Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy* / BA 5: *System Development & Demonstration (SDD)*					R-1 Program Element (Number/Name) PE 0604245M / *H-1 Upgrades*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	0.000	0.000	58.097	-	58.097	75.951	73.660	57.362	38.824	Continuing	Continuing
3359: *H-1 Improvements*	0.000	0.000	0.000	58.097	-	58.097	75.951	73.660	57.362	38.824	Continuing	Continuing

A. Mission Description and Budget Item Justification

The mission of the AH-1 attack helicopter is to provide rotary wing close air support, anti-armor, armed escort, armed/visual reconnaissance, survivability enhancements, and fire support coordination capabilities under day/night and adverse weather conditions. The mission of the UH-1 utility helicopter is to provide command and control and combat assault support under day/night and adverse weather conditions and special operations support; supporting arms coordination and aeromedical evacuation. Major modifications for both aircraft include 37 AH-1Ws converted to AH-1Zs, build 152 new AH-1Zs, remanufacture ten (10) H-1N helicopters and build 150 new UH-1Y models. AH-1Z and UH-1Y models include a 4-bladed, composite rotor system with semi-automatic bladefold, performance-matched transmissions, T700 Engine Digital Electronic Control Units, 4-bladed tail rotors and drive systems, more effective stabilizers, upgraded landing gear, and common, fully integrated cockpits and avionics systems. These upgrades add 10,000 flight hours to AH-1Z/UH-1Y airframes. The fully integrated cockpits reduce operator workload and improve situational awareness, thus increasing safety and reducing the rate of aircraft attrition. They provide considerable growth potential for future weapon systems and avionics to significantly increase mission effectiveness and survivability. The cockpits also include integration of onboard mission planning, communications, digital fire control, self-navigation, night navigation/targeting, air-to-ground missile and air-launched intercept missile weapon systems management in nearly identical crew stations, which significantly reduces training requirements. These upgrades maximize commonality between the two aircraft and provide needed improvements in crew and passenger survivability, payload, power available, endurance, range, airspeed, maneuverability and supportability.

This budget is required for follow-on improvements to H-1 aircraft via integration of sensors and weapons, avionics, and air vehicle components that will address deficiencies, systems safety, obsolescence, readiness, reliability, supportability, and relevance in the battlespace. Improvements will include all associated System Configuration Set (SCS) updates as well as integration and testing related to the aircraft platforms.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	58.097	-	58.097
Total Adjustments	0.000	0.000	58.097	-	58.097
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	0.000	0.000	58.507	-	58.507

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy					Date: February 2018
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 5: *System Development & Demonstration (SDD)*		R-1 Program Element (Number/Name) PE 0604245M *I H-1 Upgrades*			
• Rate/Misc Adjustments	0.000	0.000	-0.410	-	-0.410

Change Summary Explanation

Funds increase from FY 2018 to FY 2019 due to transfer of effort from old PE 0604245N beginning in FY 2019.

The FY 2019 funding request was reduced by $1.300 million to account for the availability of prior year execution balances.

Technical: None

Schedule: System Configuration Sets (SCS) will be continuously developed and released in conjunction with required hardware obsolescence and capability improvements. Software development as a whole are accounted for separately on the R-3 and are apportioned into development efforts for Avionics and Sensors & Weapons on the R-2a. Software is no longer portrayed separately on the R-2a or R-4 since SCS builds are linked to the development of hardware. The Mission Description section for Avionics and Sensors and Weapons state that SCS is part of each of the projects.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 5	R-1 Program Element (Number/Name) PE 0604245M / *H-1 Upgrades*	Project (Number/Name) 3359 / *H-1 Improvements*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
3359: *H-1 Improvements*	0.000	0.000	0.000	58.097	-	58.097	75.951	73.660	57.362	38.824	Continuing	Continuing
Quantity of RDT&E Articles		-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The objective of H-1 Improvements is to provide follow-on Research, Development, Test and Evaluation efforts in support of all H-1 aircraft.

Air Vehicle and Engine improvements include analysis of structural data to formulate Damage Limits and Tolerances for structural components to reduce life cycle costs and maintenance workload; and redesign of structural components and drive system components to minimize excessive and premature wear, increase reliability, and improve existing design deficiencies. Additional air vehicle upgrades include: redesign of the aircraft power-generating and electrical components (generators, inverters, wiring) to support power requirements for existing and future systems (Aircraft Survivability Equipment, emerging electronic warfare, and Degraded Visual Environment), redesign of the Environmental Control System /Thermal Redesign to support cooling of Technology Refresh Mission Computer and other avionics, redesign to add an auxiliary fuel capability, Intrepid Tiger, and upgrades the UH-1Y cabin floor panels.

Avionics improvements target digital inter-operability, integrated avionics, safety & survivability, and situational awareness for both the pilot and aircrew safety. This includes integrating Joint Battle Command-Platform (JBC-P), Full Motion Video (FMV), Degraded Visual Environment (DVE), Helmet Mounted Display improvements, cockpit displays, precision and GPS non-precision landing capability, Crash Survivable Flight Incident Recorder, collision avoidance, improved Embedded Global Positioning System (EGI), Inertial Navigation System (INS), targeting sensor systems and mission computer. H-1 capability improvements include improved Aircraft Survivability Equipment (ASE), digital operations & transfer of data, digital interoperability, digital video recording, video and data networking, and information integration with aviation combat elements and Marine Air Ground Task Force elements. Mandated capability efforts include - Communications, Navigation and Surveillance system/ Air Traffic Management (CNS/ATM), Required Navigation Performance/Area Navigation (RNP/RNAV), GPS Selective Availability Anti-Spoofing Module (SAASM), Automatic Dependent Surveillance - Broadcast (ADS-B), Crash Survivable Flight Incident Recorder, development efforts required for Depot standup and incorporation of technology and information protection/Information Assurance in critical avionics and sensor systems. In addition, the goal is to reduce total ownership cost for H-1 aircraft and related support systems by improving reliability and maintainability of critical flight and avionics systems along with associated peculiar avionics support equipment and incorporating fact-of-life obsolescence solutions. All avionics improvements include related System Configuration Set (SCS) development updates and testing.

Sensors, Weapons and Helmet Mounted Display System improvements include, manufacturing process improvements, hardware and software redesign to improve reliability, improve production methodologies, implement program security initiatives and increase the collective capability to address emerging battlefield threats. These improvements also address reliability and obsolescence, which collectively enhance Fleet readiness. The technical interface between the aircraft sensor, helmet and weapons is increasingly challenging to effectively employ advanced precision guided weapons and Aircraft Survivability Equipment (ASE) for the interface between the sensors, helmet and precision guided munitions. These systems require extensive software and hardware upgrades that translate into meaningful, sensor fusion based solutions, to provide both battlefield and situational awareness to the H1 platform. Specifically, the AN/ALQ-30 Target Sight System (TSS) will implement several block upgrade efforts with improvements to the IR Pointer, Laser and Cameras as well as adding capabilities such as Laser Spot Tracker and High Definition Video. The Optimized TopOwl (OTO) optics upgrades, reliability, additive manufacturing initiatives, will address multiple human factor improvements, to include Degraded

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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Visual Environment (DVE), as well as advanced boresighting and mapping improvements to improve weapons accuracy. The Digital Interoperability of the Helmet and Sensor will extend to improvements in ASE and Smart Dispense Technologies to improve aircraft survivability. Radar and Missile Warning improvements, including APR-39D(V)2 and the Distributed Aperture Infrared Countermeasures (DAIRCM), require extensive integration and testing. Development, test and integration efforts with the Advanced Precision Kill Weapons (APKWS), M299 Launcher improvements, Digital Rocket Launcher (DRL), AIM-9X, the AN/ALQ-231 (V) Intrepid Tiger II Electronic Warfare Pod and the Joint Air-to-Ground Missile (JAGM) Hellfire missile will follow in FY18. Improving and integrating weapon systems will align with these upgrades to improve the overall accuracy, lethality and survivability of the H1 platform.

These improvements will provide considerable growth potential for future weapon systems, air vehicle improvements, software improvements, and avionics upgrades, which will significantly increase mission effectiveness & survivability, while potentially reducing life cycle costs. The cockpits will also include integration of onboard mission planning, communications, digital fire control, self-navigation, night navigation/targeting, precision guided munitions, and air-launched intercept missile weapon systems management in nearly identical crew stations, which significantly reduce training requirements. These upgrades maximize commonality between all H-1 Type/Model/Series aircraft and provide needed improvements in crew and passenger reliability, survivability, payload, power available, endurance, range, airspeed, maneuverability and supportability.

B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Weapons and Sensors Testing and Integration	0.000	0.000	7.648	0.000	7.648
Articles:	-	-	-	-	-
FY 2018 Plans: N/A					
FY 2019 Base Plans: Conduct prototype developmental testing of TSS Block Upgrade initiatives, to include software compatibility and high definition video feed to the Optimized Top Owl HMSD (Helmet Mounted Sight Display). Conduct HMSD optics testing, digital upgrades and Sensor/ASE interfaces. Continue enhanced digital capability efforts, Aircraft Survivability Equipment (ASE) improvements, Helmet Mounted Display improvements, with full visor integration and display enhancements, systems obsolescence mitigation efforts, as well as opportunities to improve support and test equipment modifications.					
FY 2019 OCO Plans: N/A					
FY 2018 to FY 2019 Increase/Decrease Statement: Funds increase from FY18 to FY19 due to transfer of effort from old PE 0604245N beginning in FY19.					
Title: Air Vehicle and Engines Improvements	0.000	0.000	28.841	0.000	28.841
Articles:	-	-	-	-	-
FY 2018 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2019 Base Plans:*** Continue redesign of structural components to minimize excessive and premature wear, increase reliability, increase aircraft load capabilities, and improve existing design deficiencies. Continue redesign of the fuel system. Continue redesign of the aircraft electrical power-generating components and aircraft re-wiring to support power requirements for existing and future systems to include stores select-ability, future Avionics Survivability Equipment (ASE), emerging Electronic Warfare (EW), and Degraded Visual Environment (DVE) systems. Continue redesign of the Environmental Control Systems/Thermal to support other avionics on the UH-1Y/AH-1Z. Continue redesign of the drive system components (rotor brake/slip ring/standpipe/gearboxes/ drive shaft and couplers/chip detectors) to increase reliability and reduce high cost and/or failure rates. Continue upgrades and redesign of main and tail rotor blades. Continue survivability upgrades (canted forward chaff buckets, blast frag canopy, opaque armor, self-sealing fuel tanks, sump and backing board). Continue UH-1Y structural improvement program to increase capability including Intrepid Tiger, auxiliary fuel, cabin floor boards to prevent corrosion, floor panel access, and other structural reinforcements. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funds increase from FY18 to FY19 due to transfer of effort from old PE 0604245N beginning in FY19.					
Title: Avionics Improvements	0.000	0.000	21.608	0.000	21.608
Articles:	-	-	-	-	-
FY 2018 Plans: N/A ***FY 2019 Base Plans:*** Continue with software integration, Development Testing (DT) and Validation and Verification (V&V) activities associated with SCS 8.2. Support software design changes associated with SCS 8.2.2 in support of the new JAGM capability. Continue to support Avionics Test Facility (ATF), ATF SCS testing and debug. Initiate development of requirements and software architecture for SCS 9.0 to include Aircraft Network Switch (ANS), Advanced Data Transfer System (ADTS), AIM-9X, Tactical Secure Voice, Second Generation Anti-Jam Tactical UHF Radio for NATO (SATURN), and Variable Message Format (VMF) Protocol for ARC-210 RT-1939A Radio. Complete development efforts on the Mission Computer (TRMC) redesign. Continue design, development and testing for digital interoperability improvements, additional waveform functionality, avionics components /					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions, Article Quantities in Each)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
systems obsolescence mitigation efforts, peculiar avionics support equipment, automatic test equipment and mission computer SCS improvements, Satellite Communications improvement, Full Motion Video, UH-1Y Aft Cabin Display for situational awareness, portable tablet Marine Air-Ground Task Force (MAGTF) improvements, digital interoperability application of Variable Message Formatting (VMF), Aircraft Dependent Surveillance Broadcast (ADS-B), and additional waveform functionality. Continue enhancement efforts digital capability efforts, digital map and data storage capabilities, digital video recording, display systems, digital interoperability, digital systems upgrades, avionics regression testing. Initiate design and development on TAWS, Wireless Intercommunication Systems (WICS), Joint Battlefield Command - Platform (JBC-P), Mobile User Objective System (MUOS) for over the horizon communication, Degraded Visual Environment and collision avoidance capability, Embedded Global Positioning System/Inertial Navigation System (EGI) upgrade for Selective Availability Anti-Spoofing Module (SAASM), GPS non-precision approach capability and GPS signal protection efforts, Crash Survivable Flight Instrument Recorder (CSFIR), and Link tactical data exchange. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funds increase from FY18 to FY19 due to transfer of effort from old PE 0604245N beginning in FY19.					
Accomplishments/Planned Programs Subtotals	0.000	0.000	58.097	0.000	58.097

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
• APN/0178: *UH-1Y/AH-1Z APN1*	861.946	727.637	862.837	-	862.837	62.781	7.657	7.800	8.012	2.044	10,473.739
• APN/0178C: *UH-1Y/AH-1Z APN1 Advance Procurement*	49.208	42.082	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	500.492

Remarks

D. Acquisition Strategy

Follow-on H-1 Improvements will be developed using cost plus fixed fee type contracts.

E. Performance Metrics

Continue hardware and software development and test for follow-on H-1 Improvements.

Exhibit R-3, RDT&E Project Cost Analysis: PB 2019 Navy			Date: February 2018
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Product Development ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2017 Cost	FY 2017 Award Date	FY 2018 Cost	FY 2018 Award Date	FY 2019 Base Cost	FY 2019 Base Award Date	FY 2019 OCO Cost	FY 2019 OCO Award Date	FY 2019 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Primary Hardware Development	SS/CPFF	BHTI : Amarillo, TX	0.000	0.000		0.000		19.828	Jan 2019	-		19.828	53.391	73.219	73.219
Systems Engineering	WR	NAWCAD : Patuxent River, MD	0.000	0.000		0.000		0.685	Nov 2018	-		0.685	4.718	5.403	-
		Subtotal	0.000	0.000		0.000		20.513		-		20.513	58.109	78.622	N/A

Support ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2017 Cost	FY 2017 Award Date	FY 2018 Cost	FY 2018 Award Date	FY 2019 Base Cost	FY 2019 Base Award Date	FY 2019 OCO Cost	FY 2019 OCO Award Date	FY 2019 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Software Development	SS/CPFF	BHTI : Amarillo, TX	0.000	0.000		0.000		2.493	Feb 2019	-		2.493	12.923	15.416	15.416
Software Development	SS/FP	Northrup Grumman : Woodland Hills, CA	0.000	0.000		0.000		7.935	Nov 2018	-		7.935	40.484	48.419	48.419
Software Development	WR	NAWCWD : China Lake, CA	0.000	0.000		0.000		3.566	Nov 2018	-		3.566	18.367	21.933	-
		Subtotal	0.000	0.000		0.000		13.994		-		13.994	71.774	85.768	N/A

Test and Evaluation ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2017 Cost	FY 2017 Award Date	FY 2018 Cost	FY 2018 Award Date	FY 2019 Base Cost	FY 2019 Base Award Date	FY 2019 OCO Cost	FY 2019 OCO Award Date	FY 2019 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Operational Test and Evaluation	WR	COMOPTEVFOR : Norfolk, VA	0.000	0.000		0.000		2.988	Nov 2018	-		2.988	10.012	13.000	-
Development Test and Evaluation	WR	NAWCAD : Patuxent River, MD	0.000	0.000		0.000		19.319	Nov 2018	-		19.319	101.001	120.320	-
		Subtotal	0.000	0.000		0.000		22.307		-		22.307	111.013	133.320	N/A

Exhibit R-3, RDT&E Project Cost Analysis: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 5	**R-1 Program Element (Number/Name)** PE 0604245M / *H-1 Upgrades*	**Project (Number/Name)** 3359 / *H-1 Improvements*

Management Services ($ in Millions)

Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	FY 2017 Cost	FY 2017 Award Date	FY 2018 Cost	FY 2018 Award Date	FY 2019 Base Cost	FY 2019 Base Award Date	FY 2019 OCO Cost	FY 2019 OCO Award Date	FY 2019 Total Cost	Cost To Complete	Total Cost	Target Value of Contract
Contractor Engineering Support	Various	Various : Various	0.000	0.000		0.000		0.338	Nov 2018	-		0.338	1.392	1.730	1.730
Program Management Support	Various	Various : Various	0.000	0.000		0.000		0.703	Nov 2018	-		0.703	4.134	4.837	-
Travel	WR	NAVAIR : Patuxent River, MD	0.000	0.000		0.000		0.242	Oct 2018	-		0.242	Continuing	Continuing	Continuing
		Subtotal	0.000	0.000		0.000		1.283		-		1.283	Continuing	Continuing	N/A

	Prior Years	FY 2017		FY 2018		FY 2019 Base		FY 2019 OCO		FY 2019 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	0.000	0.000		0.000		58.097		-		58.097	Continuing	Continuing	N/A

Remarks

Exhibit R-4, RDT&E Schedule Profile: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 5	**R-1 Program Element (Number/Name)** PE 0604245M / *H-1 Upgrades*	**Project (Number/Name)** 3359 / *H-1 Improvements*

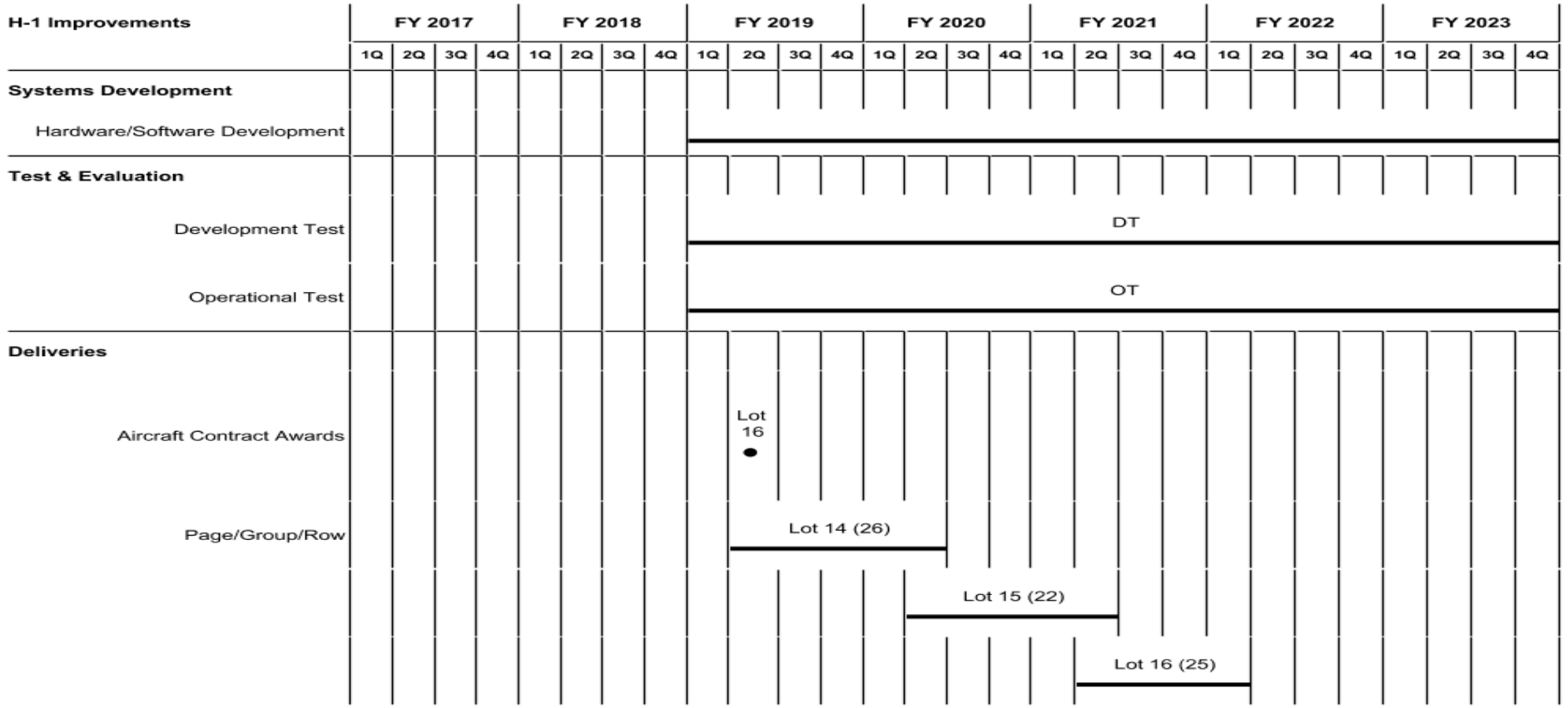

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Exhibit R-4A, RDT&E Schedule Details: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 5	**R-1 Program Element (Number/Name)** PE 0604245M / *H-1 Upgrades*	**Project (Number/Name)** 3359 / *H-1 Improvements*

Schedule Details

	Start		End	
Events by Sub Project	**Quarter**	**Year**	**Quarter**	**Year**
H-1 Improvements				
Systems Development: Hardware/Software Development: Schedule Detail	1	2019	4	2023
Test & Evaluation: Development Test: H-1 Improvements DT	1	2019	4	2023
Test & Evaluation: Operational Test: H-1 Improvements OT	1	2019	4	2023
Deliveries: Aircraft Contract Awards: Lot 16	2	2019	2	2019
Deliveries: Page/Group/Row: Lot 14 FRP Z	2	2019	2	2020
Deliveries: Page/Group/Row: Lot 15 FRP Z	2	2020	2	2021
Deliveries: Page/Group/Row: Lot 16 FRP Z	2	2021	1	2022