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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Navy **Date:** May 2017

Appropriation/Budget Activity 1319: <i>Research, Development, Test & Evaluation, Navy / BA 7: Operational Systems Development</i>	R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP
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COST (\$ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	253.140	47.496	39.134	68.553	-	68.553	95.983	90.256	112.798	115.061	Continuing	Continuing
0366: <i>MK 48 ADCAP</i>	253.140	42.186	39.134	68.553	-	68.553	95.983	90.256	112.798	115.061	Continuing	Continuing
9999: <i>Congressional Adds</i>	0.000	5.310	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.310

A. Mission Description and Budget Item Justification

MK-48 ADCAP (Advanced Capability) Research, Development, Test and Evaluation (RDT&E) program executes incremental development of weapon performance improvements in three development product areas: (1) Common Broadband Advanced Sonar System (CBASS), (2) Advanced Processor Builds (APBs), and (3) Torpedo Technology Insertion (TI). This Program Element (0205632N/0366) is tied to development programs that leverage a joint United States/Australia Armaments Cooperative Project (ACP) to develop MK-48 ADCAP CBASS; and Future Naval Capability (FNC) technologies developed by the Office of Naval Research (ONR).

Countermeasure (CM) sophistication and availability on the open market directly affects ADCAP kill proficiency and its ability to counter rapidly evolving threats. The focus of the MK-48 ADCAP Torpedo Research and Development (R&D) program beginning FY 2001 shifted from concentrating primarily on software block upgrade efforts towards coordinated hardware upgrades, rapid Commercial-Off-the-Shelf (COTS) insertion, and APBs, in order to rapidly upgrade the ADCAP to counter evolving threats and maintain robust performance. The CBASS program developed and fielded a broadband sonar capable of identifying CMs and discriminating them from the target. CBASS Phase I achieved IOC in FY 2006. The Royal Australian Navy (RAN) is jointly participating to develop CBASS Phase II to improve shallow water performance and signed a Memorandum of Agreement (MOA) extension November 2009. The Memorandum Of Agreement (MOA) extension expires November 2019.

The MK-48 ADCAP Torpedo R&D program focuses on two specific areas near term; Torpedo APBs and hardware tech insertions. The CNO continues to stress shallow water (less than 600 feet) as a critical operating area to counter third world diesel electric submarines. Torpedo testing in shallow water has demonstrated that in-service ADCAP has less than full capability in this difficult environment. However, this testing, in conjunction with laboratory simulation efforts, has shown that significant performance improvements can be made by implementing changes to weapon tactics and software algorithms. Development, implementation, and testing of these changes are being accomplished under the Torpedo APB program. The APB program also leverages the RAN joint torpedo program and FNC technologies developed by the ONR in the areas of torpedo broadband signal processing, tactics processing, and alertment. The Torpedo tech insertion program will leverage the MK-54 Lightweight torpedo algorithms.

The Torpedo Technology Insertion program will provide for evolutionary torpedo improvements and upgrades (including the transition and testing of advanced technologies from the R&D community). This approach will incorporate developmental testing of the FNC transitioning technologies for ADCAP upgrades in the areas of torpedo sensors, weapon/platform connectivity, improve fusing, and an alternate method of homing. These efforts will continue torpedo development investment at a lower cost and shorter term than traditional torpedo programs.

The MK 48 MOD 7 APB6/TI-1 Heavyweight Torpedo (HWT) program is an evolutionary upgrade to the MK 48 MOD 7 HWT; it will consist of an Operational Software (OPSW) upgrade referred to as APB 6 and a hardware upgrade referred to as TI-1. TI-1 will include a Guidance and Control (G&C) section upgrade, a redesigned

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TI-1 Warhead Electronics System (WES), and an Improved Post Launch Communications System (IPLCS). TI-1 will also include features from three Future Naval Capabilities (FNC) programs: ASuW weapon upgrades, Extended Range Modular Undersea Heavyweight Vehicle (ER MUHV) and Torpedo Common Hybrid Fuzing System (Fuze).

APB5 software upgrades are currently in process for MK-48 ADCAP torpedoes.
APB5+ software upgrades are currently in process for MK-48 ADCAP torpedoes.

Both FNC technologies and MK-54 LWT developments will be transitioned into ADCAP through APBs and technology insertion packages. Priorities for APBs and technology insertion are: (1) improved torpedo effectiveness through advanced processing algorithms, (2) advanced counter-countermeasure capability, and (3) a new array to improve torpedo effectiveness.

B. Program Change Summary (\$ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	47.703	39.134	68.563	-	68.563
Current President's Budget	47.496	39.134	68.553	-	68.553
Total Adjustments	-0.207	0.000	-0.010	-	-0.010
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.207	0.000			
• Rate/Misc Adjustments	0.000	0.000	-0.010	-	-0.010

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

Project: 9999: *Congressional Adds*

Congressional Add: *Upgrade Program*

	FY 2016	FY 2017
Congressional Add Subtotals for Project: 9999	5.310	0.000
Congressional Add Totals for all Projects	5.310	0.000

Change Summary Explanation

FY 2018: Additional funds are primarily due to the TI-1 Hardware development contract.

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Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy										Date: May 2017		
Appropriation/Budget Activity 1319 / 7					R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP				Project (Number/Name) 0366 / MK 48 ADCAP			
COST (\$ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
0366: MK 48 ADCAP	253.140	42.186	39.134	68.553	-	68.553	95.983	90.256	112.798	115.061	Continuing	Continuing
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

MK48 ADCAP program executes incremental development of weapon performance improvements in two development product areas: (1) APBs, and (2) torpedo technology insertion. This program is tied to development programs that leverage a joint United States/Australia ACP to develop MK48 ADCAP and FNC technologies being developed by the ONR.

APB software upgrades will improve torpedo performance in challenging shallow water and countered environments through incorporation of new algorithms designed to address broadband, multiband, classifications and tactics processing changes. Hardware technology insertions will improve weapon performance against slow/low doppler targets. It provides improved target detection at long and short ranges and improved counter measure rejection in countered and shallow water scenarios.

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

	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Title: TORPEDO APB	24.557	26.711	47.567	0.000	47.567
Articles:	-	-	-	-	-
FY 2016 Accomplishments: Continued APB 5 development. Continued APB 5+ development. Started APB 6 development. Started transition of Fuze and ASuW FNC products to include requirement documentation to be completed, model updates, software integration, in-water and land-based testing, and performance matrix testing.					
FY 2017 Plans: Continue APB 5 software builds for DT Continue APB 6 software development. Award TI-1 (112 Element Array) Development Contract.					
FY 2018 Base Plans: Continue APB 6 development. Continue TI-1 development Continue Weapons Analysis Facility (WAF) upgrades and accreditation. Start Fiber development.					
FY 2018 OCO Plans:					

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B. Accomplishments/Planned Programs (\$ in Millions, Article Quantities in Each)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
N/A					
Title: TEST & EVALUATION	17.629	12.423	20.986	0.000	20.986
Articles:	-	-	-	-	-
FY 2016 Accomplishments: Started APB 5 Developmental Testing(DT); 4 major DT events with 73 firings over ~ 14 days at sea as well as follow-on analysis and reports for each event. Continued Build-Test-Build development.					
FY 2017 Plans: Conduct APB 5 Developmental Testing (DT) in water events with analysis and reports for each event. Continued build-test-build development.					
FY 2018 Base Plans: Begin APB 5 Operational Testing (OT) events OT-A and OT-B with analysis and reports for each event.					
FY 2018 OCO Plans: N/A					
Accomplishments/Planned Programs Subtotals	42.186	39.134	68.553	0.000	68.553

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

<u>Line Item</u>	<u>FY 2016</u>	<u>FY 2017</u>	<u>FY 2018 Base</u>	<u>FY 2018 OCO</u>	<u>FY 2018 Total</u>	<u>FY 2019</u>	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022</u>	<u>Cost To Complete</u>	<u>Total Cost</u>
• WPN/3225: MK-48 Torpedo ADCAP Mods	56.730	46.139	38.954	-	38.954	40.599	41.374	58.685	59.866	0.000	1,425.338
• WPN/3117: MK-48 Torpedo	60.438	44.537	47.210	-	47.210	75.993	101.046	177.523	164.289	Continuing	Continuing

Remarks

D. Acquisition Strategy

Sole source production contract awarded in FY 2004 for MK48 ADCAP MODS, MK-54 LWT, and CBASS kits, including RAN units. A full and competitive procurement for MK48 MOD 7 CBASS production kits was awarded in March 2011 with a FY 2010/2011 base year and four option years for FY 2012-2015. A new FY 2016 competitive contract was awarded to continue procurement of CBASS Kits.

A new FY 2016 competitive contract was awarded to procure additional warshot torpedoes.

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E. Performance Metrics

Milestone reviews.

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Exhibit R-3, RDT&E Project Cost Analysis: FY 2018 Navy **Date:** May 2017

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP	Project (Number/Name) 0366 / MK 48 ADCAP
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Product Development (\$ in Millions)				FY 2016		FY 2017		FY 2018 Base		FY 2018 OCO		FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Primary Software Development - Spirial 4 / PY Development	WR	NUWC NPT : Newport RI	31.839	0.000		0.000		0.000		-		0.000	0.000	31.839	-
Primary Software Development - APB 5	WR	NUWC NPT : Newport RI	8.340	13.112	Oct 2015	11.024	Oct 2016	5.552	Oct 2017	-		5.552	Continuing	Continuing	Continuing
Primary Software Development - APB 6	WR	NUWC NPT : Newport RI	0.000	0.000		0.000		6.554	Oct 2017	-		6.554	0.000	6.554	-
Primary Software Development - APB 6	WR	MIT : Cambridge, Massachusetts	0.000	0.000		0.000		0.000	Mar 2018	-		0.000	0.000	0.000	-
Primary Hardware Development - Spiral 4 / PY Development	WR	NUWC NPT : Newport RI	31.201	0.000		0.000		0.000		-		0.000	0.000	31.201	-
Primary Hardware Development - TI-1	WR	NUWC NPT : Newport RI	7.755	7.125	Jan 2016	4.546	Oct 2016	9.369	Oct 2017	-		9.369	Continuing	Continuing	Continuing
Primary Hardware Development - IM	WR	Indian Head : Indian Head	0.450	0.450	Jan 2016	0.450	Oct 2016	0.450	Jan 2018	-		0.450	Continuing	Continuing	Continuing
Primary Hardware Development - TI-1	C/FFP	ARL/PSU : State College PA	0.000	0.000		0.000		0.300	Mar 2018	-		0.300	0.000	0.300	-
Primary Hardware Development - TI-1	WR	Indian Head : Indian Head	0.000	0.000		0.000		0.100	Oct 2017	-		0.100	0.000	0.100	-
Hardware Development - TI-1	C/CPFF	New - TBD : TBD	0.000	0.000		6.176	Aug 2017	20.411	Jun 2018	-		20.411	0.000	26.587	-
Subtotal			79.585	20.687		22.196		42.736		-		42.736	-	-	-

Remarks
Funds torpedo, modeling and simulation hardware and software development, including the engineering and project manager's costs. FY 2018 increased funding provided for TI-1 development and hardware development contract award.

Support (\$ in Millions)				FY 2016		FY 2017		FY 2018 Base		FY 2018 OCO		FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Software Development - APB 5	WR	NUWC NPT : Newport RI	23.252	3.353	Oct 2015	3.983	Oct 2016	3.368	Oct 2017	-		3.368	Continuing	Continuing	Continuing

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Exhibit R-3, RDT&E Project Cost Analysis: FY 2018 Navy **Date:** May 2017

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP	Project (Number/Name) 0366 / MK 48 ADCAP
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Support (\$ in Millions)				FY 2016		FY 2017		FY 2018 Base		FY 2018 OCO		FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Software Development - APB 6	WR	NUWC NPT : Newport RI	0.000	0.000		0.000		0.917	Oct 2017	-		0.917	0.000	0.917	-
Software Development	Various	Various : Not Specified	36.317	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Integrated Logistics Support	WR	NUWC NPT : Newport RI	2.243	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering WCF	WR	NUWC NPT : Newport RI	17.750	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Systems Engineering	Various	NUWC NPT : Newport RI	0.676	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Subtotal			80.238	3.353		3.983		4.285		-		4.285	-	-	-

Remarks
Funds activity program support costs, post test and evaluation weapons analysis, and Weapons Analysis Facilities (WAF) costs. Small increase in FY 2018 for APB 6 software development analysis.

Test and Evaluation (\$ in Millions)				FY 2016		FY 2017		FY 2018 Base		FY 2018 OCO		FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Test & Evaluation - Spiral 4 / PY	WR	NUWC NPT : Newport RI	17.086	0.000		0.000		0.000		-		0.000	0.000	17.086	-
Test & Evaluation - APB 5	WR	NUWC NPT : Newport RI	3.918	5.418	Oct 2015	3.183	Oct 2016	10.749	Oct 2017	-		10.749	Continuing	Continuing	Continuing
Test & Evaluation - APB 5	WR	Operational Test Force : Norfolk VA	9.270	0.545	Jul 2016	0.900	Jul 2017	2.000	Jun 2018	-		2.000	Continuing	Continuing	Continuing
Modeling & Simulation	WR	NUWC NPT : Newport RI	9.745	0.000		0.000		0.000		-		0.000	Continuing	Continuing	Continuing
Modeling & Simulation	C/CPFF	ARL / PSU : State College PA	11.114	1.476	Apr 2016	1.522	Apr 2017	0.000		-		0.000	Continuing	Continuing	Continuing
Test & Evaluation - APB 6	C/CPFF	ARL/PSU : State College PA	0.000	0.000		0.000		1.567	Apr 2018	-		1.567	0.000	1.567	-

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Exhibit R-3, RDT&E Project Cost Analysis: FY 2018 Navy											Date: May 2017				
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Test and Evaluation (\$ in Millions)				FY 2016		FY 2017		FY 2018 Base		FY 2018 OCO		FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Test & Evaluation - Spiral 4 / PY	WR	NUWC Keyport (KPT) : Keyport WA	29.437	0.000		0.000		0.000		-		0.000	0.000	29.437	-
Test & Evaluation - APB 5	WR	NUWC Keyport (KPT) : Keyport WA	7.157	10.190	Oct 2015	6.818	Oct 2016	6.670	Oct 2017	-		6.670	Continuing	Continuing	Continuing
Subtotal			87.727	17.629		12.423		20.986		-		20.986	-	-	-

Remarks
Funds in-water run costs and personnel to support such events and modeling and simulation performance evaluation. FY 2018 increase for APB 5 in-water test events and APB 6 software testing.

Management Services (\$ in Millions)				FY 2016		FY 2017		FY 2018 Base		FY 2018 OCO		FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Program Management Support	C/CPFF	Alion Science : Mclean VA	4.390	0.468	Jan 2016	0.482	Oct 2016	0.496	Nov 2017	-		0.496	Continuing	Continuing	Continuing
Travel	WR	NAVSEA : Washington DC	1.200	0.049	Oct 2015	0.050	Oct 2016	0.050	Oct 2017	-		0.050	Continuing	Continuing	Continuing
Subtotal			5.590	0.517		0.532		0.546		-		0.546	-	-	-

Remarks
Funds program support, program travel, and OPTEVFOR travel.

	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	253.140	42.186	39.134	68.553	-	68.553	-	-	-

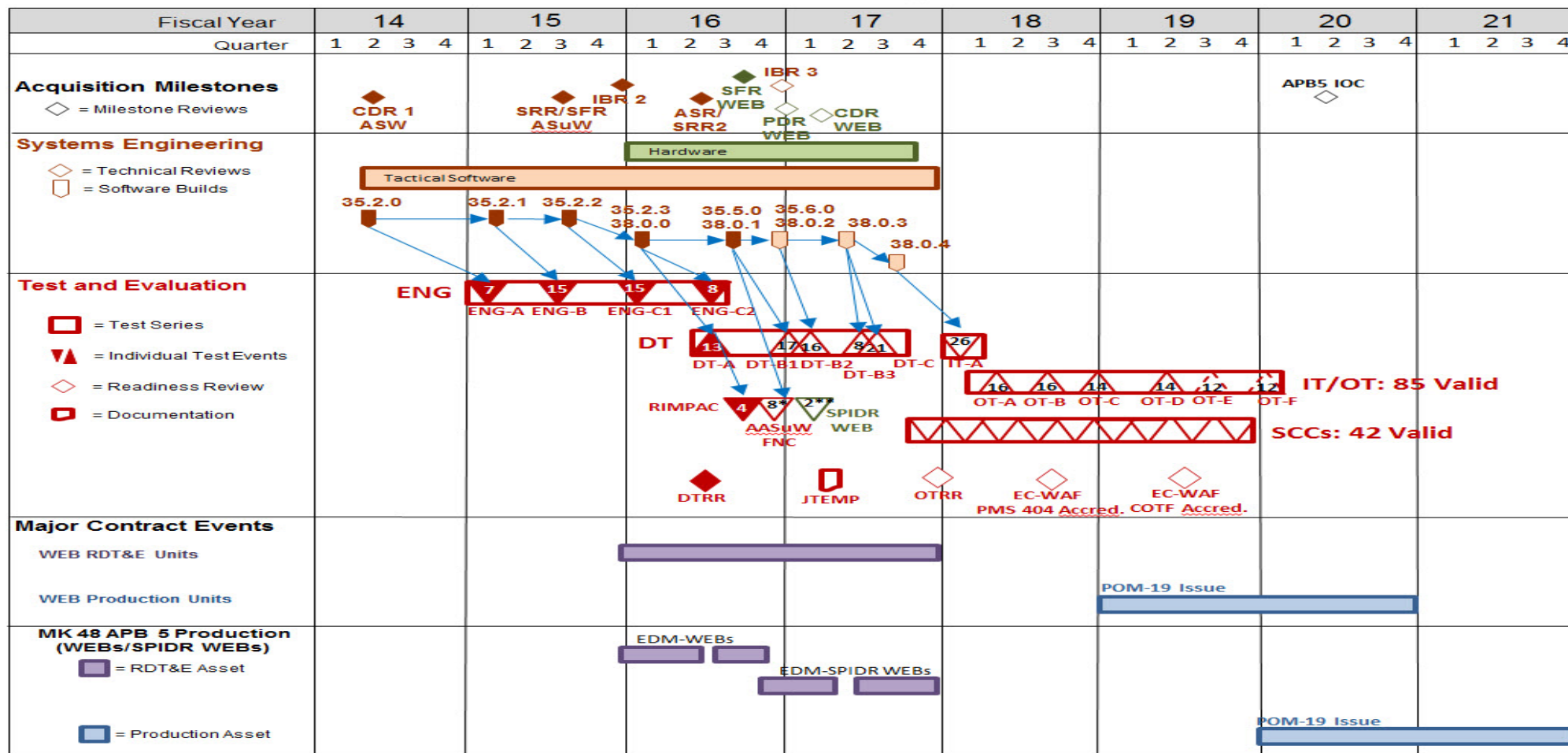
Remarks

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Exhibit R-4, RDT&E Schedule Profile: FY 2018 Navy Date: May 2017

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP	Project (Number/Name) 0366 / MK 48 ADCAP
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MK 48 MOD 7 APB5 Acquisition Schedule



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Exhibit R-4A, RDT&E Schedule Details: FY 2018 Navy **Date: May 2017**

Appropriation/Budget Activity 1319 / 7	R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP	Project (Number/Name) 0366 / MK 48 ADCAP
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Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
Proj 0366				
APB 5 Development: APB 5 Developmental Test (DT)	2	2016	4	2017
APB 5 Development: APB 5 Operation Test (OT)	1	2018	1	2020
APB 5 Development: APB 5 IOC	2	2020	2	2020
APB 6 Software / TI-1 Hardware Development: APB 6 Development	1	2016	4	2022

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Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy										Date: May 2017		
Appropriation/Budget Activity 1319 / 7					R-1 Program Element (Number/Name) PE 0205632N / MK-48 ADCAP				Project (Number/Name) 9999 / Congressional Adds			
COST (\$ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
9999: <i>Congressional Adds</i>	0.000	5.310	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.310
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

MK48 Heavyweight Torpedo APB5+ enhancements are required to address CCS/MK48 pre and post launch interface issues which limit crew full implementation of the weapon and provide numerous capability enhancements requested and endorsed by the STRG. APB5+ modernizes the torpedo-to-CCS interface, improves Pk, increases platform safety, provides platform data decoupling the CCS/MK48 operational software interdependence, and would enable torpedo operational software (OPSW) updates while deployed through the CCS. APB5+ also corrects numerous HARs and provides new CCS/MK48 interface protocol (Ethernet over DDL.) Specific mods include the interlaced telemetry, iFENCE, TMA updates, ballistics in payload, new waypoints. Secondary affect will be to improve overall CCS/MK48 program alignment and/or efficiency.

APB5+ will provide increased platform safety and will enable future payload-to-platform capabilities providing for full utilization of platform data to the weapon (as well as data from the weapon to the platform) with the cumulative effect of increasing Pk. APB5+ addresses safety HARs and modernizes the torpedo to weapon interface to enable more effective communications.

APB5+ requires a corresponding Combat Control System modification to benefit from the improved capabilities.

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

	FY 2016	FY 2017
Congressional Add: Upgrade Program	5.310	0.000
FY 2016 Accomplishments: APB 5+ development efforts: - Update Interface Design Specification - Conduct Future Torpedo Studies - Design Advanced Weapon Performance Models		
FY 2017 Plans: N/A		
Congressional Adds Subtotals	5.310	0.000

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

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: FY 2018 Navy		Date: May 2017
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E. Performance Metrics

Milestone review