Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy											**Date:** March 2019	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*					**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*							

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	0.000	14.826	39.672	13.335	-	13.335	1.948	1.987	2.027	2.068	Continuing	Continuing
2917: *Shallow Water MCM Demos*	0.000	14.826	13.172	13.335	-	13.335	1.948	1.987	2.027	2.068	Continuing	Continuing
9999: *Congressional Adds*	0.000	0.000	26.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	26.500

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 and investment directions as defined by Department of Defense (DoD) Directive 5160.62 "Single Manager Responsibility for Military Explosive Ordnance Disposal Technology and Training (EODT&T)" and approved by the DoD Explosive Ordnance Disposal (EOD) Program Board (Sep 2012). This strategy is based on needs and capabilities from Navy and Marine Corps guidance, 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). The strategy is also based on the unique needs and capabilities identified by the Joint Requirements Oversight Council (JROC) and the DoD EOD Program Board. It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval and Joint EOD forces in the 21st century. The strategy focuses and aligns Naval S&T with Naval missions, DoD EOD S&T with Joint EOD missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE primarily develops and demonstrates prototype Mine Countermeasures (MCM), Expeditionary Warfare and Joint EOD system components that support capabilities enabling Naval and Joint EOD Forces to influence operations ashore. Adversarial nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littorals. They also have the capability to develop or modify explosive devices such as mines and unexploded ordnance to construct Improvised Explosive Devices (IEDs) for the purpose of targeting Joint Forces. Real world operations have demonstrated the requirement to quickly counter the mine threat. Current operations have also demonstrated the requirement to quickly counter the threat from explosive hazards and IEDs during DoD operations. Advanced technologies must rapidly detect and neutralize all mine types, from deep water to the inland objective. Advanced technologies must enable Joint EOD forces to detect/locate, gain access, diagnose, render safe, neutralize, recover, exploit and dispose of a broad spectrum of explosive hazards including unexploded ordnance and IEDs. This program supports the advanced development and integration of sensors, processing, warheads, and delivery vehicles to demonstrate improved Naval Warfare capabilities. It supports the advanced development and integration of sensors and tools for standoff capabilities such as detection and location of IEDs (particularly in dismounted operations), dismounted diagnosis of buried munitions and other explosive hazards, precision render safe and neutralization of surface munitions and other explosive hazards, and enhanced access to IEDs. It supports the MCM-related FNC Enabling Capabilities (ECs). 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.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy			Date: March 2019		
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 3: *Advanced Technology Development (ATD)*			**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*		

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	15.164	0.000	0.000	-	0.000
Current President's Budget	14.826	39.672	13.335	-	13.335
Total Adjustments	-0.338	39.672	13.335	-	13.335
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	39.672			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.339	0.000			
• Program Adjustments	0.000	0.000	13.335	-	13.335
• Rate/Misc Adjustments	0.001	0.000	0.000	-	0.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: 9999: *Congressional Adds*		
Congressional Add: *Sensor for Maritime Capabilities Demonstration*	0.000	23.500
Congressional Add: *Additive Manufacturing*	0.000	3.000
Congressional Add Subtotals for Project: 9999	0.000	26.500
Congressional Add Totals for all Projects	0.000	26.500

Change Summary Explanation
Program change reflects original PE structure being retained

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy										Date: March 2019	

Appropriation/Budget Activity 1319 I 3	R-1 Program Element (Number/Name) PE 0603782N I Mine and Expeditionary Warfare Advanced Technology	Project (Number/Name) 2917 I Shallow Water MCM Demos

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
2917: Shallow Water MCM Demos	0.000	14.826	13.172	13.335	-	13.335	1.948	1.987	2.027	2.068	Continuing	Continuing

A. Mission Description and Budget Item Justification

This Program Element (PE) develops and demonstrates prototype technology for Mine Countermeasures (MCM), US Naval sea mining, and Expeditionary Warfare and Joint EOD system components that support capabilities enabling Naval and Joint EOD Forces to influence operations ashore. Adversarial nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littorals. They also have the capability to develop or modify explosive devices such as mines and unexploded ordnance to construct Improvised Explosive Devices (IEDs) for the purpose of targeting Joint Forces. Real world operations have demonstrated the requirement to quickly counter the mine threat. Current operations have also demonstrated the requirement to quickly counter the threat from explosive hazards and IEDs during DoD operations. Advanced technologies must rapidly detect and neutralize all mine types, from deep water to the inland objective. Advanced technologies must enable Joint EOD forces to detect/locate, gain access, diagnose, render safe, neutralize, recover, exploit and dispose of a broad spectrum of explosive hazards including unexploded ordnance and IEDs. This program supports the advanced development and integration of sensors, processing, warheads, and delivery vehicles to demonstrate improved Naval Warfare capabilities.

This PE supports the advanced development and integration of sensors and tools for standoff capabilities such as detection and location of IEDs (particularly in dismounted operations), dismounted diagnosis of buried munitions and other explosive hazards, precision render safe and neutralization of surface munitions and other explosive hazards, and enhanced access to IEDs. It supports advanced development for battlespace shaping weapons including advanced undersea weapons. It supports the MCM related FNC Enabling Capabilities (ECs). 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.

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

B. Accomplishments/Planned Programs ($ in Millions)

	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Joint EOD Demos	1.819	1.984	1.946	0.000	1.946

Description: This activity focuses on developing and demonstrating technologies to support a standoff or remote capability for detection and location, diagnosis, render safe, neutralization and enhanced access. Efforts include: electromagnetic, electro-optical, and acoustic sensors and systems for detection of explosive threat components including explosives, device housings/containers, and triggering mechanisms, standoff identification and confirmation of trace explosives, fusion of multi-sensor input for high confidence detection and diagnosis of buried threats, highly dexterous manipulators and imitative controllers for lightweight, efficient (strength/weight ratio) dual manipulator systems integrated onto EOD robots for enhanced access, enhanced robotic autonomy to support EOD missions, data compression and visualization techniques to support precise render

Exhibit R-2A, **RDT&E Project Justification:** PB 2020 Navy		**Date:** March 2019	
Appropriation/Budget Activity 1319 *I* 3	**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 2917 *I Shallow Water MCM Demos*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**
safe and neutralization, and neutralization devices containing reactive materials to neutralize devices with low collateral damage. This S&T investment supports the Joint Requirements Oversight Council (JROC) and DoD EOD Program Board validated requirements for Joint EOD missions. This S&T investment provides critical S&T transitions to acquisition programs. This investment in Joint EOD S&T is reported annually to the DoD EOD Program Board. This S&T investment is documented in the DoD EOD Applied Research Program Plan which is reviewed and approved annually by the DoD EOD Program Board. *FY 2019 Plans:* Conduct advanced technology development and demonstration in electro-optic & acoustic technologies for buried mine detection, robotic manipulation for ordnance exploitation & neutralization, standoff detection and classification for ordnance, and identification of explosives. Efforts in this thrust include prototype and demonstration of laser interferometric sensor / systems for detection of buried objects, highly dexterous dual manipulator systems (manipulators, controllers) for EOD robots for precision render safe and neutralization missions, Resonance Raman (single or dual wavelength) detector for standoff detection, and excavation tools and techniques for precision recovery and diagnosis of buried objects. Initiate development and demonstration of technologies for low-observability underwater ordnance neutralization. *FY 2020 Base Plans:* Conduct advanced technology development and demonstration in electro-optic & acoustic technologies for buried mine detection, robotic manipulation for ordnance exploitation & neutralization, standoff detection and classification for ordnance, and identification of explosives. Efforts in this thrust include prototype and demonstration of laser interferometric sensor / systems for detection of buried objects, highly dexterous dual manipulator systems (manipulators, controllers) for EOD robots for precision render safe and neutralization missions, technologies for low-observable underwater ordnance neutralization and technologies for the inspection of underwater explosive threats. *FY 2020 OCO Plans:* N/A *FY 2019 to FY 2020 Increase/Decrease Statement:* No significant change between FY 2019 and FY 2020					
Title: Mine Technology *Description:* This activity focuses on developing and demonstrating technology to support on-demand battlespace shaping through advanced undersea weapons. Efforts include command & control (C2), remote	13.007	11.188	11.389	0.000	11.389

Exhibit R-2A, **RDT&E Project Justification:** PB 2020 Navy		**Date:** March 2019
Appropriation/Budget Activity 1319 *I* 3	**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 2917 *I Shallow Water MCM Demos*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**
control, advanced sensing technologies, compatibility with unmanned delivery options, detection & classification, and targeting solutions. The program, Modular Undersea Effector System (MUSE), is a limited duration effort for advanced mining and responds to recent request for capability from the fleet. *FY 2019 Plans:* Conduct advanced technology development and demonstration in advanced mining concepts including remote control, advanced sensing, command and control (C2), and more discriminative targeting solutions. Efforts in this thrust include prototyping advanced sensors and sensor configuration technologies for improved discrimination as well as communications, command, and control technologies. Initiate prototyping and demonstration for next-generation target detection devices. Funding supports JEON PC-0012 Advanced Maritime Mining Capability. *FY 2020 Base Plans:* Conduct advanced technology development in advanced mining technologies for clandestine, flexible, and scalable minefield deployment, longevity, and endurance, to include remote control, advanced sensing for detection and classification, command & control (C2), and more discriminative targeting solutions. Efforts in this thrust include prototyping and demonstration of advanced sensors and sensor configuration technologies for improved discrimination as well as communications, command, and control technologies. Continue prototyping and demonstration for next-generation target detection devices and mine effects. *FY 2020 OCO Plans:* N/A *FY 2019 to FY 2020 Increase/Decrease Statement:* No significant change between FY 2019 and FY 2020					
Accomplishments/Planned Programs Subtotals	14.826	13.172	13.335	0.000	13.335

C. Other Program Funding Summary ($ in Millions)
 N/A
Remarks

D. Acquisition Strategy
 N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2020 Navy		**Date:** March 2019
Appropriation/Budget Activity 1319 *I* 3	**R-1 Program Element (Number/Name)** PE 0603782N *I Mine and Expeditionary Warfare Advanced Technology*	**Project (Number/Name)** 2917 *I Shallow Water MCM Demos*

E. Performance Metrics

The overall metrics of this advanced technology program are the development of technologies supporting the Mine and Expeditionary Warfare challenges of reducing the MCM tactical timeline from months to days and eliminating the need for Navy divers and manned equipment to enter minefields. Another important metric is the scheduled transition of 6.3 advanced technology projects from the FNCs program into Navy and Marine Corps acquisition programs at agreed upon Technology Readiness Levels. Technology-specific metrics include: Mine warfare data fusion capabilities yielding a 10%-25% reduction in time and risk to mine hunting activities; Mine hunting sensors - Probability of Detection = 95%, Probability of Identification of Proud Mines = 90%, Probability of Classification of Buried Mines = 80%; Unmanned Systems for MCM sized for inclusion in the Littoral Combat Ship Mine Warfare Mission Package; MCM sensors sized, packaged and capable of 12 hour missions with a search rate greater than .05 square nautical mines per hour; Mine sweeping: Modular magnetic and acoustic influence sweeping systems packaged for deployment from Unmanned Surface Vehicles; Minesweeping single sortie coverage > 9.4 square nautical miles at 20 nautical miles per hour during a 4 hour mission up to Sea State 3; Surface-laid mine and obstacle breaching capability > 90% in the Beach Zone (BZ) using unitary warheads, and > 80% in the Surf Zone (SZ).

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019

Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603782N / *Mine and Expeditionary Warfare Advanced Technology*	Project (Number/Name) 9999 / *Congressional Adds*

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	0.000	26.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	26.500

A. Mission Description and Budget Item Justification
Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019
Congressional Add: Sensor for Maritime Capabilities Demonstration	0.000	23.500
FY 2018 Accomplishments: N/A		
FY 2019 Plans: Development of an airborne, multi-spectral sensor to demonstrate potential for long range detection, increased persistence, and ability to operate on different ISR platforms.		
Congressional Add: Additive Manufacturing	0.000	3.000
FY 2018 Accomplishments: N/A		
FY 2019 Plans: Development of new advanced manufacturing technologies, such as additive manufacturing, friction stir welding and surface processing, and laser thermal and mechanical surface treatments to improve performance, increase reliability, and reduce costs for small turbojet and turbofans engines.		
Congressional Adds Subtotals	0.000	26.500

C. Other Program Funding Summary ($ in Millions)
N/A
Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
Congressional Interest Items not included in other Projects.