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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2013 Navy **DATE:** February 2012

<b>APPROPRIATION/BUDGET ACTIVITY</b> 1319: <i>Research, Development, Test &amp; Evaluation, Navy</i> BA 2: <i>Applied Research</i>				<b>R-1 ITEM NOMENCLATURE</b> PE 0602782N: <i>Mine &amp; Exp Warfare Applied Res</i>							
<b>COST (\$ in Millions)</b>	<b>FY 2011</b>	<b>FY 2012</b>	<b>FY 2013 Base</b>	<b>FY 2013 OCO</b>	<b>FY 2013 Total</b>	<b>FY 2014</b>	<b>FY 2015</b>	<b>FY 2016</b>	<b>FY 2017</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
Total Program Element	34.925	37.583	32.394	-	32.394	32.547	33.358	34.126	34.792	Continuing	Continuing
0000: <i>Mine &amp; Exp Warfare Applied Res</i>	34.925	37.583	32.394	-	32.394	32.547	33.358	34.126	34.792	Continuing	Continuing

**Note**

FY 2013 funding associated with Future Naval Capability (FNC) efforts are transferring to a new Program Element titled Future Naval Capabilities Applied Research (PE 0602750N). This is to enhance the visibility of the FNC Program by providing an easily navigable overview of all 6.2 FNC investments in a single location.

**A. Mission Description and Budget Item Justification**

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

This PE 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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1319: Research, Development, Test & Evaluation, Navy		PE 0602782N: Mine & Exp Warfare Applied Res			
BA 2: Applied Research					
B. Program Change Summary (\$ in Millions)	FY 2011	FY 2012	FY 2013 Base	FY 2013 OCO	FY 2013 Total
Previous President's Budget	36.833	37.583	42.368	-	42.368
Current President's Budget	34.925	37.583	32.394	-	32.394
Total Adjustments	-1.908	-	-9.974	-	-9.974
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.830	-			
• SBIR/STTR Transfer	-0.891	-			
• Program Adjustments	-	-	-10.303	-	-10.303
• Rate/Misc Adjustments	-	-	0.329	-	0.329
• Congressional General Reductions Adjustments	-0.187	-	-	-	-
Change Summary Explanation					
Technical: Not applicable.					
Schedule: Not applicable.					

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2013 Navy								<b>DATE:</b> February 2012			
<b>APPROPRIATION/BUDGET ACTIVITY</b> 1319: <i>Research, Development, Test &amp; Evaluation, Navy</i> BA 2: <i>Applied Research</i>				<b>R-1 ITEM NOMENCLATURE</b> PE 0602782N: <i>Mine &amp; Exp Warfare Applied Res</i>				<b>PROJECT</b> 0000: <i>Mine &amp; Exp Warfare Applied Res</i>			
<b>COST (\$ in Millions)</b>	<b>FY 2011</b>	<b>FY 2012</b>	<b>FY 2013 Base</b>	<b>FY 2013 OCO</b>	<b>FY 2013 Total</b>	<b>FY 2014</b>	<b>FY 2015</b>	<b>FY 2016</b>	<b>FY 2017</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
0000: <i>Mine &amp; Exp Warfare Applied Res</i>	34.925	37.583	32.394	-	32.394	32.547	33.358	34.126	34.792	Continuing	Continuing
<b>Note</b> Special Warfare/EOD R2 Activity includes the funding increase for the Joint Service Explosive Ordnance Disposal (JSEOD) effort.											
<b>A. Mission Description and Budget Item Justification</b> 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>B. Accomplishments/Planned Programs (\$ in Millions)</b>								<b>FY 2011</b>	<b>FY 2012</b>	<b>FY 2013</b>	
<b>Title:</b> MINE TECHNOLOGY								0.315	0.474	0.675	
<b>Description:</b> 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.											
FY 2011 to FY 2012 funding increase is due to added effort associated with Target Detection Devices.											
FY 2012 to FY 2013 funding increase responds to priority naval requirements for new and innovative offensive mining concepts. New investments will address clandestine delivery of mobile mines via unmanned underwater vehicles, remote command and control of autonomous minefields, and distributed sensor technologies to enable fire control solutions for mobile mines.											
<b>FY 2011 Accomplishments:</b> - Continued assessment of sea mine technologies in order to maintain a level of expertise in naval mines. - Continued development of concepts for semi-autonomous and remote controlled mines and minefields. - Completed evaluation of an acoustic sensing capability for the naval mine Target Detection Device (TDD). - Initiated development of target discrimination technology for Target Detection Device (TDD).											
<b>FY 2012 Plans:</b>											

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APPROPRIATION/BUDGET ACTIVITY 1319: Research, Development, Test & Evaluation, Navy BA 2: Applied Research	R-1 ITEM NOMENCLATURE PE 0602782N: Mine & Exp Warfare Applied Res	PROJECT 0000: Mine & Exp Warfare Applied Res		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2011	FY 2012	FY 2013
- Continue all efforts of FY 2011, less those noted as completed above.				
FY 2013 Plans: - Continue all efforts of FY 2012.				
Title: MINE/OBSTACLE DETECTION  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).  FY 2012 to FY 2013 funding decrease is due to realignment of Future Naval Capabilities (FNCs) SHD-FY10-03 Integrated Forward looking Sonar - Dual Frequency Synthetic Aperture Sonar (FLS-DFSAS), SHD-FY10-03 Long Range LFBB Sonar (AUV Platform Option), SHD-FY10-03 VSW Acoustic Color-Imaging Sonar, SHD-FY12-04 Compact Modular Sensor-Processing Suite (CMSS), and SHD-FY12-04 Mine Drift Prediction Tactical Decision Aid (TDA) to R2 Activity SEA SHIELD in PE 0602750N.  FY 2011 Accomplishments: - Continued development of automatic mine detection and classification algorithms for integrated forward-looking iPUMA sonar and side-looking sonars. - Continued development of UUV-based extended range electro-optic identification sensors and supporting meteorology and oceanography and planning systems. - 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 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. - 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.		24.300	23.598	18.680

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2011</b>	<b>FY 2012</b>
<ul style="list-style-type: none"> <li>- Continued modeling of data fusion and mine contact handling.</li> <li>- Continued research to demonstrate new structural-acoustic-based mine identification algorithms that do not require extensive training data to work in new underwater environments.</li> <li>- Continued research to extend electro-optical imaging resolution in underwater environments by using short exposure techniques.</li> <li>- Continued 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.</li> <li>- Continued 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.</li> <li>- Continued development of Long Range Low Frequency Broadband (LRLFBB) Sonar to significantly increase the minehunting area coverage rate.</li> <li>- Continued 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.</li> <li>- Continued Phase 2 of Advanced Mission Module Technology Development.</li> <li>- Continued performance evaluation of physical layer signal processing algorithms and signaling schemes developed for underwater acoustic communication networks.</li> <li>- Continued implementation of candidate physical layer algorithms and signaling schemes into acoustic modems targeted for UUV platforms.</li> <li>- Continued investigation into cross-layer and/or network layer design strategies for ad hoc underwater acoustic communication networks comprised of fixed and/or mobile nodes.</li> <li>- Continued development of technologies for detection of mines and obstacles in riverine environments.</li> <li>- Continued development of mine burial prediction models which include migrating sandwaves.</li> <li>- Continued development of prediction models for surf zone optical properties.</li> <li>- Continued 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.</li> <li>- Continued development of new waveforms and algorithms for improved automatic discrimination of mines from non-traditional clutter.</li> <li>- Completed large area search and survey based upon multiple, cooperating UUVs and USVs.</li> <li>- Completed Phase 2 of Advanced Mission Module Technology Development with a final demonstration.</li> <li>- Completed 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.</li> <li>- Completed performance evaluation of physical layer signal processing algorithms and signaling schemes developed for underwater acoustic communication networks.</li> </ul>			
		<b>FY 2013</b>	

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2011</b>	<b>FY 2012</b>
<ul style="list-style-type: none"> <li>- Completed development of Multiple Input Multiple Output (MIMO) UUV communications by determining channel capacity and extending use to moving platforms.</li> <li>- Completed demonstration of flapping fin propulsion on an inexpensive, stealthy undersea vehicle to enable new mine warfare mission capabilities.</li> <li>- Completed development of an ultrafast silicon carbide (SiC) avalanche transistor and a SiC drift step recovery diode.</li> <li>- Completed at sea prototype Low Frequency Broadband (LFBB) acoustic scattering sonar focusing on multi-aspect mine classification/identification and characterization of clutter in various environments.</li> <li>- Initiated development of system concepts for wide area detection of surface and submerged drifting mines.</li> <li>- Initiated effort to demonstrate proof-of-concept for a new standoff technology for helicopters that can detect buried mines in the surf-zone and onto the beach.</li> </ul> <p><b>FY 2012 Plans:</b></p> <ul style="list-style-type: none"> <li>- Continue all efforts of FY 2011, less those noted as completed above.</li> <li>- Complete implementation of candidate physical layer algorithms and signaling schemes into acoustic modems targeted for UUV platforms.</li> <li>- 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.</li> <li>- Initiate development of advanced overhead tactical sensing concepts.</li> <li>- Initiate applied research in MCM-specific autonomous behaviors, distributed autonomy, modernization of MCM search theory, autonomy/warfighter interface, and enablers of scalable autonomy.</li> <li>- Initiate development of the compact Modular Sensor Suite for real time detection and classification of surface and near surface moored and drifting mines.</li> <li>- Initiate development of Mine Drift Prediction Tactical Decision Aid.</li> </ul> <p><b>FY 2013 Plans:</b></p> <ul style="list-style-type: none"> <li>- Continue all efforts of FY 2012, less those noted as completed above.</li> <li>- Complete investigation and development of signal processing algorithms in areas of research such as environmentally adaptive channel estimation/equalization, multi-carrier modulations 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.</li> <li>- Complete development of new waveforms and algorithms for improved automatic discrimination of mines from non-traditional clutter.</li> <li>- Initiate investigation into associated phenomenology and development of sensing technologies for mine and obstacle detection, classification and localization.</li> </ul>			
<b>Title:</b> MINE/OBSTACLE NEUTRALIZATION		0.763	0.853
			0.825

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2011</b>	<b>FY 2012</b>
<p><b>Description:</b> 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>FY 2011 to FY 2012 funding increase is due to added emphasis on surface drifting mines.</p> <p><b>FY 2011 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>- Continued development of concepts for sweeping and/or jamming of advanced mine threats.</li> <li>- Continued a project to study feasibility of mine jamming from autonomous undersea vehicles.</li> <li>- Continued development of system concepts for autonomous neutralization of surface and submerged drifting mines.</li> <li>- Completed development of AUV technologies for neutralization of littoral sea mines.</li> <li>- Completed development of autonomous behaviors to improve neutralization efficiency of littoral sea mines.</li> <li>- Initiated demonstration of autonomous neutralization of littoral sea mines.</li> </ul> <p><b>FY 2012 Plans:</b></p> <ul style="list-style-type: none"> <li>- Continue all efforts of FY 2011, less those noted as completed above.</li> <li>- Complete demonstration of autonomous neutralization of littoral sea mines.</li> <li>- Complete a project to develop mine jamming capability as a spiral capability addition to a LCS mine warfare mission package.</li> <li>- Complete a project to study feasibility of jamming threat mines that were deferred/ not studied in previous D&amp;I efforts.</li> <li>- Complete a project to study feasibility of mine jamming from autonomous undersea vehicles.</li> <li>- Initiate concept development for neutralization of war surface drifting mines.</li> </ul> <p><b>FY 2013 Plans:</b></p> <ul style="list-style-type: none"> <li>- Continue all efforts of FY 2011, less those noted as completed above.</li> <li>- Complete development of concepts for sweeping and/or jamming of advanced mine threats.</li> <li>- Complete concept development for neutralization of wear surface drifting mines.</li> </ul>			
<b>Title:</b> SPECIAL WARFARE/EOD		9.547	12.658
<p><b>Description:</b> 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</p>			12.214

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2011</b>	<b>FY 2012</b>	<b>FY 2013</b>
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.  The FY 2011 to FY 2012 funding increase is due to the Joint Service Explosive Ordnance Disposal (JSEOD) effort.  <b>FY 2011 Accomplishments:</b> <ul style="list-style-type: none"> <li>- Continued development of AUV technologies for autonomous inspection of ship hulls.</li> <li>- Continued development of maritime Tagging, Tracking, and Locating (TTL) technologies.</li> <li>- Continued development of technologies for contaminated water diving.</li> <li>- Continued development of technologies for enhanced navigation and Intelligence, Surveillance and Reconnaissance (ISR) in riverine environments.</li> <li>- Continued development of technologies to detect and locate IEDs.</li> <li>- Completed development of low collateral damage neutralization device.</li> <li>- Completed development of technologies for the detection and disruption of passive and active Infra Red (IR) sensors.</li> <li>- Initiated development of technologies to access IEDs.</li> <li>- Initiated effort to demonstrate the operation of a short-range underwater sensor network operating in a riverine environment for several months.</li> </ul> <b>FY 2012 Plans:</b> <ul style="list-style-type: none"> <li>- Continue all efforts of FY 2011, less those noted as completed above.</li> <li>- Initiate development of technologies to diagnose and identify underwater munitions.</li> <li>- Initiate development of technologies to identify and diagnose components and characteristics of Improvised Explosive Devices.</li> <li>- Initiate development of technologies to detect and locate buried munitions.</li> <li>- Initiate effort to support Joint Service Explosive Ordnance Disposal (JSEOD) applied research.</li> </ul> <b>FY 2013 Plans:</b> <ul style="list-style-type: none"> <li>- Continue all efforts of FY 2012, less those noted as completed above.</li> <li>- Complete development of maritime Tagging, Tracking, and Locating (TTL) technologies.</li> <li>- Complete effort to demonstrate the operation of a short-range underwater sensor network operating in a riverine environment for several months.</li> </ul>				
<b>Accomplishments/Planned Programs Subtotals</b>		34.925	37.583	32.394
<b>C. Other Program Funding Summary (\$ in Millions)</b>				
N/A				



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<b><u>D. Acquisition Strategy</u></b> Not applicable.		
<b><u>E. Performance Metrics</u></b> 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.		