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Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Navy **Date:** February 2020

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy / BA 6: RDT&E Management Support</i>	R-1 Program Element (Number/Name) PE 0604759N / <i>Major T&E Investment</i>
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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	0.000	86.967	107.348	85.195	-	85.195	73.510	63.901	66.900	68.182	Continuing	Continuing
2195: <i>T & E Investment</i>	0.000	73.935	85.348	85.195	-	85.195	73.510	63.901	66.900	68.182	Continuing	Continuing
9999: <i>Congressional Adds</i>	0.000	13.032	22.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.032

A. Mission Description and Budget Item Justification

This project corrects major deficiencies, improves Test & Evaluation (T&E) capabilities, and increases T&E support effectiveness at Navy Major Range and Test Facility Base ranges and facilities. The T&E Investment project improves, modernizes and adds new test capabilities at the following test facilities: the Naval Undersea Warfare Center Division Newport Atlantic Undersea Test and Evaluation Center, Andros Island, Bahamas; the Nanoose and Dabob ranges of the Naval Undersea Warfare Center Division Keyport, Keyport, WA; the Sea Range, Land Ranges, Target Operations, Ordnance T&E Facility, Test Wing Pacific located at the Naval Air Warfare Center Weapons Division, Point Mugu, CA and China Lake, CA; and the Atlantic Test Range, Air Combat Environment T&E Facility, Electromagnetic Environmental Effects, Air Vehicle Modification and Instrumentation facility, Test Wing Atlantic, Target Operations, and the Propulsion Systems Evaluation Facility located at the Naval Air Warfare Center Aircraft Division, Patuxent River, MD and the test and evaluation capabilities located at the Pacific Missile Range Facility, Kauai, HI.

JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under RESEARCH, DEVELOPMENT, TEST and EVALUATION MANAGEMENT SUPPORT because it supports efforts directed toward sustaining or modernizing installations or operations required for general research, development, test and evaluation.

B. Program Change Summary (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	90.514	85.348	83.560	-	83.560
Current President's Budget	86.967	107.348	85.195	-	85.195
Total Adjustments	-3.547	22.000	1.635	-	1.635
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	22.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.434	0.000			
• SBIR/STTR Transfer	-1.113	0.000			
• Program Adjustments	0.000	0.000	1.635	-	1.635
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000

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

Project: 9999: *Congressional Adds*

FY 2019	FY 2020

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

	FY 2019	FY 2020
Congressional Add: <i>Fifth Generation Radar Ground Test Upgrades</i>	3.861	8.000
Congressional Add: <i>Complex Electronic Warfare Test Equipment</i>	3.379	5.000
Congressional Add: <i>Ground Based Sense-and-Avoid</i>	5.792	0.000
Congressional Add: <i>Undersea range modernization</i>	0.000	4.000
Congressional Add: <i>Naval research laboratory facilities</i>	0.000	5.000
Congressional Add Subtotals for Project: 9999	13.032	22.000
Congressional Add Totals for all Projects	13.032	22.000

Change Summary Explanation

The FY 2021 funding request increased by \$2.3M in support of Joint Electronic Warfare Threats (JETS).

FY 2021 funding request was reduced by \$0.665 million to account for the availability of prior year execution balances.

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Appropriation/Budget Activity 1319 / 6					R-1 Program Element (Number/Name) PE 0604759N / Major T&E Investment				Project (Number/Name) 2195 / T & E Investment			
COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
2195: T & E Investment	0.000	73.935	85.348	85.195	-	85.195	73.510	63.901	66.900	68.182	Continuing	Continuing
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

This project corrects major deficiencies, improves Test & Evaluation (T&E) capabilities, and increases T&E support effectiveness at Navy Major Range and Test Facility Base ranges and facilities. The T&E Investment project improves, modernizes and adds new test capabilities at the following test facilities: the Naval Undersea Warfare Center Division Newport Atlantic Undersea Test and Evaluation Center (AUTECH), Andros Island, Bahamas; the Nanoose and Dabob ranges of the Naval Undersea Warfare Center Division Keyport, Keyport, WA; the Sea Range, Land Ranges, Target Operations, Ordnance T&E Facility, Test Wing Pacific located at the Naval Air Warfare Center Weapons Division, Point Mugu, CA and China Lake, CA; and the Atlantic Test Range, Air Combat Environment T&E Facility, Electromagnetic Environmental Effects, Air Vehicle Modification and Instrumentation facility, Test Wing Atlantic, Target Operations, and the Propulsion Systems Evaluation Facility located at the Naval Air Warfare Center Aircraft Division, Patuxent River, MD and the test and evaluation capabilities located at the Pacific Missile Range Facility, Kauai, HI.

B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: UNDERSEA RANGE INVESTMENTS	6.611	6.281	11.736	0.000	11.736
Articles:	-	-	-	-	-
Description: This effort funds the modernization, upgrades, and new test and evaluation capabilities required at the Navy's Major Range Test Facility Base undersea ranges, to include AUTECH, Andros Island, Bahamas and the Nanoose and Dabob ranges of the Naval Undersea Warfare Center Division Keyport, Keyport, WA.					
FY 2020 Plans:					
- Continue the minor upgrade and modernization of test capabilities at AUTECH, Nanoose and Dabob.					
- Continue tracking system modernization at Nanoose and Dabob.					
- Continue torpedo control panel modernization at Nanoose and Dabob.					
- Complete recovery system improvement at Nanoose and Dabob.					
- Initiate range telemetry and communications upgrade at Nanoose and Dabob.					
- Initiate procurement of small range craft for unmanned underwater vehicle (UUV) work at Nanoose and Dabob.					
- Initiate modernization of range data management system at Nanoose and Dabob.					
- Initiate cyber security upgrades at Nanoose and Dabob.					
FY 2021 Base Plans:					
- Continue the minor upgrade and modernization of test capabilities at AUTECH, Nanoose and Dabob.					
- Continue modernization of range data management system at Nanoose and Dabob.					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
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- Complete tracking system modernization at Nanoose and Dabob.
- Complete torpedo control panel modernization at Nanoose and Dabob.
- Complete range telemetry and communications upgrade at Nanoose and Dabob.
- Complete procurement of small range craft for unmanned underwater vehicle (UUV) work at Nanoose and Dabob.
- Complete cyber security upgrades to critical range instrumentation and networks at Nanoose and Dabob.
- Initiate replacement of underwater cables to hydrophone arrays at Nanoose and Dabob.
- Initiate upgrade to acoustic acquisition systems and replace the acoustic signal processing systems at Nanoose and Dabob.
- Initiate replacement of the acoustic signal processing system at AUTEK.
- Initiate replacement of the shore electronics interface to the hydrophone system at AUTEK.
- Initiate replacement of the array structures at Nanoose and Dabob.

FY 2021 OCO Plans:
N/A

FY 2020 to FY 2021 Increase/Decrease Statement:
The funding increase from FY 2020 to FY 2021 is due to the initiation of multiple projects including the underwater cable replacement, shore electronics replacement and multiple acoustic signal processor efforts.

Title: OPEN AIR RANGE INVESTMENTS	40.168	34.901	37.695	0.000	37.695
Articles:	-	-	-	-	-

Description: This effort funds the modernization and upgrades of existing capabilities and the development of new T&E capabilities required at the Navy's Major Range Test Facility Base open air ranges at the Naval Air Warfare Center Aircraft Division (NAWCAD), Patuxent River, MD, Naval Air Warfare Center Weapons Division (NAWCWD), Point Mugu, CA and China Lake, CA and Pacific Missile Range Facility (PMRF), Kauai, HI.

- FY 2020 Plans:**
- Continue the minor upgrade and modernization of test capabilities at NAWCAD, NAWCWD and PMRF.
 - Continue procurement of Range Support Aircraft.
 - Continue the development of Environmental Impact Statements at NAWCAD and NAWCWD.
 - Continue the development and integration of Telemetry and optics equipment on the Range Support Aircraft.
 - Complete the modernization of the telemetry antenna controllers and data processors at PMRF.
 - Complete the modernization of the imaging radar at PMRF.
 - Complete the upgrade of the avionic data processing and display system at NAWCAD.

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
<ul style="list-style-type: none"> - Complete modernization of the imaging radar mechanical assemblies at PMRF. - Complete the replacement of the FOCUS cable at NAWCWD. - Complete the upgrade for ground based testing against a 5th generation aerial threat. This effort will upgrade an existing track test facility at NAWCWD with the ability to suspend a 5th generation aircraft for use in testing sensors. - Initiate the imaging radar transmitter modernization at PMRF. - Initiate cyber security upgrades at NAWCWD. - Initiate and complete the modernization of the down range network at NAWCAD. - Initiate and complete the modernization of the surface surveillance radars at NAWCAD. - Initiate and complete the modernization of the HD video distribution capability at NAWCWD. - Initiate and complete the modernization of the command and control transmitter at NAWCWD. -Initiate and complete the laser designator modernization at NAWCWD. <p>FY 2021 Base Plans:</p> <ul style="list-style-type: none"> - Continue the minor upgrade and modernization of test capabilities at NAWCAD, NAWCWD and PMRF. - Continue procurement of Range Support Aircraft. - Continue the development of Environmental Impact Statements at NAWCAD. - Continue the development and integration of Telemetry and optics equipment on the Range Support Aircraft. - Continue the imaging radar transmitter modernization at PMRF. - Continue cyber security upgrades to critical range instrumentation and networks at NAWCWD. - Complete the development of Environmental Impact Statements at NAWCWD. - Initiate remotely operated tracking radar modernization at NAWCWD. - Initiate telemetry recorder replacement at PMRF. - Initiate telemetry processor modernization at NAWCAD. - Initiate optical tracking mount replacement at PMRF. - Initiate optical sensor modernization at PMRF. - Initiate tracking pedestal modernization at NAWCAD. - Initiate mobile radio replacement at NAWCWD. - Initiate imaging radar modernization at NAWCAD. - Initiate software modifications to increase Joint Electronic Warfare Threats (JETS) air warfare battleshaping capabilities at NAWC WD. <p>FY 2021 OCO Plans:</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
N/A					
<i>FY 2020 to FY 2021 Increase/Decrease Statement:</i> The funding increase from FY 2020 to FY 2021 is due to the initiation of multiple projects including increasing the Joint Electronic Warfare Threats (JETS) air warfare battleshaping capabilities, the modernization of the remotely operated radar, the telemetry processor, optical sensors, tracking pedestal, and the imaging radar as well as the purchase of mobile radios and the optical tracking mount.					
<i>Title:</i> TEST FACILITIES INVESTMENTS	27.156	44.166	35.764	0.000	35.764
<i>Articles:</i>	-	-	-	-	-
<i>Description:</i> This effort funds the modernization and upgrades of existing capabilities and the development of new Test & Evaluation capabilities required at the Navy's Major Range Test Facility Base ground test facilities at NAWCAD, Patuxent River, MD, and NAWCWD, Point Mugu, CA and China Lake, CA.					
<i>FY 2020 Plans:</i>					
- Continue the minor upgrade and modernization of test capabilities at NAWCAD and NAWCWD and the upgrade to general instrumentation and equipment.					
- Continue the test cell performance improvement at NAWCAD. This effort will upgrade Propulsion Systems Evaluation Facility turbine engine test cell to provide uniform temperature and pressure intake airflow and improve dynamometer performance. FY 2020 work includes completing the design work, ordering materials and beginning the assembly of the equipment.					
- Continue the modernization of the insensitive munitions test arena at NAWCWD. Tasks include developing requirements for modernizing the control room, test pads and cable paths to the test arena and developing a contract package to implement the modernization of the Ordnance test facility.					
- Complete the upgrade for model and simulation testing against a 5th generation aerial threat. This effort will develop the capability to synchronize radio frequency output of different electronic warfare environment generators for a coherent presentation.					
- Complete the modernization of the data acquisition and processing system at NAWCAD. This effort will modernize the Electro Magnetic Pulse (EMP) instrumentation by replacing analog fiber links and obsolete oscilloscopes and control triggers with modern supportable equipment. In FY 2019, the prototype instrumentation package will be developed.					
- Complete the procurement of the direct drive electromagnetic test system at NAWCAD. This effort will evaluate potential amplifier solutions to replace amplifiers at the Electromagnetic/Environmental/Effects (E3) facility that are no longer supported by the manufacturer. The replacement amplifiers will provide less distortion/better representation responses and be maintainable.					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
<p>- Initiate the purchase of materials that will enable the establishment of free standing chamber walls at NAWCAD. This will allow an increased through put of testing by allowing limited anechoic testing in spaces that were not designed to be anechoic.</p> <p>- Initiate and complete the purchase of a global positioning simulator at NAWCAD.</p> <p>- Initiate and complete the purchase of x-ray equipment designed to examine munitions and ordnance at NAWCWD.</p> <p>Modeling and Simulation:</p> <p>- Continue multi-site and multi-domain modeling and simulation test bed design. Develop virtualized representations of high-priority Navy systems to integrate into complex digital battle space and into National Cyber Range. Innovate and standardize virtualization and integration process for use in DON Modeling & Simulation/Live Virtual Constructive (LVC) Environment. Evaluate architecture of major modeling and simulation environments and integrate major multi-domain test beds using best practices, open interfaces and ensure standing persistent connectability. Task will promulgate Enterprise models across Air, Surface, Subsurface and Cyber domains. Collaborate on improvements required for multi-Domain modeling and complex security environments to facilitate "Capability" Analysis/RDT&E/Training and fund enabling technologies. FY 2020 work includes decomposing major modeling architecture frameworks and designing a common compatible framework and developing a configuration methodology for promulgating enterprise models across multiple domains.</p> <p>- Continue common modeling and simulation tool design effort. Enhance Model Based Systems Engineering tools and integrate tools with T&E capabilities, allowing improved planning for agile software testing and cyber evaluations. Develop state-of-the-art data analysis and mining tools to integrate and present cohesive results in complex LVC environments. Develop architecture to integrate emerging Threat Intelligence products for both classified software, virtual and low cost hardware representations. Improve and integrate Integrated Threat Analysis Simulation Environment to meet Navy requirements. Update immersive visualization model suite to add complex Electronic Warfare (EW) effects and improve ability to evaluate and understand complex interactions tied to warfighting outcomes. Continue to integrate and transition best-of-breed innovations coming from research centers, DIUX and the gaming industry into use at RDT&E facilities for program and prototyping support. Incorporate improved EW effects/interactions into constructive modeling and integrate with virtual/hardware in the loop labs/ranges to create a coherent LVC EW/Electromagnetic Spectrum Maneuver Warfare evaluation environment. Analyze future state and develop plan to assess new capabilities for fusion and predictive systems. Integrate ONR modeling tools into test beds to allow assessment of human performance when assisted by improved machine-learning technologies. Focus on integration with Next Generation Threat System as core enterprise simulation and allow assessment in both test/training environments. Design, develop and integrate reference Interoperability emulators, low fidelity capability assessment tools and battlespace</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)

	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
<p>suite design to allow platforms to assess performance early in system development. FY 2020 work includes adding EW effects to immersive visualization model suites and adding EW effects into constructive models and integrating them with virtual and hardware in the loop labs and ranges.</p> <ul style="list-style-type: none"> - Initiate advanced immersive visualization of battlespace and red/blue interactions. Task will update immersive visualization model suite to add complex EW effects and improve ability to evaluate and understand complex interactions tied to warfighting outcomes. - Initiate update of Naval model and simulation environment to implement improved electronic warfare modeling effect and interactions. Task will incorporate improved Electronic Warfare (EW) effects and interactions into constructive modeling and integrate with virtual and hardware-in-the-loop labs and ranges to create a coherent Live Virtual Constructive (LVC) EW evaluation environment. - Initiate update to Family Of Simulation models to account for offensive and defensive cyber effects in the battlespace. Task will update constructive models used for analysis and RDT&E to incorporate modeling of red/blue cyber effects - Improvement to support assessment of machine-assisted learning and automated intelligence (AI). Integrate AI tools with Next Generation Threat System as core enterprise simulation and allow assessment in both test/training environments. <p><i>FY 2021 Base Plans:</i></p> <ul style="list-style-type: none"> - Continue the minor upgrade and modernization of test capabilities at NAWCAD and NAWCWD and the upgrade to general instrumentation and equipment. - Complete the test cell performance improvement at NAWCAD. This effort will upgrade Propulsion Systems Evaluation Facility turbine engine test cell to provide uniform temperature and pressure intake airflow and improve dynamometer performance. - Complete the modernization of the insensitive munitions test arena at NAWCWD. Tasks include renovating and modernizing the control room, refurbishing the test pads and cable paths to the test arena and replacing associated cabling between the test pad and control room at the Ordnance test facility. - Complete the implementation of a free standing chamber NAWCAD. This will allow an increased through put of testing by allowing limited anechoic testing in spaces that were not designed to be anechoic. - Initiate ordnance test arena at NAWC WD by replacing conduits, cabling, firing control system and data collection system. - Initiate helicopter drive system upgrade by aligning test stand and replacing loading and instrumentation at NAWCAD. <p>Modeling and Simulation:</p>					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
<p>- Continue multi-site and multi-domain modeling and simulation test bed design. Integrate virtualized representations of high-priority Navy systems including Littoral Combat Ship, P-8A and MQ-4C Triton into complex digital battle space and National Cyber Range. Implement virtualization and integration methodology for use in DON Modeling & Simulation/Live Virtual Constructive (LVC) Environment. Implement enterprise toolbox to integrate diverse models into prototype laboratory environment.</p> <p>- Continue common modeling and simulation tool design effort. Implement and test architecture interface to integrate emerging Threat Intelligence products with hardware representations. Threat Intelligence models will include the Integrated Threat Analysis Simulation Environment.</p> <p>- Continue advanced immersive visualization of battlespace and red/blue interactions. Demonstrate immersive visualization model suite, which added complex Electronic Warfare (EW) effects, to evaluate the level of improvement over the traditional tools. Analyze visualization areas still requiring refinement and develop implementation plan.</p> <p>- Continue update of Naval model and simulation environment to implement improved electronic warfare modeling effect and interactions. Test and analyze the fidelity and accuracy of the Electronic Warfare (EW) interactions that are available because of the improvements to the modeling environment. Testing will include virtual and hardware-in-the-loop labs and ranges to create a coherent Live Virtual Constructive (LVC) EW evaluation environment.</p> <p>- Continue update to Family Of Simulation models to account for offensive and defensive cyber effects in the battlespace. Integrate Automated Intelligence and Machine Learning models with the Next Generation Threat System environment then assess the improvements available to both test and training.</p> <p>FY 2021 OCO Plans: N/A</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding decrease from FY 2020 to FY 2021 is due to the completion of the test cell performance improvement project, the modernization of the insensitive munitions test arena and the purchase of the freestanding chamber.</p>					
Accomplishments/Planned Programs Subtotals	73.935	85.348	85.195	0.000	85.195

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

Remarks

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D. Acquisition Strategy

Not Applicable.

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COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
9999: Congressional Adds	0.000	13.032	22.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.032
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Congressional Add

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

	FY 2019	FY 2020
<p>Congressional Add: Fifth Generation Radar Ground Test Upgrades</p> <p>FY 2019 Accomplishments: Initiate the development of advanced radar target generators for modern radar test support at NAWCAD.</p> <p>FY 2020 Plans: Continue and complete the development of advanced radar target generators for modern radar test support at NAWCAD.</p>	3.861	8.000
<p>Congressional Add: Complex Electronic Warfare Test Equipment</p> <p>FY 2019 Accomplishments: Initiate upgrades to Air Combat Environment Test & Evaluation Facility (ACETEF) EW stimulation capability in support Mission testing at NAWCAD.</p> <p>FY 2020 Plans: Continue and complete upgrades to Air Combat Environment Test & Evaluation Facility (ACETEF) EW stimulation capability in support Mission testing at NAWCAD.</p>	3.379	5.000
<p>Congressional Add: Ground Based Sense-and-Avoid</p> <p>FY 2019 Accomplishments: To initiate and complete the enhancement of Atlantic Test Range (ATR) air and ground surveillance capability in support of Unmanned Aircraft Systems (UAS) operations at Naval Air Warfare Center Aircraft Division (NAWCAD).</p> <p>FY 2020 Plans: N/A</p>	5.792	0.000
<p>Congressional Add: Undersea range modernization</p> <p>FY 2019 Accomplishments: N/A</p> <p>FY 2020 Plans: Initiate and complete modernization to the undersea tracking and communication infrastructure at NUWC Keyport.</p>	0.000	4.000
<p>Congressional Add: Naval research laboratory facilities</p>	0.000	5.000

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020
<i>FY 2019 Accomplishments:</i> N/A		
<i>FY 2020 Plans:</i> Initiate and complete modernization to laboratories and equipment at NAWC AD and NAWC WD.		
Congressional Adds Subtotals	13.032	22.000

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

Remarks

D. Acquisition Strategy
Not required for Congressional Adds