses on the development of platform-based sources and receivers aimed at denying submarines the ability to target gray ships. This technology area is primarily	16.152	9.871	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
concerned with detections inside 10 nautical miles. Battlegroup ASW Defense integrates next-generation technologies, automatic target recognition, sensors that adjust to complex acoustic environments, and environmentally adaptive processing techniques. Research aimed at understanding and predicting the impacts of manmade underwater sound on marine mammals is also conducted in this activity. Battlegroup ASW Defense will enable smaller, lighter, and cheaper acoustic/non-acoustic arrays, large multi-line arrays, and submarine flank arrays (all with environmental adaptation capabilities). The FY 2008 to FY 2009 decrease is associated with the movement of funds to establish the new Marine Mammals Activity ($4.3M). The FY 2009 to FY 2010 funding decrease is due to the realignment of this Activity to the newly established ASW Distributed Search and Surveillance Activities in FY 2010. *FY 2008 Accomplishments:* - Continued development of signal processing improvements for coherent tactical active sonar systems aimed at improving Detection, Classification, and Localization of small, slow moving submarines in shallow water. - Continued design and development of underwater projectors using structural magnetostrictive materials. - Continued development of improved techniques to distinguish submarine echoes from those produced by ocean bottom features. - Continued development of an acoustic/magnetic hybrid sensor. - Continued development of low cost, compact, combined acoustic sensor. - Continued electroactive polymer smart sensor development. - Continued dipole projector array design and development. - Continued compact low frequency projector developments. - Completed development of advanced sonar signal processing algorithms that integrate target classification and tracking into a combined system for autonomous deployable sensor processing. - Initiated development of target classification algorithms that adapt to local shipping noise conditions, thereby reducing false alarm probability. - Initiated development of environmentally adaptive target detection and classification algorithms for deep water operating environments.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated an accelerated effort for marine mammal detection involving signal processing of surface radar and the use of autonomous vehicles to allow passive acoustic and electromagnetic detection and monitoring of marine mammals off ranges during fleet ASW experimentation exercises and demonstrations when sound is transmitted underwater. This effort transfers to the newly established Marine Mammals Activity in FY 2009. The following efforts contribute to the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continued development of signal processing and system control algorithms for the AN/WSQ-11 “Tripwire” torpedo protection system. (Transferred to PE 0603123N) - Continued development of an AN/WSQ-11 “Tripwire” testbed for the testing of algorithms. (Transferred to PE 0603123N) - Completed a focused research study to evaluate sonar performance using the acoustic array testbed. *FY 2009 Plans:* - Continue development of signal processing improvements for coherent tactical active sonar systems aimed at improving Detection, Classification, and Localization of small, slow moving submarines in shallow water. - Continue design and development of underwater projectors using structural magnetostrictive materials. - Continue development of improved techniques to distinguish submarine echoes from those produced by ocean bottom features. - Continue dipole projector array design and development. - Continue compact low frequency projector developments. - Initiate single crystal and hybrid projector design and development. The above efforts transfer to the new ASW Distributed Search activity in FY 2010. - Continue development of an acoustic/magnetic hybrid sensor. - Continue development of low cost, compact, combined acoustic sensor. - Continue electroactive polymer smart sensor development.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Continue development of target classification algorithms that adapt to local shipping noise conditions, thereby reducing false alarm probability. - Continue development of environmentally adaptive target detection and classification algorithms for deep water operating environments. - Initiate research to improve detection of quiet diesel-electric submarines using passive sonar arrays in deep ocean environments. The above efforts transfer to the new ASW Surveillance activity in FY 2010.					
MARINE MAMMALS The goal of this activity is to support: (1) marine mammal research related to understanding impacts of underwater sound (especially sonar) on marine mammal behavior, hearing, physiology, distributions and ecology; (2) development and testing of new technologies for the detection of marine mammals at sea; (3) research on the bio-acoustic properties, use of sound for detection of, and effects of sound on fish and lesser marine organisms; and (4) research on optically important biota in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare (including oceanic bioluminescence and the development and testing of bioluminescence sensors). The marine mammals research conducted in this Program Element (P.E.) represents part of a total effort executed in coordination with complementary research performed in P.E. 0602435N. This Activity has been created specifically to address the work associated with determining and mitigating the effects on the behavior of marine mammals of manmade sound transmitted underwater. The FY 2008 to FY 2009 funding increase is associated with this newly created Activity which was funded from the Battlegroup Anti-Submarine Warfare Activity ($4.3M) and the Wide Area Anti-Submarine Warfare Surveillance Activity ($1.2M). *FY 2009 Plans:* - Complete an accelerated effort for marine mammal detection involving signal processing of surface radar and the use of autonomous vehicles to allow passive acoustic and electromagnetic detection		0.000	5.500	5.145	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
and monitoring of marine mammals off ranges during fleet Anti-Submarine Warfare experimentation exercises and demonstrations when sound is transmitted underwater. This effort transferred to this newly established Activity from the Battlegroup Anti-Submarine Warfare Defense Activity. - Initiate multi-investigator, coordinated field research to test responses of marine mammals (especially beaked whales) to controlled sound exposures. - Initiate development of new technologies for detection and localization of marine mammals, including (but not restricted to) gliders equipped with passive acoustic sensors, radar and thermal imagery. - Initiate research examining hearing sensitivity of marine mammals (including temporary and permanent threshold shifts). - Initiate research efforts examining distributions and abundances of marine mammals relative to prey fields and basic oceanographic parameters. - Initiate development of and evaluate models that predict time- and space-dependent sound fields produced by anthropogenic noise sources and mammal responses to the noise. - Initiate development and testing of multi-frequency acoustic technologies for detection, identification and enumeration of fish. - Initiate research to examine sensitivity of fish to anthropogenic sound. - Initiate research leading to better predictability of bioluminescent and pigment-bearing planktonic organisms. *FY 2010 Plans:* - Continue all FY 2009 efforts, less those noted as completed above. - Initiate research on effects of chronic physiological stress related to acoustic exposure of marine mammals in the wild.				
NEUTRALIZATION Efforts under this R-2 Activity move to the new Undersea Weaponry R-2 Activity in FY10. This activity's purpose is to develop enabling technologies for undersea weapons to counter threat submarines and surface vessels by increasing Probability of Kill and platform survivability. Weapon technology focus areas include: Explosives and Warheads, Guidance and Control (G&C), Multidisciplinary	22.370	16.513	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
Systems Design & Optimization (MSDO) (comprising Simulation Based Design, Silencing, and Propulsion), Power Sources, Supercavitation, and Torpedo Defense (TD). The ultimate goal of this activity is to develop modular and reduced sized undersea weapons based on common technology enablers (where possible), to provide revolutionary capabilities needed to fill Sea Shield Warfighter Capability Gaps, and enable new undersea weapon concepts of operations to rapidly transition to submarine neutralization/ engagement in deep and shallow water under unique payload limitations posed by unmanned platforms, external stowage, and future Naval platforms. The following demonstration FNC projects are included in this activity: 1) the Lightweight Torpedo Technology (LTT) project (transitions to PE 0603747N in FY 2009), and 2) the Compact Rapid Attack Weapon (CRAW) project. The funding decrease from FY 2008 to FY 2009 represents the phased movement of technologies from Applied (6.2) to Advanced (6.3) Research as the technologies mature. The FY 2009 to FY 2010 funding decrease is due to the realignment of the Neutralization activity to the newly established Undersea Weaponry activity in FY 2010. *FY 2008 Accomplishments:* - Continued development of technologies for terminal defense against close-in waterborne/underwater threats and high-speed weapons (examine experimentally, in water, the physics of interactions among multiple supercavitating projectiles in a projectile burst). - Continued optimization of undersea weapons system design using MSDO with respect to constraints in cost and performance. - Continued effort to conduct full ship validation effort for Explosion Response simulation code, using Dynamic System Mechanics Advanced Simulation (DYSMAS) Hydrocode (test plan developed, finite element ship model was completed, pretest simulations were conducted). - Continued implementation of MSDO tools in hybrid propulsion and Weapons Silencing systems development. – Continued development of high-speed supercavitating torpedo vehicle control and homing sensor. - Continued to conduct experiments and tests on vehicle control concepts and homing sensors.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continued fourth quarter (of the fiscal year) explosive testing for warhead projects. - Continued conduct of computer code refinements and investigation of supercavitating vehicle dynamics and instability. - Continued development of a supercavitating 6.75-inch (or full-scale) vehicle with vehicle control devices and homing sensors. - Continued feasibility investigations (including acoustic element construction) to test the ability of single crystal to operate at high field, high drive, and high duty cycle for both torpedo Tonpiltz transducer and broadband cylindrical projector applications. - Continued fin and cavitator control, and integrate with controller for the supercavitating 6.75-inch vehicle. - Continued torpedo design and optimization to support the external weapon stowage effort in DARPA Tango Bravo Program. - Continued data collection on a technology test-bed for surface ship close in torpedo defensive system using supercavitating projectiles. - Continued efforts in electric propulsion for the Next Generation Torpedo. - Continued signal processing and homing algorithms for supercavitating vehicle. - Continued efforts that enhance undersea weapons G&C capabilities in autonomy, sensors, sensor processing, communication and networking by leveraging current, or contribute to developing, technologies for UUVs. - Continued weaponization study for unmanned undersea vehicle initiated in FY 2007. - Completed validation of computational models for torpedo lethality and transition to NAVSEA/PMS415. - Initiated test and evaluation of signal processing and homing algorithms for supercavitating vehicle. - Initiated integration of hydroreactive shaped charge technology into CRAW warhead development. (Technology transitioning from PE 0602123N) - Initiated long pulse concept to exploit explosion bubble technology to enhance undersea warhead performance with smaller volumetric requirements. - Initiated efforts to develop air and underwater delivered kinetic energy enhanced lethality warhead concepts. - Initiated hybrid propulsion for Heavyweight Torpedo. - Initiated weaponization study for unmanned surface vehicle.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continued application of MSDO tools probabilistic methods and uncertainty analysis for LWT design. - Continued development of enhanced performance for torpedo warheads through the use of focused energy technologies for Light Weight Torpedo (LWT) Improvement and CRAW applications. - Continued development of a reduced size/weight CRAW for air deployment. This effort included sensor, guidance and control, warhead, propulsion, and air frame integration tasks. - Continued technology to enable a CRAW warhead to achieve required lethality against submarine targets. - Continued use of design techniques for LWT using undersea weapons system design tools transitioned from Discovery and Innovation to FNC. - Continued development of a shaped charge liner for CRAW warhead initiated in FY 2007. - Continued an iterative algorithm development to enable the CRAW to search, home, and terminally home against targets in deep and shallow water both without and with countermeasures. - Initiated LTT development of an underwater acoustics communications capability to enable coordinated attack and net-centric connectivity. (Transitions to PE 0603747N in FY 2009) - Initiated LTT development of salvo weapons tactics utilizing behavior-based control. (Transitions to PE 0603747N in FY 2009) *FY 2009 Plans:* - Continue all efforts of FY 2008 less those noted as completed above. - Complete transition of appropriate supercavitating vehicle control technology and devices to DARPA Underwater Express Program. - Complete efforts in electric propulsion for LWT. - Complete signal processing and homing algorithms for supercavitating vehicle. - Complete the evaluation of the integration of hydroreactive shaped charge technology into CRAW warhead development. - Complete weaponization study for unmanned undersea vehicle. - Initiate development of advanced undersea warhead fuzing concepts.				

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B. Accomplishments/Planned Program ($ in Millions)		**FY 2008**	**FY 2009**	**FY 2010**	**FY 2011**
- Initiate quiet propulsion systems development for torpedoes. - Initiate and complete development of enhanced yield explosive concepts for undersea warhead applications. The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continue all efforts of FY 2008.					
UNDERSEA WEAPONRY This is a new R-2 Activity starting in FY10. Efforts in this R-2 Activity were funded in the Neutralization R-2 Activity prior to FY10. Undersea Weaponry focuses on the development of enabling technologies to counter threat submarines and surface vessels by increasing Probability of Kill and platform survivability. Weapon technology focus areas include: Explosives and Warheads, Guidance and Control (G&C), Multidisciplinary Systems Design & Optimization (MSDO) (comprising Simulation Based Design, Silencing, and Propulsion), Power Sources, Supercavitation, and Counter Weapons/Counter Measures. The ultimate goal of this activity is to provide revolutionary capabilities needed to fill Sea Shield Warfighter Capability Gaps, to accommodate unique payload limitations through the development of modular and reduced sized undersea weapons based on common technology enablers (where possible), and to provide improved submarine wide area search/cuing in deep and shallow water ocean environments while providing the capability to rapidly adapt the submarine mission to engagement/neutralization. The FY 2009 to FY 2010 funding increase is due to the realignment from the Neutralization activity to this newly established Undersea Weaponry activity in FY 2010. *FY 2010 Plans:* – Complete evaluation of alternative undersea warhead fuzing concept developed under the advanced undersea warhead fuzing initiative.		0.000	0.000	14.766	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Complete weaponization study for unmanned surface vehicle. - Complete assessment of the kinetic energy warhead concept potential to provide enhanced undersea warhead performance. - Complete transition of the Torpedo Intelligent Controller to NAVSEA/PMS 404 (for heavyweight torpedoes, PE 0205632N) The following efforts support the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continue development of a reduced size/weight CRAW for air deployment. This effort will include sensor, guidance and control, warhead, propulsion, and air frame integration tasks. - Continue the development of algorithms for CRAW to search, home and terminally home in deep and shallow water against targets both without and with countermeasures. - Continue the development of a CRAW warhead that will achieve required performance against submarine targets, and demonstrate feasibility of achieving final goal. - Complete development of enhanced performance concept for torpedo warheads using focused energy technologies for Light Weight Torpedo (LWT) Improvement and CRAW applications.				
WIDE AREA ANTI-SUBMARINE WARFARE (ASW) SURVEILLANCE Wide Area ASW Surveillance is focused on dramatically improving the capability to sanitize large areas relative to the capabilities of legacy ASW sensors. Efforts include the development of affordable off-board systems with associated processing and robust, high bandwidth communications links. The cornerstone of Wide Area Surveillance is the ability to rapidly distribute acoustic and non-acoustic sensors from air, surface, and sub-surface platforms as well as to develop long-endurance sensors and unmanned ASW vehicles. This activity represents a shift from traditional fixed surveillance systems to autonomous, networked-components, multi-static operation, and supported by passive/active signal processing all with the objective of increased detection capabilities. The decrease from FY 2008 to FY 2009 is due to zero-sum realignment within the Future Naval Capability program of record to fund Navy approved Enabling Capabilities. Additionally, FY 2009 funds were moved to the newly established Marine Mammals Activity ($1.2M). The FY 2009 to FY 2010 funding decrease	29.055	26.521	0.000	

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
is due to the realignment of this activity to the newly established ASW Distributed Search, Performance Assessment, Precision Localization and Surveillance activities in FY 2010. *FY 2008 Accomplishments:* - Continued development of signal processing algorithms aimed at reducing clutter-generated false alerts. - Continued development/improvement of multi-static signal processing techniques for systems employing coherent sound sources. - Continued development of “intelligent” algorithms aimed at optimizing distributed multistatic sources/ receivers. - Continued development of a non-traditional tracking system for deployment on undersea vehicles. - Continued testing of a non-traditional tracking system. - Continued development of alternative active optical sources and sensor devices for Non-Acoustic ASW systems. - Continued an effort to extend the technology base for blue laser sources for Undersea Warfare applications including underwater communications. - Continued an effort to extend the technology base for high performance electro-optic detectors suitable for Undersea Warfare applications including underwater communications. - Continued an effort to extend the technology base for high performance electro-optic filters suitable for Undersea Warfare applications including underwater communications. - Continued an effort to develop consistent and comprehensive modeling and simulation tools for photonic Undersea Warfare and underwater communications components and systems. - Continued an effort to develop optical signal processing technology appropriate for Undersea Warfare and underwater communications systems. - Continued and completed third geomagnetic noise coherence investigation from cooperating airborne measurement platforms. - Continued the development of technologies for a low source-level, light-weight ship-protection system against underwater intruders, including vessels with explosives. - Continued development of signal processing algorithms for operational and pipeline ASW active sonar systems by extending Navy’s broadband, beam-based theory for the Time Reversal Operator.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Completed development of tracking and classification algorithms for broadband Doppler sensitive waveforms for wide area surveillance. - Completed magnetic mapping and localization study and component development for small-diameter Autonomous Undersea Vehicles. - Initiated design of a "Sea Star" undersea local area network to link peripheral sensors to a centralized node through high-bandwidth, short-haul acoustic communications. - Initiated development of spin-dependent tunneling and coupled magnetostrictive/piezoelctric passive magnetometer device technologies. - Initiated development of new acoustic and magnetic sensors for autonomous, networked underwater threat monitoring over large spatial scales. - Initiated development of models that accurately characterize short and long range forward scattering from the ocean boundaries for surveillance through tactical sonar frequencies. - Initiated fiber optic technology development to support the next generation of submarine hull arrays including new transducers, optical multiplexing, and optical components. The following efforts contribute to the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continued an applied research effort to improve distributed system processing techniques and capabilities. - Continued development of automatic signal processing algorithms for use with a Deep Water Active Deployable System (DWADS) for surveillance of deep ocean submarine threats. - Continued development of a transmit/receive array for use with a DWADS for surveillance of deep ocean submarine threats. - Completed Submarine Track and Trail applied research efforts for UUV technology in the areas of advanced undersea sensors, communications, and autonomy. - Completed experimental test planning for Palantir sensor. - Initiated incorporation and enhancement of technology from real-time data fusion technologies into Distributed System Processing (DSP).				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiated and completed a FY 2008 Palantir data collection exercise. All Palantir system related products developed in this PE transition to PE 0603747N where Palantir system development continues. - Initiated development of algorithms to optimize the placement of uncontrolled drifting systems. - Initiated development of a simulator for placement of uncontrolled drifting systems. - Initiated development of technologies to provide rapid localization of threat submarines for On-Demand Detection, Classification and Localization (On-Demand DCL). *FY 2009 Plans:* - Continue development of signal processing algorithms aimed at reducing clutter-generated false alerts. - Continue development/improvement of multi-static signal processing techniques for systems employing coherent sound sources. - Continue development of “intelligent” algorithms aimed at optimizing distributed multistatic sources/ receivers. - Initiate a research effort to accomplish array shape estimation using fiber-optic interferometric methods. - Initiate a collaborative follow-on Joint Research Project for Next Generation Autonomous Sensing (NGAS). The above efforts transfer to the new ASW Distributed Search activity in FY 2010. - Continue development of a non-traditional tracking system for deployment on undersea vehicles. - Continue testing of a non-traditional tracking system. - Continue development of alternative active optical sources and sensor devices for Non-Acoustic ASW systems. - Continue an effort to extend the technology base for blue laser sources for Undersea Warfare applications including underwater communications. - Continue an effort to extend the technology base for high performance electro-optic detectors suitable for Undersea Warfare applications including underwater communications. - Continue an effort to extend the technology base for high performance electro-optic filters suitable for Undersea Warfare applications including underwater communications. - Continue an effort to develop consistent and comprehensive modeling and simulation tools for photonic Undersea Warfare and underwater communications components and systems.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Continue an effort to develop optical signal processing technology appropriate for Undersea Warfare and underwater communications systems. - Continue development of spin-dependent tunneling and coupled magnetostrictive/piezoelctric passive magnetometer device technologies. The above efforts transfer to the new ASW Precision Localization activity in FY 2010. - Continue development of models that accurately characterize short and long range forward scattering from the ocean boundaries for surveillance through tactical sonar frequencies. The above effort transfers to the new ASW Performance Assessment activity in FY 2010. - Continue design of a "Sea Star" undersea local area network to link peripheral sensors to a centralized node through high-bandwidth, short-haul acoustic communications. - Continue development of new acoustic and magnetic sensors for autonomous, networked underwater threat monitoring over large spatial scales. - Continue fiber optic technology development to support the next generation of submarine hull arrays including new transducers, optical multiplexing, and optical components. - Complete development of technologies for a low source-level, light-weight ship-protection system against underwater intruders, including vessels with explosives. - Complete development of signal processing algorithms for operational and pipeline ASW active sonar systems by extending Navy's broadband, beam-based theory for the Time Reversal Operator. The above efforts transfer to the new ASW Surveillance activity in FY 2010. The following efforts contribute to the Sea Shield FNC in the Littoral Anti-Submarine Warfare Mission Area: - Continue an applied research effort to improve distributed system processing techniques and capabilities. The above effort transfers to the new ASW Distributed Search activity in FY 2010.				

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B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010	FY 2011
- Initiate research effort aimed at the ideal placement and control of acoustic sources and drifting sensor systems. - Initiate a research effort focusing on distributed system in-situational environmental characterization and system monitoring. - Initiate a research effort to determine the placement of and follow-on control and pattern keeping of mobile sources and distributed sensor systems. The above efforts transfer to the new ASW Performance Assessment activity in FY 2010. - Continue development of algorithms to optimize the placement of uncontrolled drifting systems. - Continue development of a simulator for placement of uncontrolled drifting systems. - Initiate algorithm testing of uncontrolled drifting systems using a simulator. The above efforts transfer to and continue in PE 0603747N under the new ASW Performance Assessment activity in FY 2010. - Continue development of technologies to provide rapid localization of threat submarines for On-Demand Detection, Classification and Localization (On-Demand DCL). The above effort transfers to the new ASW Surveillance activity in FY 2010. - Complete incorporation and enhancement of technology from real-time data fusion technologies into Distributed System Processing (DSP). The above effort completes; it does not transfer or continue in FY 2010. - Complete development of automatic signal processing algorithms for use with a DWADS for surveillance of deep ocean submarine threats. - Complete development of a transmit/receive array for use with DWADS for surveillance of deep ocean submarine threats. The above efforts complete, and the project transitions to PE 0603561N in FY 2010.				

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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 0601153N/Defense Research Sciences									Continuing	Continuing
PE 0602114N/Power Projection Applied Research									Continuing	Continuing
PE 0602123N/Force Protection Applied Research									Continuing	Continuing
PE 0602435N/Ocean Warfighting Environment Applied Research									Continuing	Continuing
PE 0602702E/Tactical Technology									Continuing	Continuing
PE 0602782N/Mine and Expeditionary Warfare Applied Research									Continuing	Continuing
PE 0603114N/Power Projection Advanced Technology									Continuing	Continuing
PE 0603123N/Force Protection Advanced Technology									Continuing	Continuing
PE 0603506N/Surface Ship Torpedo Defense									Continuing	Continuing
PE 0603553N/Surface ASW									Continuing	Continuing
									Continuing	Continuing

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PE 0603561N/Advanced Submarine System Development		
PE 0603739E/Advanced Electronics Technologies	Continuing	Continuing
PE 0603747N/Undersea Warfare Advanced Technology	Continuing	Continuing
PE 0603758N/Navy Warfighting Experiments and Demonstrations	Continuing	Continuing
PE 0604221N/P-3 Modernization Program	Continuing	Continuing
PE 0604261N/Acoustic Search Sensors	Continuing	Continuing
PE 0604784N/Distributed Surveillance System	Continuing	Continuing

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall metrics of applied research in undersea warfare are to develop technologies aimed at improving target detection, classification, localization, tracking, increasing attack capabilities against quiet adversary submarines operating in noisy and cluttered shallow water environments, countering enemy torpedoes, providing the ability to conduct long-range engagements, increasing weapons load-out, providing multi-platform connectivity, increasing endurance/survivability, and reducing size and power requirements.