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Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Navy **DATE:** February 2011

APPROPRIATION/BUDGET ACTIVITY				R-1 ITEM NOMENCLATURE							
1319: <i>Research, Development, Test & Evaluation, Navy</i> BA 2: <i>Applied Research</i>				PE 0602782N: <i>Mine & Exp Warfare Applied Res</i>							
COST (\$ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
Total Program Element	42.756	36.833	37.583	-	37.583	42.368	47.686	56.426	62.224	Continuing	Continuing
0000: <i>Mine & Exp Warfare Applied Res</i>	39.569	36.833	37.583	-	37.583	42.368	47.686	56.426	62.224	Continuing	Continuing
9999: <i>Congressional Adds</i>	3.187	-	-	-	-	-	-	-	-	0.000	3.187

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 (Feb 2009). 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 provides technologies for Naval Mine Countermeasures (MCM), Expeditionary Warfare, U.S. Naval sea mining, Naval Special Warfare (NSW), and Joint Tri-Service Explosive Ordnance Disposal (EOD). This program is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capability Objectives through the development of technologies to achieve military objectives with minimal casualties and collateral damage. Within the Naval Transformation Roadmap, this investment will achieve one of three "key transformational capabilities" required by "Sea Shield" as well as technically enable the Ship to Objective Maneuver (STOM) key transformational capability within "Sea Strike" by focusing on technologies that will provide the Naval Force with the capability to dominate the battlespace, project power from the sea, and support forces ashore with particular emphasis on rapid MCM operations. These efforts concentrate on the development and transition of technologies for the MCM-related and Urban Asymmetric/Expeditionary Warfare Operations (UAEO)-related Future Naval Capabilities (FNC) Enabling Capabilities (ECs). The Mine and Obstacle Detection/Neutralization efforts include technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting and neutralization/breaching. The Urban Asymmetric Operation effort includes critical warfighting functions such as Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), fires, maneuver, sustainment, etc. The Naval Special Warfare and Explosive Ordnance Disposal technology efforts concentrate on the development of technologies for safe near-shore mine detection, diver mobility and survivability, and ordnance disposal operations.

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 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	43.897	36.833	37.836	-	37.836
Current President's Budget	42.756	36.833	37.583	-	37.583
Total Adjustments	-1.141	-	-0.253	-	-0.253
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	-0.082	-			
• SBIR/STTR Transfer	-0.675	-			
• Program Adjustments	-	-	0.133	-	0.133
• Section 219 Reprogramming	-0.383	-	-	-	-
• Rate/Misc Adjustments	-	-	-0.386	-	-0.386
• Congressional General Reductions Adjustments	-0.001	-	-	-	-

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

Project: 9999: Congressional Adds

Congressional Add: *Electromagnetic Signatures Assessment System*

Congressional Add: *Virtual Onboard Analyst for Multi-Sensor Mine Detection*

Congressional Add Subtotals for Project: 9999

Congressional Add Totals for all Projects

	FY 2010	FY 2011
	1.992	-
	1.195	-
Congressional Add Subtotals for Project: 9999	3.187	-
Congressional Add Totals for all Projects	3.187	-

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

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Exhibit R-2A, RDT&E Project Justification: PB 2012 Navy **DATE:** February 2011

APPROPRIATION/BUDGET ACTIVITY			R-1 ITEM NOMENCLATURE					PROJECT			
1319: <i>Research, Development, Test & Evaluation, Navy</i> BA 2: <i>Applied Research</i>			PE 0602782N: <i>Mine & Exp Warfare Applied Res</i>					0000: <i>Mine & Exp Warfare Applied Res</i>			
COST (\$ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
0000: <i>Mine & Exp Warfare Applied Res</i>	39.569	36.833	37.583	-	37.583	42.368	47.686	56.426	62.224	Continuing	Continuing

Note

Special Warfare/EOD R2 Activity includes the funding increase for the Joint Service Explosive Ordnance Disposal (JSEOD) effort.

A. Mission Description and Budget Item Justification

This project focuses on reducing the time involved in conducting MCM operations and increasing safe standoff from minefields. It develops and transitions technologies for MCM-related and UAEO-related FNC ECs. The MCM effort includes technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting, neutralization/breaching and clearance. The Littoral Warfare effort includes critical warfighting functions such as C4ISR, fires, maneuver, sustainment, etc. The sea mining effort emphasizes technologies for future sea mines. The Naval Special Warfare and Explosive Ordnance technology efforts concentrate on the development of technologies to enhance diver capabilities including: safe near-shore mine sensing, mobility and survivability, and ordnance disposal operations.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2010	FY 2011	FY 2012
<p>Title: MINE TECHNOLOGY</p> <p>Description: This activity assesses advanced sea mine technologies to maintain expertise in this Naval Warfare area. An acoustic sensing capability for the naval mine Target Detection Device (TDD) is being addressed. Future mine and minefield concepts are being addressed.</p> <p>FY 2010 Accomplishments:</p> <ul style="list-style-type: none"> - Continued assessment of sea mine technologies in order to maintain a level of expertise in naval mines. - Continued evaluation of an acoustic sensing capability for the naval mine Target Detection Device (TDD). - Initiated development of concepts for semi-autonomous and remote controlled mines and minefields. <p>FY 2011 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2010. - Complete evaluation of an acoustic sensing capability for the naval mine Target Detection Device (TDD). - Initiate development of target discrimination technology for Target Detection Device (TDD). <p>FY 2012 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2011, less those noted as completed above. 	0.275	0.330	0.474
Title: MINE/OBSTACLE DETECTION	28.018	25.684	23.598

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2010	FY 2011	FY 2012
<p>Description: This activity focuses on applied research to enable longer detection ranges and precise mine location with fewer false alarms in a variety of challenging environments. It supports Discovery and Invention (D&I) and MCM-related FNC ECs. Efforts in Synthetic Aperture Sonar (SAS) technologies for longer range detection and classification of mine-like targets and magnetic gradiometer sensing and electro-optic (EO) technology for buried mine identification, and sensor integration onto Autonomous Underwater Vehicles (AUVs) are being addressed. EO sensor research develops algorithms to enable image processing for rapid overt reconnaissance from an Unmanned Aerial Vehicle (UAV). Other processing, classification and data fusion techniques to reduce operator workload, and a mine burial prediction "expert system" are also being developed. Efforts also support development of MCM Mission Modules for Littoral Combat Ships (LCS).</p> <p>FY 2010 to FY 2011 funding decrease is due to the completion and transition of major Future Naval Capability (FNC) - MCM Data Fusion Techniques Using Multiple Unmanned Sensors and Systems; MCM Systems for Littoral Combat Ship, Advanced Flight, Mission Modules; Undersea Cooperative Cueing and Intervention for MCM operations and D&I programs.</p> <p>FY 2010 Accomplishments:</p> <ul style="list-style-type: none"> - Continued at-sea testing of prototype Low Frequency Broadband (LFBB) acoustic scattering sonar focusing on multi-aspect mine classification/identification and characterization of clutter in various environments. - Continued development of automatic mine detection and classification algorithms for integrated forward-looking iPUMA sonar and side-looking sonars. - Continued development of multi-platform fusion of data from high-resolution mine hunting systems (e.g. AN/AQS-20) and submarine-launched Mine Warfare (MIW) Unmanned Underwater Vehicles (UUVs) via registration with those from the Mine Warfare Environmental Data Library (MEDAL) for improved mine detection and avoidance. - Continued development of UUV-based extended range electro-optic identification sensors and supporting meteorology and oceanography and planning systems. - Continued large area search and survey based upon multiple, cooperating UUVs. - Continued demonstration of flapping fin propulsion on an inexpensive, stealthy undersea vehicle to enable new mine warfare mission capabilities. - Continued development of an ultrafast silicon carbide (SiC) avalanche transistor and a SiC drift step recovery diode. - Continued development of Multiple Input Multiple Output (MIMO) UUV communications by determining channel capacity and extending use to moving platforms. - Continued integration of iPUMA and SAS systems in a single vehicle to obtain 100% area coverage. - Continued to investigate and develop signal processing algorithms in areas of research such as 			

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2010	FY 2011
<p>environmentally adaptive channel estimation/equalization, multi-carrier modulation techniques, and spatial diversity exploitation to enable reliable, high-rate communication between fixed and/or mobile nodes in an ad hoc underwater acoustic communication network.</p> <ul style="list-style-type: none"> - Continued development of a Mine/Obstacle Detection and Avoidance capability for Autonomous Underwater Vehicles (AUVs) equipped with the iPUMA sonar system. - Continued development of a small ultrasound acoustic underwater camera for UUV-based classification and identification of underwater mines. - Continued development of drifting mine detection concepts. - Continued development of heat engine for unmanned underwater vehicles powered by thermal gradients in the water column. - Continued modeling of data fusion and mine contact handling. - Continued research to demonstrate new structural-acoustic-based mine identification algorithms that do not require extensive training data to work in new underwater environments. - Continued research to extend electro-optical imaging resolution in underwater environments by using short exposure techniques. - Completed technology development for a Tactical UAV (TUAV) buried minefield detection sensor. - Completed development of advanced 3-D Light Detection and Ranging (LIDAR) mine detection algorithms to support post mission analysis. - Completed development of the Performance Analysis and Training Tool (PATT) to assess the performance characteristics of high frequency imaging sonars and the associated sonar processing concepts. - Completed investigation of Finite Element Modeling (FEM) for estimating the performance of the Low Frequency Broadband (LFBB) Buried Mine Identification System over a wide range of tactically important environments. - Completed technology development for MCM Mission Module systems for Advanced Flight LCS. - Initiated development of iPUMA/Synthetic Aperture Sonar system to provide the first non marine mammal based mine detection and classification capability for confined or highly obstructed areas. - Initiated development of Small Acoustic Color/Imaging Sonar system to provide the first non marine mammal detection, classification and identification capability for very shallow water (VSW) and reduce the false-alarm rate by x20 for all VSW mine threats. - Initiated development of Long Range Low Frequency Broadband (LRLFBB) Sonar to significantly increase the minehunting area coverage rate. - Initiated development of a high source level, single crystal based projector that can extend the maximum detection range of the Low Frequency Broadband (LFBB) Mine Identification System. - Initiated Phase 2 of Advanced Mission Module Technology Development. 			

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B. Accomplishments/Planned Programs (\$ in Millions)				FY 2010
<ul style="list-style-type: none"> - Initiated performance evaluation of physical layer signal processing algorithms and signaling schemes developed for underwater acoustic communication networks. - Initiated implementation of candidate physical layer algorithms and signaling schemes into acoustic modems targeted for UUV platforms. - Initiated investigation into cross-layer and/or network layer design strategies for ad hoc underwater acoustic communication networks comprised of fixed and/or mobile nodes. - Initiated development of technologies for detection of mines and obstacles in riverine environments. - Initiated development of mine burial prediction models which include migrating sandwaves. - Initiated development of prediction models for surf zone optical properties. - Initiated effort to quantify and validate improvements in probability of detection and the reduction of false alarms that can be achieved through multi-static acoustic sensing and processing for cooperating, unmanned vehicles. - Initiated development of new waveforms and algorithms for improved automatic discrimination of mines from non-traditional clutter. <p>FY 2011 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2010, less those noted as completed above. - Continue development of automatic mine detection and classification algorithms for integrated forward-looking iPUMA sonar and side-looking sonars. - Continue research to extend electro-optical imaging resolution in underwater environments by using short exposure techniques. - Complete large area search and survey based upon multiple, cooperating UUVs and USVs. - Complete Phase 2 of Advanced Mission Module Technology Development with a final demonstration. - Complete development of multi-platform fusion of data from high-resolution mine hunting systems (e.g. AN/AQS-20) and submarine-launched Mine Warfare (MIW) UUVs via registration with those from the Mine Warfare Environmental Data Library (MEDAL) for improved mine detection and avoidance. - Complete performance evaluation of physical layer signal processing algorithms and signaling schemes developed for underwater acoustic communication networks. - Complete development of Multiple Input Multiple Output (MIMO) UUV communications by determining channel capacity and extending use to moving platforms. - Complete demonstration of flapping fin propulsion on an inexpensive, stealthy undersea vehicle to enable new mine warfare mission capabilities. - Complete development of an ultrafast silicon carbide (SiC) avalanche transistor and a SiC drift step recovery diode. - Complete at sea prototype Low Frequency Broadband (LFBB) acoustic scattering sonar focusing on multi-aspect mine classification/identification and characterization of clutter in various environments. 				
				FY 2011
				FY 2012

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2010	FY 2011	FY 2012
<ul style="list-style-type: none"> - Initiate development of system concepts for wide area detection of surface and submerged drifting mines. <p>FY 2012 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2011, less those noted as completed above. - Complete implementation of candidate physical layer algorithms and signaling schemes into acoustic modems targeted for UUV platforms. - Complete investigation into cross-layer and/or network layer design strategies for ad hoc underwater acoustic communication networks comprised of fixed and/or mobile nodes. - Initiate development of advanced overhead tactical sensing concepts. - Initiate applied research in MCM-specific autonomous behaviors, distributed autonomy, modernization of MCM search theory, autonomy/warfighter interface, and enablers of scalable autonomy. - Initiate development of the compact Modular Sensor Suite for real time detection and classification of surface and near surface moored and drifting mines. - Initiate development of Mine Drift Prediction Tactical Decision Aid. 				
<p>Title: MINE/OBSTACLE NEUTRALIZATION</p> <p>Description: Activity includes applied research to support selected MCM related FNC ECs for rapid mine and obstacle neutralization and sea mine jamming techniques to increase surface ship safe standoff from threat mines. It includes various lethality, vulnerability and dispensing computational tools, models and assessments to support the various far-term Surf Zone (SZ) and Beach Zone (BZ) mine and obstacle breaching concepts.</p> <p>The FY 2010 to FY 2011 funding decrease is due to the completion of Future Naval Capability (FNC) - AUV Technology for Neutralization of Littoral Mines.</p> <p>FY 2010 Accomplishments:</p> <ul style="list-style-type: none"> - Continued development of AUV technologies for neutralization of littoral sea mines. - Completed acoustic organic mine jamming investigations as a follow-on to FNC work in electromagnetic organic mine jamming. - Completed development of precision navigation capability for targeting, safe navigation through assault lanes including lane marking. - Completed development of prototype mission planner for Joint Direct Attack Munition (JDAM) Assault Breaching System (JABS) in the VSW. - Completed review of data collected during Amphibious Assault Vehicle (AAV) testing with augmented reality. - Completed review of GPS augmentation data collected during end-to-end tests with AAV and airborne platform with mine detection sensor. 		1.200	0.801	0.853

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2010	FY 2011	FY 2012
<ul style="list-style-type: none"> - Completed technology development for autonomous neutralization of sea mines in VSW areas. - Initiated development of concepts for sweeping and/or jamming of advanced mine threats. - Initiated a project to study feasibility of mine jamming from autonomous undersea vehicles. - Initiated development of autonomous behaviors to improve neutralization efficiency of littoral sea mines. - Initiated development of system concepts for autonomous neutralization of surface and submerged drifting mines. <p>FY 2011 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2010, less those noted as completed above. - Complete development of AUV technologies for neutralization of littoral sea mines. - Complete development of autonomous behaviors to improve neutralization efficiency of littoral sea mines. - Initiate demonstration of autonomous neutralization of littoral sea mines. - Initiate a project to study system concepts for autonomous neutralization of surface and submerged drifting mines. <p>FY 2012 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2011, less those noted as completed above. - Complete demonstration of autonomous neutralization of littoral sea mines. - Complete a project to develop mine jamming capability as a spiral capability addition to a LCS mine warfare mission package. - Complete a project to study feasibility of jamming threat mines that were deferred/ not studied in previous D&I efforts. - Complete a project to study feasibility of mine jamming from autonomous undersea vehicles. - Initiate concept development for neutralization of war surface drifting mines. 				
<p>Title: SPECIAL WARFARE/EOD</p> <p>Description: The goal of this effort is to develop technologies to extend stand-off of special operations and EOD forces in clandestine hydrography, mine clearance and port security missions while increasing the range and effectiveness of divers. Advanced technologies are needed to gain access to areas contaminated by area-denial sensors and/or booby traps. Developed technologies will transition to the Joint Service EOD Program, the Naval EOD Program, or the DOD Technical Response Group. This activity includes applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems to increase detection range and accuracy in harsh environments. Other efforts include mission support technology improvements for AUVs and human divers - such as communications, navigation and life support.</p> <p>The FY 2011 to FY 2012 funding increase is due to the Joint Service Explosive Ordnance Disposal (JSEOD) effort.</p> <p>FY 2010 Accomplishments:</p> <ul style="list-style-type: none"> - Continued development of AUV technologies for autonomous inspection of ship hulls. 		10.076	10.018	12.658

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2010	FY 2011	FY 2012
<ul style="list-style-type: none"> - Continued development of low collateral damage neutralization device. - Continued development of technologies for the detection and disruption of passive and active Infra-red (IR) sensors. - Completed design of an underwater riverine autonomous surveillance system that uses multiple small sensor nodes to provide persistent surveillance. - Completed development of low probability of intercept/low probability of detection (LPI/LPD) underwater communications. - Completed development of metal-hydride based thermal control technology for combat divers. - Completed development of tactile-feedback robotic manipulators. - Completed development of technologies for portable hand-held detection of concealed Improvised Explosive Devices (IEDs). - Completed development of technology to detect, monitor, and disrupt operation of Explosive Safe and Arming (ESA) devices. - Initiated development of maritime Tagging, Tracking, and Locating (TTL) technologies. - Initiated development of technologies for contaminated water diving. - Initiated development of technologies for enhanced navigation and Intelligence, Surveillance and Reconnaissance (ISR) in riverine environments. - Initiated development of technologies to detect and locate IEDs. <p>FY 2011 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2010, less those noted as completed above. - Complete development of low collateral damage neutralization device. - Complete development of technologies for the detection and disruption of passive and active IR sensors. - Initiate development of technologies to access IEDs. <p>FY 2012 Plans:</p> <ul style="list-style-type: none"> - Continue all efforts of FY 2011, less those noted as completed above. - Initiate development of technologies to diagnose and identify underwater munitions. - Initiate development of technologies to identify and diagnose components and characteristics of Improvised Explosive Devices. - Initiate development of technologies to detect and locate buried munitions. - Initiate effort to support Joint Service Explosive Ordnance Disposal (JSEOD) applied research. 			
Accomplishments/Planned Programs Subtotals	39.569	36.833	37.583

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C. Other Program Funding Summary (\$ in Millions)

<u>Line Item</u>	<u>FY 2010</u>	<u>FY 2011</u>	<u>FY 2012</u>			<u>FY 2013</u>	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016</u>	<u>Cost To</u>	
			<u>Base</u>	<u>OCO</u>	<u>Total</u>					<u>Complete</u>	<u>Total Cost</u>
• 0603782N: <i>MINE AND EXPEDITIONARY WARFARE ADVANCED TECHNOLOGY</i>	34.315	21.591	21.941	0.000	21.941	4.373	4.483	2.810	0.000	0.000	89.513

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

The overall metrics of this applied research program are the development of technologies which focus on the Expeditionary Warfare challenge of speeding the tactical timeline and increasing safe standoff from minefields. Individual project metrics include the transition of 6.2 technology solutions into 6.3 advanced technology programs.

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COST (\$ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
9999: <i>Congressional Adds</i>	3.187	-	-	-	-	-	-	-	-	0.000	3.187

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2010	FY 2011
<i>Congressional Add:</i> Electromagnetic Signatures Assessment System	1.992	-
<i>FY 2010 Accomplishments:</i> This effort supported phase III applied research for creation of an electromagnetic signatures assessment system using multiple autonomous undersea vehicles.		
<i>Congressional Add:</i> Virtual Onboard Analyst for Multi-Sensor Mine Detection	1.195	-
<i>FY 2010 Accomplishments:</i> This effort conducted laboratory and field testing of a multi-sensor mine detection system and analyzed the data collected.		
Congressional Adds Subtotals	3.187	-

C. Other Program Funding Summary (\$ in Millions)

N/A

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Interest Items not included in other Projects.