Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Navy										DATE: February 2010	
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601152N: *In-House Lab Independent Res*							
COST ($ in Millions)	**FY 2009 Actual**	**FY 2010 Estimate**	**FY 2011 Base Estimate**	**FY 2011 OCO Estimate**	**FY 2011 Total Estimate**	**FY 2012 Estimate**	**FY 2013 Estimate**	**FY 2014 Estimate**	**FY 2015 Estimate**	**Cost To Complete**	**Total Cost**
Total Program Element	17.103	18.001	17.979	0.000	17.979	18.579	18.623	19.051	19.451	Continuing	Continuing
0000: *In-House Lab Independent Res*	17.103	18.001	17.979	0.000	17.979	18.579	18.623	19.051	19.451	Continuing	Continuing

A. Mission Description and Budget Item Justification

This program element (PE) sustains U.S. Naval Science and Technology (S&T) superiority by providing new technological concepts for the maintenance of naval power and national security and by helping to avoid scientific surprise while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities (FNCs). The Department of Navy (DON) component responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements and is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command. It enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. The In-house Laboratory Independent Research (ILIR) program also adds increased emphasis to the revitalization of the scientist and engineer workforce component at the Navy's Warfare Centers and Laboratories by attracting superior candidates and retaining our best members through the provision of exciting and meaningful work.

This PE addresses DON Basic Research which includes scientific study and experimentation directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental, and life sciences; and is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in thirteen research focus areas: Power and Energy; Operational Environments; Maritime Domain Awareness; Asymmetric and Irregular Warfare; Information, Analysis and Communication; Power Projection; Assure Access and Hold at Risk; Distributed Operations; Naval Warfighter Performance and Protection; Survivability and Self-Defense; Platform Mobility; Fleet/Force Sustainment; Affordability, Maintainability and Reliability.

This portion of the DON Basic Research Program provides participating Naval Warfare Centers and Laboratories with funding for: basic research to support the execution of their assigned missions; developing and maintaining a cadre of active researchers who can distill and extend results from worldwide research and apply them to solve Naval problems; promoting hiring and development of new scientists; and encouragement of collaboration with universities, private industry, and other Navy and Department of Defense laboratories.

ILIR efforts are selected by Naval Warfare Centers/Lab Commanding Officers and Technical Directors near the start of each Fiscal Year through internal competition. Efforts typically last three years, and are generally designed to assess the promise of new lines of research. Successful efforts attract external, competitively awarded

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funding. Because the Warfare Centers and Labs encompass the full range of naval technology interests, the scope of ILIR topics roughly parallels that of PE 0601153N, Defense Research Science.

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

B. Program Change Summary ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Previous President's Budget	17.207	18.076	0.000	0.000	0.000
Current President's Budget	17.103	18.001	17.979	0.000	17.979
Total Adjustments	-0.104	-0.075	17.979	0.000	17.979
• Congressional General Reductions		-0.075			
• Congressional Directed Reductions		0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds		0.000			
• Congressional Directed Transfers		0.000			
• Reprogrammings	0.047	0.000			
• SBIR/STTR Transfer	-0.151	0.000			
• Program Adjustments	0.000	0.000	17.979	0.000	17.979

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

FY11 from previous President's Budget is shown as zero because no FY11-15 data was presented in President's Budget 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy			DATE: February 2010
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COST ($ in Millions)	FY 2009 Actual	FY 2010 Estimate	FY 2011 Base Estimate	FY 2011 OCO Estimate	FY 2011 Total Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost To Complete	Total Cost
0000: *In-House Lab Independent Res*	17.103	18.001	17.979	0.000	17.979	18.579	18.623	19.051	19.451	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project sustains U.S. Naval S&T superiority, provides new technological concepts for the maintenance of naval power and national security, and mitigates scientific surprises, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities (FNC's). It responds to S&T directions of the Naval S&T Strategic Plan for long term Navy and Marine Corps improvements. It is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command (NWDC) and the Marine Corps Combat Development Command (MCCDC), and enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities.

This portion of the DON Basic Research Program provides participating Naval Warfare Centers and Laboratories with funding for basic research to support the execution of their assigned missions, for developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research and apply them to naval problems, to promote hiring and development of new scientists, and to encourage collaboration with universities, private industry, and other Navy and Department of Defense laboratories.

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
ADVANCED MATERIALS	3.295	3.542	3.485	0.000	3.485
Efforts include: structural materials; functional materials; maintenance reduction, hydrodynamics; power generation; energy conservation and conversion. *FY 2009 Accomplishments:* - Continued research and development on energy flow control and redirection of anisotropic cylindrical shells. This research focuses on reduction and redirection of vibrational energy propagation through cylindrical structures by utilizing new anisotropic materials that are now available.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Continued research and development effort to reinvestigate the nature of the Cathodic Delamination (CD) problem and determine the effectiveness of new approaches to combating the old scourge of CD on naval hardware. - Continued research in the development of an algorithm that makes use of both forward and inverse modeling techniques to determine variations in the static and dynamic material properties of hyperelastic materials from experimental measurement. This research seeks to develop a technique that combines modeling and experimental measurements to quantify spatial variations in a material's response to static and dynamic loads. - Continued research on mesoscale models to include dissipative particle dynamics and automata-based modeling strategies. - Completed research to investigate a radical new technique for producing structures that have reconfigurable embedded functionality based on chemistry and nanotechnology. The research centers on the creation of a Micro Conduit Network (MCN) which is a series of interconnected micron-size channels designed to permeate though a structure and occupy the smallest volume fraction in order to preserve the strength and stiffness of the structure. - Completed research to quantify the small angle X-ray scattering and tensile mechanical tests of the mechanical mechanism for protective response to different polyurea chemistries and characterized the response limits in terms of strain and high strain rates (10E-1s - 10E4/s) to ensure specific impact loading levels in the protective range of the polyurea coatings. The strain rate material response for both elastic and plastic were incorporated into the constitutive equation for modeling and hydrocode simulation for further calculations of the geometries and layer thickness. - Completed research into conduction and electrical mechanisms through porous membranes for fuel cell membranes, chemical analysis and biological transport. The research revealed unusual and enhanced conduction properties in pores with widths less than 1um; exceeding the diameter by which the current theory predicts. This research will exploit the enhanced current where there exists the potential for order-of-magnitude improvements in sensors, computation and communications. - Completed research from a previously sponsored ILIR project that produced the scientific foundation of a new technology for the epitaxial deposition of lattice-mismatched films on substrates of silicon (Si)					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
and gallium arsenide (GaAs). This technology features the formation of an atomic layer or template that serves as an interface between the film and substrate. It was discovered that the layer formation happens when there is a chemical reaction between the substrate and the impinging molecules. This research focused on the hypothesis that instead of fusion, the impinging molecules come in sequence with a narrow distribution of velocities than ideal gas with lower entropy. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as complete above. - Complete research and development on energy flow control and redirection of anisotropic cylindrical shells. - Complete research and development effort on the nature of the CD problem for the Navy and determine the effectiveness of new approaches to combating CD on Naval hardware. - Complete research in the development of an algorithm that makes use of both forward and inverse modeling techniques to determine variations in static and dynamic material properties of hyperelastic materials from experimental measurement. - Complete research on mesoscale models to include dissipative particle dynamics and automata-based modeling strategies. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: - Continue all efforts of FY 2010, less those noted as complete above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Naval Materials by Design and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Sea Basing, and National Naval Responsibility initiatives in Undersea Weaponry and Naval Engineering.					
ELECTRONICS SENSOR SCIENCES Efforts include: sensing, diagnostics, and detectors; navigation and timekeeping; nano electronics; real time targeting, Electro Optical/InfraRed (EO/IR) electronics; EO/IR electronic warfare; and EO/IR sensors for surface and subsurface surveillance. *FY 2009 Accomplishments:* - Continued research into the Space-Charge-Limited (SCL) transport of charge carriers across a potential difference. The related publications on theoretical, experimental and numerical investigations have undergone excess growth in the number of disciplines for which SCL related flows are found to be applicable. SCL is found to have a strong impact on ion diodes in connection with inertial fusion, cold cathode emission, field-emitter-arrays, and on the capabilities of photocathode guns. This research investigated the limitations of SCL transport and certain extensions that have recently been proposed which may lead to enhancements in the amount charge and ability to transport in 1-D, 2-D, and 3-D geometries. - Continued research into the twin concepts of post-selection of wave function in quantum mechanics and the Aharonov-Vaidman formula which has opened up new avenues in what can and cannot be measured in quantum mechanics. Each theory and experiment confirmation has proven new, previously unexpected effects in quantum mechanics and identifies a possible new area of technology.	2.458	2.608	2.562	0.000	2.562

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Research was conducted to translate the aspects of quantum mechanical models into a classical weak observable signature setting to determine if these effects can occur in electromagnetic and other wave theories. This research has the potential to provide: a new way to enhance signals that otherwise would not be detectable; new types of signatures to be looked for in the radar waveform returns; new phenomena - weak energy. Research was conducted to investigate these phenomena in the classical signals that are regularly used in Naval applications such as radar, sonar and electro-optics. - Completed research on new approaches to miniaturization and integration of optical components into compact functional systems capable of generating, localizing, detecting, amplifying, and processing light signals. This research focused on novel coupling and beam splitting methods utilizing metallic tip and multilayer stock. The beam splitting effect can be employed to construct a nanoplasmonic Y-splitter, the basic component in many optical devices. Nanoscale optics is expected to form the basis for future nanolithography, optical sensors, and diagnostics in the single-molecular level through surface Plasmon enhanced Ramon scattering. - Completed research using mid-IR solid state laser to photo-acoustically generate large dimension, short-lived underwater filaments. Filament dimensions on the order of 10 mm in diameter and 10 cm long with durations ranging from 100 microseconds to a few milliseconds are expected as a result of using an existing laser system. This research has the potential to produce large dimension filaments and accompanying controlled transient shock waves that may revolutionize air/surface-to-underwater communications and development of additional Naval applications to support situational awareness efforts. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Electric Power Sources and Multifunctional Electronics for Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Persistent Surveillance, and the National Naval Responsibility in Undersea Weaponry.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2010 Plans: - Continue all efforts of FY 2009, less those noted as complete above. - Complete research into the SCL transport of charge carriers across a potential difference. - Complete research into the twin concepts of post-selection of wave function in quantum mechanics and the Aharonov-Vaidman formula which has opened up new avenues in what can and cannot be measured in quantum mechanics. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Electric Power Sources and Multifunctional Electronics for Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Persistent Surveillance, and the National Naval Responsibility in Undersea Weaponry. *FY 2011 Base Plans:* - Continue all efforts of FY 2010, less those noted as complete above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Electric Power Sources and Multifunctional Electronics for Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Electromagnetic Gun and Persistent Surveillance, and the National Naval Responsibility in Undersea Weaponry.					
ENERGY SCIENCES Efforts include: undersea weaponry; energetic materials and propulsion; directed energy; and TeraHertz Time-Domain Spectroscopy (THz-TDS) technology that addresses overseas contingency operations and Counter Improvised Explosive Device (C-IED) detection by detecting and spectroscopically identifying military and home-made explosives and formulations.	1.271	1.366	1.342	0.000	1.342

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2009 Accomplishments: - Continued research to develop Computational Fluid Dynamic (CFD) modeling techniques to support flow optimization in diving, fire fighting, Chemical, Biological, Radiological, and Nuclear (CBRN) protection, and aeronautical and aerospace life support helmets. The goal of this research is to improve CO2 transport from life support helmets to optimize performance without resorting to an oral-nasal mask. - Continued research into the development of a theory that will describe vibrational energy transfer between a shock wave and the local vibrations/electrons of explosive molecules. The goal of this research is to provide a simplified theoretical expression for the rate of energy transfer into an explosive molecule, without lengthy molecular dynamics or quantum chemical calculations. The approach combines both macroscopic thermodynamic properties and ultra fast spectroscopy data to study the initial nanosecond a shock passes through the material. - Completed research on the physical properties of explosively driven, guided shock waves. An explosively driven, guided shock wave is a shock wave produced in a guide tube that was initiated by an explosion at one end of the tube. The goal of this project is explore the properties of guided shock waves to include the pressure, temperature, and velocity of the gas through which the guided shock wave travels. - Completed research in the THz-TDS technology which addressed overseas contingency operations and C-IED detection by detecting and spectroscopically identifying military and home-made explosives and formulations. The continued focus of this research is to establish peak assignments of explosives in the THz regime by comparing solid-state quantum chemistry calculations. Results of this study will provide the fundamental THz reflection and absorption spectra of explosives found in IEDs. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Naval Battlespace Awareness and Intelligent naval Sensors, Innovative Naval					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as complete above. - Complete research to develop CFD modeling techniques to support flow optimization in diving, fire fighting, CBRN protection, and aeronautical and aerospace life support helmets. The goal of this research is to improve CO2 transport from life support helmets to optimize performance without resorting to an oral-nasal mask. - Complete research to develop a theory to describe vibrational energy transfer between a shock wave and the local vibrations/electrons of explosive molecules. The goal of this research is to provide a simplified theoretical expression for the rate of energy transfer into an explosive molecule, without lengthy molecular dynamics or quantum chemical calculations. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2011 Base Plans:* - Continue all efforts of FY 2010, less those noted as complete above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.					
HUMAN PERFORMANCE SCIENCES	2.036	2.183	2.147	0.000	2.147

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Efforts include: biosensors, biomaterial, bioprocesses; marine mammals; casualty care management, undersea medicine; human factors and organizational design; manpower, personnel and advanced cockpit; and operational training and education. These efforts are coordinated with the Navy Medical Research Center (NMRC). *FY 2009 Accomplishments:* - Continued research to improve the understanding of vection (visually induced illusion of self-motion) in relation to contact. The goal of this research is identify the threshold for vection as a function of stimulus and understand when a pilot is susceptible to disorientation due to vection in critical environment conditions. - Continued research to examine whether or not various forms of visuospatial attention are a manifestation of a single cognitive process. The intent of this research is to understand the basic principles of visuospatial attention to allow engineers to define upper and lower boundaries for attentional ability and design display systems to consider these aspects of operator performance. - Continued research into exhaled nitric oxide measurement to provide a reliable and sensitive noninvasive marker of pulmonary oxygen toxicity in humans. The research seeks to measure normal day-to-day individual variability in pulmonary function and exhaled nitric oxidant and contrast these measurements with pulmonary function, exhaled nitric oxide and pulmonary oxygen toxicity symptoms. - Completed research to elucidate the pathogenic mechanism, looking for common and different underlying mechanisms of injury, in hyperbaric oxygen and Blast OverPressure (BOP) induced injury by specific induction of heme oxygenase-1 or specific suppression of inducible nitric oxide synthesis in lungs. - Completed research to determine if inhaled heavy metals contribute to the pathogenesis of neurodegeneration. This research focused on the olfactory and trigeminal sensory nerves in the nasal mucosa. The hypothesis is that retrograde axonal transport of inhaled heavy metals from sensory nerves in the upper airway to the central nervous system results in significant neurotoxicity. - Completed research in the proliferation and differentiation of adult/stem progenitor cells to mature, terminally differentiated cells of skin, muscle, bone, nerve, heart, tendon, liver, and pancreas in a					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
multi-step process. There is continual evidence that some tissue regenerative cells, particularly found in bone marrow migrate within the body and can contribute to healing at multiple sites in multiple lineages. Bone marrow-derived hematopoietic stem cells, mesenchymal stem cells, endothelial progenitor cells and skeletal muscle-derived stems can contribute to the regeneration of a variety of tissues in vivo. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as complete above. - Complete research in the area of understanding of vection in relation to contact. The goal of this research is identify the threshold for vection as a function of stimulus and understand when a pilot is susceptible to disorientation due to vection in critical environment conditions. - Complete research to examine whether or not various forms of visuospatial attention are a manifestation of a single cognitive process. - Complete research in the area of exhaled nitric oxide measurements to provide a reliable and sensitive noninvasive marker of pulmonary oxygen toxicity in humans. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
FY 2011 Base Plans: - Continue all efforts of FY 2010, less those noted as complete above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.					
INFORMATION SCIENCES Efforts include: mathematical foundation and computational theory and tools for design communications; decision support theory; algorithm and tools, information assurance, secure and reliable infrastructure for command and control; mathematical optimization for optimal resource allocation and usage; modeling and computational propagation; seamless, robust connectivity and networking and cyber warfare. *FY 2009 Accomplishments:* - Continued research into the connection between graphs and commutative algebra, and construction of fast algorithms to compute interesting new invariants. This research will link graph theory, commutative algebra, geometry and topology to provide a new way to analyze data and information. - Continued research into recent advances in Commercial Off The Shelf (COTS) microprocessor performance that have largely been achieved via added parallelism (adding additional microprocessor "cores" on the system), rather than by the more familiar method of increasing the clock speed. Research into developing software to perform well on these parallel architectures is difficult and expensive. The problem has been made more difficult by the vastly different programming techniques required by the two leading COTS parallel architectures (IBM "Cell BE" vs Intel/AMD x86). Initiated an investigation into a technique to automatically apply a specialized Navy algorithm to these radically	2.052	2.208	2.172	0.000	2.172

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
different architectures, and use a stochastic search to optimize the performance of the algorithm to each targeted architecture. - Continued research to improve the methodology of time series summarization by utilizing the framework of second generation wavelets and on-off system models, and by inventing and utilizing better pre-processing strategies, segmentation algorithms, data transforms and dissimilarity functions. - Completed research to harness the power of clustering algorithms in association with other analytical techniques to detect changes in a system. This research focused on development of algorithms to compare different clustered data to find and measure changes in data using data clustering as an underlying representation of the data. - Completed research focused on the development of nonlinear dynamics based criteria to distinguish structural damage from general dynamic characteristic changes which include environmental effects. The goal of this research effort is to finalize the phased array interrogation/sensing signal extraction and nonlinear dynamic analysis schema to provide real-time health monitoring and diagnostic technology which has potential for a variety of applications. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as complete above. - Complete research into the connection between graphs and commutative algebra, and construction of fast algorithms to compute interesting new invariants. - Complete research into recent advances in COTS microprocessor performance that have largely been achieved via added parallelism (adding additional microprocessor "cores" on the system), rather than by the more familiar method of increasing the clock speed.					

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
- Complete research to improve the methodology of time series summarization by utilizing the framework of second generation wavelets and on-off system models, and by inventing and utilizing better pre-processing strategies, segmentation algorithms, data transforms and dissimilarity functions. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2011 Base Plans:* - Continue all efforts of FY 2010, less those noted as complete above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.					
NAVAL PLATFORM DESIGN SCIENCES Efforts include: novel hull forms, materials, structures and signatures; and virtual shaping concepts for structures and platforms. *FY 2009 Accomplishments:* - Continued research in the area of experimental breaking wave loads by bringing the analysis into the computational realm using Reynolds Average Navier Strokes (RANS) codes. This research investigates four general phases: creating consistent, repeatable breaking waves; creating these waves so that they break on the surface to analyze impact forces; validating those impact forces with existing and additional experimental data; and exploring the scaling effects of the impact forces. The	1.400	1.503	1.481	0.000	1.481

Exhibit R-2A, RDT&E Project Justification: PB 2011 Navy		DATE: February 2010
APPROPRIATION/BUDGET ACTIVITY 1319: *Research, Development, Test & Evaluation, Navy* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601152N: *In-House Lab Independent Res*	PROJECT 0000: *In-House Lab Independent Res*

B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
goal of the research is to gain a much clearer understanding of the functional physics of breaking waves and the loads that are created, and to replicate these characteristics in a computational environment. This computational capability provided guidance for future fleet designs and improved understanding of hydro loads on structural ship design. - Continued research on a virtual shaping concept for structures and platforms. Virtual shaping is implemented by introducing a phase shift gradient in the reflective wave along a structural surface, which will cause the reflection of an incoming plane wave to be in a non-specular direction, minimizing the chance of detection by the emitter. The virtual shaping concept could be implemented by surface treatments, appliques containing micropatch arrays constructed to simulate the effects of shaping when applied to the ship structure. The goals of this research are to reduce the need for the tumblehome design for stealthiness, reduce surface area of topside structures, and development of a retrofitting process for existing ships to reduce their radar cross section. - Continued research to develop the next generation of prediction tools based on RANS such that arbitrary complex geometries, including non-circular body, can be handled and the reliance on empiricism can be minimized. The goal of this research is to be accurate and fast enough to do real time analysis, support submarine design, and be able to accommodate the submarine submerged operating envelope. - Completed research on the increasing sophistication of sensor systems that have made mid- and high-frequency acoustic signature identification possible. New ship classes are given tight acoustic budgets, driving the exploration of new and novel concepts in hull form, materials and propulsion and development of structural and acoustic analysis tools to evaluate the vulnerability. The focus of this research project was to develop a method for efficiently addressing a class of mid-frequency vibration problems highly relevant to Naval vessels. The goal was to capture directly the mid-frequency physics rather than apply a hybrid approach. - Completed research into ThermoElectric (TE) devices used for waste heat recovery and its conversion to electrical energy. Conversion efficiencies of the TE devices are related to a dimensionless figure of merit referred to as ZT. Devices have low efficiencies to due to a low value of ZT. The goal of this research was to provide an improved understanding of the physical and chemical					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
properties of a material that lead to an increase in the value of ZT and subsequently an increase in conversion efficiency. - Completed research to increase the energy density and lower the self-discharge rate of energy storage systems by identifying the physicochemical properties of the electrode/electrolyte interface associated with capacitance. Focus was on novel carbons and lithium electrolytic salts (as opposed to tetraethylammonium tetrafluoroborate used in current capacitors) and non-aqueous, asymmetric hybrid supercapacitors. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as completed above. - Complete research on breaking wave loads utilizing the computational RANS codes. The research will investigate four general phases: creating consistent, repeatable breaking waves; creating these waves so that they break on the surface to analyze impact forces; validating those impact forces with existing and additional experimental data; and exploring the scaling effects of the impact forces. - Complete research on a virtual shaping concept for structures and platforms. - Complete research to develop the next generation prediction tools based on RANS such that arbitrary complex geometries including non-circular body can be handled and the reliance on empiricism can be minimized. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry. *FY 2011 Base Plans:* - Continue all efforts of FY 2010, less those noted as completed above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Naval Battlespace Awareness and Intelligent Naval Sensors, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and the National Naval Responsibility in Undersea Weaponry.					
OCEAN/SPACE SCIENCES Efforts include: Littoral Geosciences, Optics, and biology; Marine Mammals; Ocean Acoustics; and autonomous systems. *FY 2009 Accomplishments:* - Continued Naval Research Enterprise Intern Program (NREIP) to support undergraduate and graduate students performing Navy-related research at Naval Warfare Centers under the supervision and mentorship of DON Scientists, thus exposing them to interesting and challenging work done at the centers. NREIP is a continuing Navy education program. - Continued research into the development of a pentacene based neutron detector. This effort will seek to explore processing parameters for preparing thick pentacene-based films at purities suitable for neutron detection and develop a fundamental understanding of the electronic structure and interaction of pentacene with organo-boron-containing film components. - Continued research into the phenomenon of Core-Valence Luminescence (CVL) in scintillators that have the potential for radiation discrimination. CVL is the emission resulting from radiative transitions	4.591	4.591	4.790	0.000	4.790

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
between the valance and first core band under gamma excitation. This research will explore unique spectral properties which can be exploited to discriminate between different types of nuclear radiation. - Continued research into the relative performance of Probabilistic Multi-Hypothesis Tracker (PMHT) and Joint Probabilistic Data Association (JPDA) and methods for integrating the best aspects of both into a single multi-target tracking and data fusion algorithm. This research will seek to integrate an Interacting Multiple Model (IMM) algorithm into the PMHT algorithm, with a Multi-Dimensional Assignment (MDA). - Continued research and development into a new scaleable Computational Fluid Dynamics (CFD) tool to simulate the propulsion and maneuvering hydrodynamics of a biominetic Autonomous Underwater Vehicles (AUV) employing multiple flapping foils as the primary propulsor and control surfaces. This research effort investigates CFD as a tool for; evaluating biominetic AUV designs, and development of control strategies for optimizing the hydrodynamic performance of biomimetic designs while minimizing undesirable effects (such as unwanted vehicle motions) that can degrade sensor performance. - Completed the development of test algorithms for acoustic marine mammals (Beaked Whales). Density data was analyzed for spatial, seasonal and diurnal trends, and the relationships to oceanographic features. Detection and localization archive files from marine mammal monitoring on Navy ranges at the Atlantic Undersea Test and Evaluation Center, Bahamas were incorporated. The results of the algorithms were required to meet proposed mitigation measures for both at sea operations and long term monitoring of the Navy's undersea acoustic ranges. - Completed research to determine whether chaos based communications can be applied to typical range tracking scenarios. Chaos based spread-spectrum communications to underwater telemetry have been explored, simulated and demonstrated for low-Doppler littoral environments. - Initiated ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. FY 2009 projects have gone through a rigorous selection process at the naval warfare centers. Projects selected for FY 2009 focused on supporting Naval Battlespace Awareness, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility initiatives in Ocean Acoustics and Undersea Weaponry.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Acquisition Workforce Fund - Funded DoD Acquisition Workforce Fund. *FY 2010 Plans:* - Continue all efforts of FY 2009, less those noted as completed above. - Complete research into the development of a pentacene based neutron detector. - Complete research into the phenomenon of CVL in scintillators that have the potential for radiation discrimination. - Complete research into the relative performance of PMHT and JPDA and methods for integrating the best aspects of both into a single multi-target tracking and data fusion algorithm. - Complete research and development into a new scalable CFD tool to simulate the propulsion and maneuvering hydrodynamics of a biominetic AUV employing multiple flapping foils as the primary propulsor and control surfaces. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2010 will focus on supporting Naval Battlespace Awareness, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility initiatives in Ocean Acoustics and Undersea Weaponry. *FY 2011 Base Plans:* - Continue all efforts of FY 2010, less those noted as completed above. - Complete FY 2009 initiated ILIR projects during FY 2011. - Initiate ILIR projects that are intended to be approximately three years in length. Based on historical trends approximately 30% of ILIR projects will turn over each year. Projects selected for FY 2011 will focus on supporting Naval Battlespace Awareness, Innovative Naval Prototype initiatives in Persistent Surveillance and Sea Basing, and National Naval Responsibility initiatives in Ocean Acoustics and Undersea Weaponry.					

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B. Accomplishments/Planned Program ($ in Millions)

	FY 2009	FY 2010	FY 2011 Base	FY 2011 OCO	FY 2011 Total
Accomplishments/Planned Programs Subtotals	17.103	18.001	17.979	0.000	17.979

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

The ILIR initiative seeks to improve the quality of defense research conducted predominantly through the Naval Warfare Centers/Laboratories. It also supports the development of technical intellect and education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in a military laboratory environment. Initial research focus is often conducted in an unfettered environment since it is basic research, but many projects focus on applying recently developed theoretical knowledge to real world military problems with the intention of developing new capabilities and improving the performance of existing systems. Individual project metrics then become more tailored to the needs of specific applied research and advanced development programs. The National Research Council of the National Academies of Science and Engineering's Congressionally directed "Assessment of Department of Defense Basic Research" concluded that the DoD is managing its basic research program effectively.