United States Government Accountability Office
Report to Congressional Committees
May 2019
GAO-19-336SP

WEAPON SYSTEMS ANNUAL ASSESSMENT

Limited Use of Knowledge-Based Practices Continues to Undercut DOD's Investments

Part 3 Navy and Marine Corps Program Assessments

Accessible Version

Contents

Letter 1

Navy and Marine Corps Program Assessments 1
Amphibious Combat Vehicle Increment 1.1 (ACV 1.1) 4
Air and Missile Defense Radar (AMDR) 6
CH-53K Heavy Lift Replacement Helicopter (CH-53K) 8
CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78) 10
DDG 1000 Zumwalt Class Destroyer (DDG 1000) 12
Ground/Air Task Oriented Radar (G/ATOR) 14
F/A-18E/F Infrared Search and Track (IRST) 16
Joint Precision Approach and Landing System (JPALS) 18
Littoral Combat Ship-Mission Modules (LCS Packages) 20
MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton) 22
MQ-25 Unmanned Aircraft System (MQ-25 Stingray) 24
Next Generation Jammer Mid-Band (NGJ Mid-Band) 26
Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1) 28
SSBN 826 Columbia Class Ballistic Missile Submarine (SSBN 826) 30
Ship to Shore Connector Amphibious Craft (SSC) 32
John Lewis Class Fleet Replenishment Oiler (T-AO 205) 34
VH-92A Presidential Helicopter Replacement Program (VH-92A) 36
DDG 51 Arleigh Burke Class Destroyer, Flight III (DDG 51 Flight III) 38
Guided Missile Frigate (FFG(X)) 39
LHA 8 Amphibious Assault Ship (LHA 8) 40
LPD 17 San Antonio Class Amphibious Transport Dock, Flight II (LPD 17 Flight II) [formerly LX(R)] 41
Next Generation Jammer – Low Band (NGJ-LB) 42
P-8A Poseidon, Increment 3 (P-8A Increment 3) 43
SSN 774 Virginia Class Submarine Block V (SSN 774 Block V) 44

Abbreviations

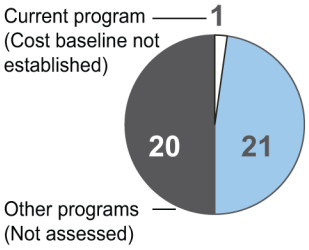
AEHF	Advanced Extremely High Frequency Satellite
CDR	Critical Design Review

CPAF	cost-plus-award-fee
CPFF	cost-plus-fixed-fee
CPIF	cost-plus-incentive fee
CVN 78	Gerald R. Ford Class Nuclear Aircraft Carrier
DAMIR	Defense Acquisition Management Information Retrieval
DDG 51	DDG 51 Arleigh Burke Class Guided Missile Destroyer
DOD	Department of Defense
eSRS	Electronic Subcontracting Reporting System
F-35	F-35 Lightning II Joint Strike Fighter
FFP	firm-fixed-price
FPDS-NG	Federal Procurement Data System-Next Generation
FPI	fixed-price incentive
IDIQ	indefinite-delivery/indefinite-quantity
MDAP	Major Defense Acquisition Program
MH-60R	MH-60R Multi-Mission Helicopter
MRL	manufacturing readiness level
NA	not applicable
NDAA	National Defense Authorization Act
OMB	Office of Management and Budget
P-8A Increment 3	P-8A Poseidon, Increment 3
SAR	Selected Acquisition Report
SBIRS High	Space Based Infrared System High
SSN 774	SSN 774 Virginia Class Submarine
TBD	to be determined
TRL	technology readiness level
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
WIN-T Inc. 2	Warfighter Information Network-Tactical Increment 2
WIN-T Inc. 3	Warfighter Information Network-Tactical Increment 3
WSARA	Weapon Systems Acquisition Reform Act

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.

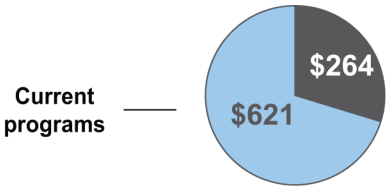
NAVY and MARINE CORPS PROGRAM ASSESSMENTS

GAO Assessed 21 of the Navy's 42 Current Major Defense Acquisition Programs



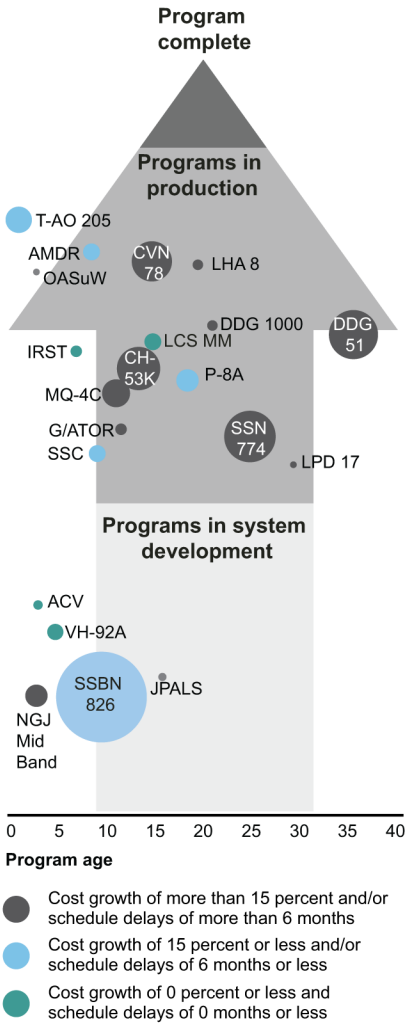
The 21 Current Programs GAO Assessed Represent 70 Percent of the Navy's $885 Billion Estimated Total Acquisition Costs

(Fiscal year 2019 dollars in billions)



- We also assessed two future major defense acquisition programs. We did not assess programs that had yet to enter technology development or had already progressed into full-rate production.

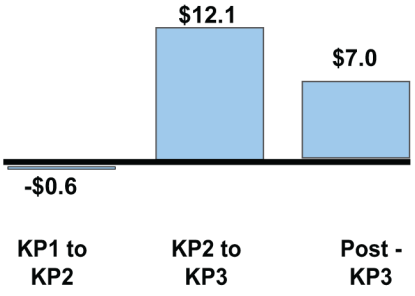
Most Current Programs GAO Assessed Have Either Cost Growth, Schedule Delays, or Both



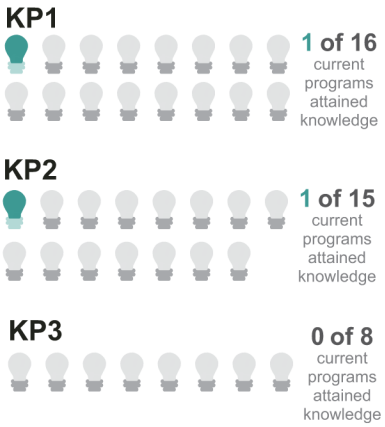
Note: Bubble size is based on each program's currently estimated future acquisition funding needed.

Total Acquisition Cost Performance in Current Programs Varied Among Knowledge Points (KP)

(Fiscal year 2019 dollars in billions)



Most Current Programs Did Not Attain Knowledge at Key Points



- We did not assess knowledge attainment for five current programs that are well into production, or for one current program that did not have a baseline as of December 2017.
- For shipbuilding programs, we correlated detail design contract award, fabrication start, and lead ship delivery with development start, critical design review, and production start, respectively. Shipbuilding programs are excluded from KP3 because our best practices do not identify a corresponding knowledge point for ships.

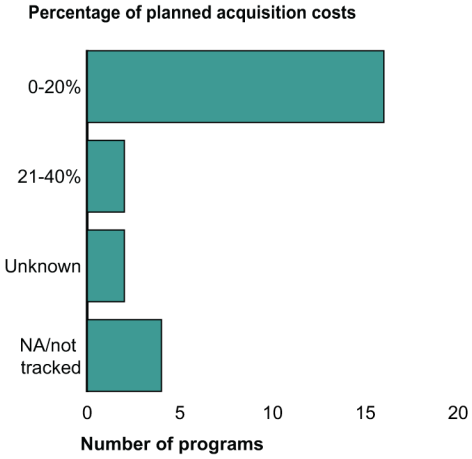
Average Acquisition Cycle Time of Current Programs Increased by 29 Months from First Full Estimate (FFE) to Current Estimate

- One current program—MQ-25—entered system development after December 2017 and therefore is excluded from our cost, schedule, knowledge attainment, and contract analysis.
- Cost and schedule analysis is primarily based on estimates from December 2017 selected acquisition reports. This information may differ from the amounts reported in the individual assessments, which are based on more recent program estimates in some cases. Please see appendix II for details.

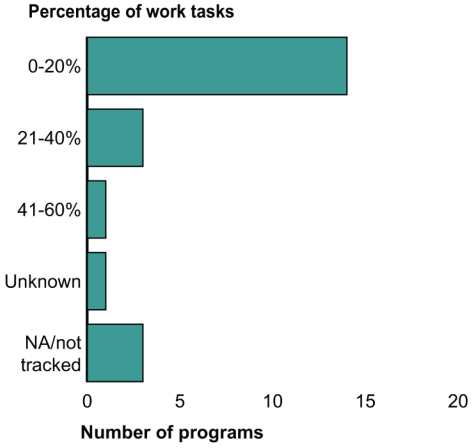
Source: GAO analysis of Department of Defense data. | GAO-19-336SP

NAVY and MARINE CORPS PROGRAM ASSESSMENTS

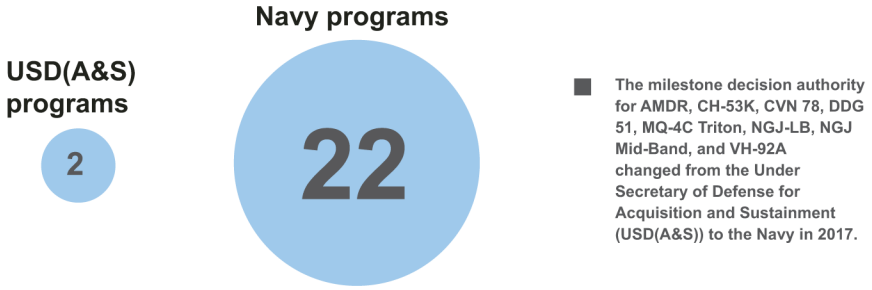
Most Current and Future Navy Programs Report that Less than 20 Percent of Planned Acquisition Costs are Specifically for Software



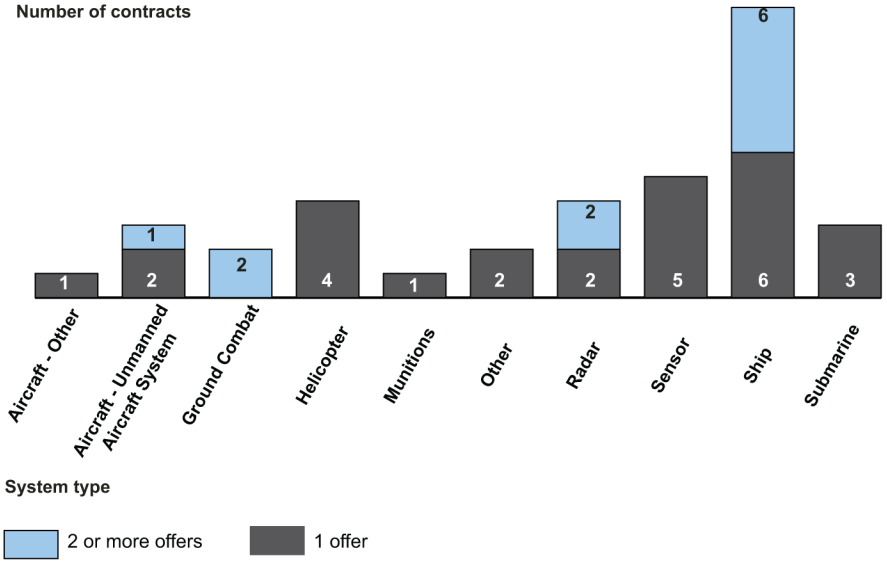
Most Current Navy Programs Report that Less than 20 Percent of Work Tasks are Software-Related



The Navy was the Milestone Decision Authority in 2017 for 22 of its Current and Future Programs in GAO's Review



The Navy Received One Offer on Solicitations for Just Over Two Thirds of its Currently Reported Major Contracts for Development and Procurement



Source: GAO analysis of Department of Defense data. | GAO-19-336SP

Navy and Marine Corps Program Assessments[a]	Page number
2-page assessments	
Amphibious Combat Vehicle Increment 1.1 (ACV 1.1)	
Air and Missile Defense Radar (AMDR)	
CH-53K Heavy Lift Replacement Helicopter (CH-53K)	
CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)	
DDG 1000 Zumwalt Class Destroyer (DDG 1000)	
Ground/Air Task Oriented Radar (G/ATOR)	
F/A-18E/F Infrared Search and Track (IRST)	
Joint Precision Approach and Landing System (JPALS)	
Littoral Combat Ship-Mission Modules (LCS Packages)	
MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)	
MQ-25 Unmanned Aircraft System (MQ-25 Stingray)	
Next Generation Jammer Mid-Band (NGJ Mid-Band)	
Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1)	
SSBN 826 Columbia Class Ballistic Missile Submarine (SSBN 826)	
Ship to Shore Connector Amphibious Craft (SSC)	
John Lewis Class Fleet Replenishment Oiler (T-AO 205)	
VH-92A Presidential Helicopter Replacement Program (VH-92A)	
1-page assessments[b]	
DDG 51 Arleigh Burke Class Destroyer, Flight III (DDG 51 Flight III)	
Guided Missile Frigate (FFG(X))	
LHA 8 Amphibious Assault Ship (LHA 8)	
LPD 17 San Antonio Class Amphibious Transport Dock, Flight II (LPD 17 Flight II) [formerly LX(R)]	
Next Generation Jammer – Low Band (NGJ-LB)	
P-8A Poseidon, Increment 3 (P-8A Increment 3)	
SSN 774 Virginia Class Submarine Block V (SSN 774 Block V)	

[a]We abbreviate the following contract types in the individual assessments: cost-plus-award-fee (CPAF), cost-plus-fixed-fee (CPFF), cost-plus-incentive-fee (CPIF), firm-fixed-price (FFP), and fixed-price incentive (FPI).

[b]DDG 51 Flight III, LHA 8, LPD 17 Flight II, P-8A Increment 3, and SSN 774 Block V are current major defense acquisition programs that are well into production, but we have assessed them in a one-page format because they are planning to introduce new increments of capability.

Source: BAE.

Amphibious Combat Vehicle Increment 1.1 (ACV 1.1)

The Marine Corps' ACV is the successor program to the canceled Expeditionary Fighting Vehicle. The ACV is intended to transport Marines from ship to shore and provide them with improved mobility and high levels of protection. The ACV acquisition approach calls for three increments of development (1.1, 1.2, and 2.0) and leverages work accomplished under the EFV program. We assessed increment 1.1. Late in our assessment period, in January 2019, the Navy merged ACV 1.1 and ACV 1.2 into a single program, the ACV Family of Vehicles.

Program Essentials

Milestone decision authority: Navy

Program office: Stafford, VA

Prime contractors: BAE Systems and Land Armaments LP; Science Applications International Corporation (SAIC)

Contract types: FPI/FFP/CPFF (development—SAIC) (development and low-rate initial production—BAE Systems and Land Armaments LP)

Software development approach: NA

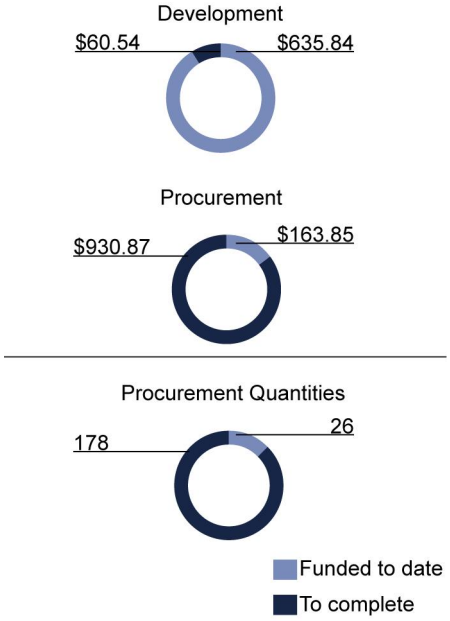
Next major milestone: Start of operational testing (February 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (05/2016)	Latest (07/2018)	Percentage change
Development	$821.70	$696.40	-15.3%
Procurement	$1,091.80	$1,094.70	+0.3%
Unit cost	$8.18	$7.64	-6.6%
Acquisition cycle time (months)	57	57	0.00%
Total quantities	240	240	0.00%

Total quantities comprise 36 development quantities and 204 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	○
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	●	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

ACV 1.1 Program

Technology Maturity, Design Stability, and Production Readiness

The ACV 1.1 program has matured its critical technologies and stabilized its system design. However, the ACV 1.1 contractor is building vehicles prior to bringing critical manufacturing processes into statistical control—an approach inconsistent with best practices.

The ACV 1.1's two critical technologies—the driver vision enhancement system and the remote weapon station—are fully mature. According to program officials, the ACV 1.1 has exceeded its reliability growth targets in its most recent tests, excluding failures related to the government-furnished remote weapon station. Program officials added that they are conducting dedicated testing to localize and determine a root cause for the remote weapon station failures.

The ACV 1.1 program released 100 percent of its design drawings before the production decision in June 2018. The Navy approved the program's entry into low-rate initial production with the selected contractor's (BAE Systems) manufacturing readiness below the level recommended by the Department of Defense guidance and best practices. An assessment made by the Defense Contract Management Agency for the ACV 1.1 production readiness review identified high-risk areas such as manufacturing personnel and process capability and control. Three months before the production decision, the program conducted a risk assessment and reported two areas as risks to the overall ACV 1.1 production schedule: facilities and personnel. Program officials said that, in June 2018, BAE Systems submitted a risk mitigation plan that addresses these manufacturing risks, and the program is monitoring its implementation.

The program reported that following the production decision, the Marine Corps exercised a contract option with BAE Systems for 30 low-rate initial production vehicles. Officials also reported that in December 2018, the Marine Corps exercised another contract option with BAE Systems for a second lot of 30 vehicles.

Other Program Issues

The Marine Corps selected BAE Systems from two competing contractors for ACV 1.1 low-rate initial production. During the development phase, two contractors designed and produced 16 prototypes each. Starting in March 2017, the program conducted developmental and live fire testing of the prototypes to determine the extent to which they met capability requirements such as technical performance, reliability, force protection, and system survivability. The Marine Corps subsequently conducted an operational assessment from January to March 2018 to inform the contractor selection and the decision to enter production. The operational assessment did not identify any systemic problems that would necessitate a major redesign, and live fire testing indicated that prototypes met key force protection requirements. However, the Director, Operational Test and Evaluation, made recommendations as a result of the tests, including to investigate ways to prevent damage to steering and suspension from debris, and to modify the troop commander's station to make it easier to move between the hatch and seat. Since the operational assessment, the program has held corrective action periods to implement minor design modifications in response to testing and plans to continue developmental testing into December 2019.

Officials stated that the program has awarded a production contract to BAE Systems that includes options for the production of the second increment of the ACV (ACV 1.2). The primary intended upgrade for ACV 1.2 over ACV 1.1 was improved amphibious capability, including the ability to self-deploy from an amphibious ship and travel to shore. However, the program developed and tested these capabilities during the development of ACV 1.1. As result, the ACV program officials said that they expect the transition to the next increment will be relatively seamless.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office noted that, in January 2019, it received approval from the Navy to merge the ACV programs into a single program, the ACV Family of Vehicles. The program office said that this merger includes acquiring ACV 1.1 and ACV 1.2 under a single set of performance requirements, developing additional ACV models with different mission profiles, and updating acquisition documentation for the full-rate production decision review. The program office also stated that it is continuing low-rate initial production and plans to test production representative vehicles beginning in the third quarter of fiscal year 2019.

Source: © 2015 Raytheon Company.

Air and Missile Defense Radar (AMDR)

The Navy's AMDR is a next-generation radar program supporting surface warfare and integrated air and missile defense. The Navy expects AMDR's radar—known as AN/SPY-6(V)1—to provide increased sensitivity for long-range detection to improve ballistic missile defense against advanced threats. The program office is also developing a radar suite controller that will interface with an upgraded Aegis combat system to provide integrated air and missile defense for DDG 51 Flight III destroyers.

Program Essentials

Milestone decision authority: Navy

Program office: Washington Navy Yard, DC

Prime contractor: Raytheon

Contract types: CPIF (development)

FPI (low-rate initial production)

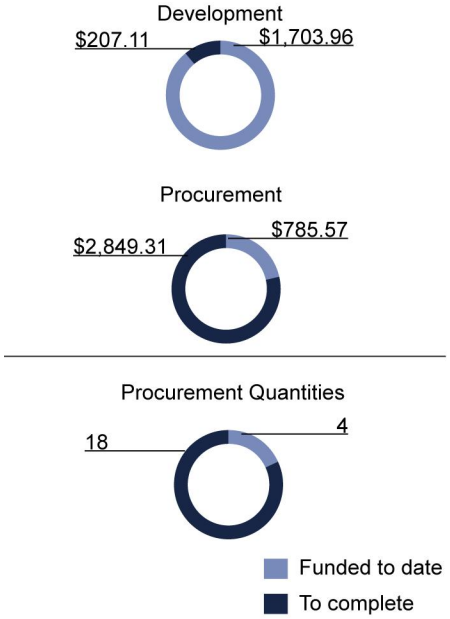
Software development approach: Agile development

Next major milestone: First production radar delivery (April 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (10/2013)	Latest (06/2018)	Percentage change
Development	$2,029.70	$1,911.10	-5.8%
Procurement	$4,197.80	$3,634.90	-13.4%
Unit cost	$284.50	$253.51	-10.9%
Acquisition cycle time (months)	156	161	+3.2%
Total quantities	22	22	0.00%

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	●	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	○	○

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

AMDR Program

Technology Maturity and Design Stability

The program office reported that AMDR's four critical technologies are mature—although we disagree—and that the system design is stable. Since our 2018 assessment, the program office has further demonstrated the radar system's performance and capabilities through live testing and simulation. However, based on industry best practices, the program cannot fully demonstrate all critical technologies until the Navy tests them in their realistic, at-sea environment with the Aegis combat system. According to the AMDR program schedule, such testing will occur in 2023 during operational testing with a DDG 51 Flight III ship. Until the Navy completes this testing, the program's design stability remains at risk for disruption. Specifically, any performance deficiencies the Navy discovers during at-sea testing could require it to revise existing design drawings to remedy issues.

As part of developmental testing, the program office tested a full-scale, single-face radar array at the Navy's Pacific Missile Range Facility (PMRF) beginning in September 2016. The program office successfully completed several live ballistic missile defense, anti-air, and anti-surface warfare tests. However, in March 2018, the array failed a ballistic missile test because of a defective software update that caused the array to stop tracking a live target. Officials said a software update corrected the issue and they verified the array's performance through a successful retest in January 2019. Officials said the single-face array, originally scheduled to support Aegis combat system equipment testing, will undergo additional testing at PMRF through 2019. As a result, the Navy has revised the acquisition schedule and will instead divert the delivery of a new array to support land-based Aegis combat system equipment testing sometime in 2019.

The program has completed software development to support core radar capabilities and will continue to develop radar updates to support system improvements, cybersecurity, and combat system integration through 2021. In parallel to the radar's software development, significant software development remains to integrate AMDR with the Aegis combat system. Program officials said this software development must complete before both systems can be fully integrated and tested. While the Navy plans to test the radar and initial Aegis combat system software at a land-based site, the Navy will not test the radar and final Aegis combat system until both are installed on the lead ship. Any issues identified after the systems are installed on the lead ship could require retrofits to the radar or ship.

Production Readiness

Nearly 18 months after entering production, the program has not demonstrated that all of its critical manufacturing processes are in statistical control. The program reported that it exercised a contract option for the fourth low-rate initial production unit in April 2018 and was authorized to procure five additional low-rate production units in February 2019. However, in August 2018, the contractor reported early cost growth and schedule variance for the first three low-rate production units because of increased material costs and other production delays. Officials said the delays are partly due to a problem with a digital receiver component, which the contractor is testing. As a result, contractor delivery of the first production radar is at risk of delay from December 2019 to April 2020.

The AMDR program office plans to procure more than two-thirds of its 22 total radars prior to completing operational testing. The Navy deliberately planned for AMDR to begin production prior to the start of Aegis upgrade software development to allow time for key radar technologies to mature and for the design to stabilize. However, this concurrency means any deficiencies identified during combat system integration or operational testing may lead to retrofitting after production is underway or complete for many of the radars. Any required retrofitting is likely to increase program costs or delay radar deliveries.

Other Program Issues

DOD's Director, Operational Test and Evaluation (DOT&E) has yet to approve the AMDR Test and Evaluation Master Plan. DOT&E stated that the proposed test approach for the AMDR and DDG 51 Flight III programs does not provide realistic operational conditions without the use of an AMDR- and Aegis-equipped unmanned self-defense test ship. Because the Navy has elected not to request funds for a test ship, DOT&E and the Navy are revising the DDG 51 Flight III operational test strategy to include AMDR operational requirements and an updated simulation strategy. DOT&E cautioned, however, that DDG 51 Flight III's self-defense and survivability capabilities will not be fully known until the program completes operational testing.

Program Office Comments and GAO Response

We provided a draft of this assessment to the program office for review and comment. In its comments, the program office disagreed with our assessment of the program's technology maturity, stating that combat system testing is not required to demonstrate mature radar technologies since the technologies have been tested and proven at the land-based PMRF site. We disagree. The PMRF site does not provide a realistic, at-sea environment to test the fit and function of the radar and combat system on a ship.

Source: U.S. Navy.

CH-53K Heavy Lift Replacement Helicopter (CH-53K)

The Marine Corps' CH-53K heavy-lift helicopter is intended to transport armored vehicles, equipment, and personnel to support operations deep inland from a sea-based center of operations. The CH-53K is expected to replace the legacy CH-53E helicopter and provide increased range and payload, survivability and force protection, reliability and maintainability, and coordination with other assets, while reducing total ownership costs.

Program Essentials

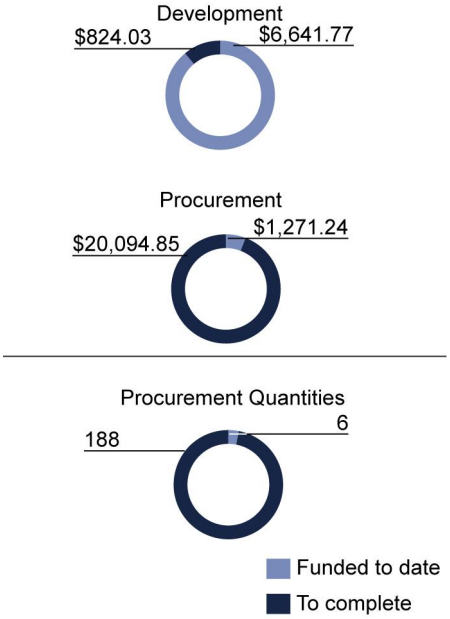
Milestone decision authority: Navy
Program office: Patuxent River, MD
Prime contractor: Sikorsky Aircraft
Contract type: CPIF (development) FFP/CPFF (engine development) FPI/CPFF/FFP (LRIP)
Software development approach: Mixed
Next major milestone: Start of operational testing (May 2021)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (12/2005)	Latest (07/2018)	Percentage change
Development	$4,902.9	$7,465.8	+52.3%
Procurement	$13,635.6	$21,366.1	+56.7%
Unit cost	$118.84	$144.23	+21.4%
Acquisition cycle time (months)	117	187	+59.8%
Total quantities	156	200	+28.2%

Total quantities comprise 6 development and 194 procurement quantities. Latest initial capability date reflects a 16-month delay from the July 2018 estimate. The program has not yet determined any associated cost changes.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	●	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

CH-53K Program

Technology Maturity, Design Stability, and Production Readiness

The CH-53K program entered production in March 2017 with mature critical technologies and a stable design, but without demonstrated production processes. Due to a number of technical deficiencies identified through developmental testing, since last year's assessment, the program office has delayed the start of operational testing by almost 2 years, to May 2021, and postponed initial operational capability by 20 months, to September 2021.

The program office identified two critical technologies—the main rotor blade and the main gearbox—for CH-53K. Although,the program office reported that both critical technologies are mature, there are technical issues with the main gear box causing low service life projections. The program office also noted that while there are parts shortages with the main gearbox,the supplier has recently improved its manufacturing processes in an effort to reduce the backlog of needed parts. It is too soon to tell if this will reduce the parts shortages.

The program office also reported that it has released 99 percent of CH-53K design drawings, which constitutes a stable design. Nonetheless, recent deficiencies discovered in developmental testing may require the program to undertake design changes that could disrupt that design stability.Developmental tests have revealed high engine bay temperatures, which could cause exhaust gas to enter the aircraft fuselage during operations. The program extended its developmental testing into January 2021. Program officials stated that all technical problems likely will not be addressed before operational testing begins in May 2021. The program office is currently amending its test plan and is considering different scenarios to address this situation.

Delivery of production aircraft is scheduled for the fourth quarter of fiscal year 2020. The program has yet to demonstrate that its critical manufacturing processes are in statistical control—an approach inconsistent with best practices. Since our 2018 assessment, the program delayed award of a planned second low-rate initial production contract for four aircraft. The program planned to award this contract in March 2018, but changes to the program's test plan have caused the program to delay this award.

Further, the CH-53K contractor has delivered to the Navy only three of six planned system demonstration test articles. The contractor was scheduled to deliver the fourth test article to the Navy in the first quarter of fiscal year 2019. However, the contractor used the fourth test article to supply parts for the first three due to parts shortages. The contractor now plans to deliver the fourth aircraft by December 2020. According to the program office, the first two test articles are currently being used for developmental testing while the third was delivered to the Marines for logistics demonstration projects. The program plans to use the first four test articles in operational testing. However, the first three will need to be modified first, which is not expected to be completed by the start of testing. If the fourth aircraft delivery is delayed again, the Navy will have to delay operational testing until the aircraft are ready.

Other Program Issues

The program office has increasingly discovered software deficiencies over the past year. Specifically, developmental testing showed a failure in the software to detect the transition from ground to flight causing increased safety concerns. The program is currently working to solve this problem through additional software development. The program office stated they generally revised the software plan so they could be more flexible in addressing software deficiencies. The program office also reported increased risk in completing additional software development efforts to meet cyber security needs. According to the office of the Director, Operational Test and Evaluation, the program updated its test and evaulation plan to emphasize cyber security test strategies.

In addition, the contractor moved the CH-53K assembly line from West Palm Beach, Florida, to Stratford, Connecticut, in June 2018. The final two test articles will be produced in Connecticut, but the program office does not expect the relocation to affect production.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that, because of technical issues during developmental testing, the program has completed test events slower than planned, which has affected schedule and cost. The program will miss four key baseline dates, and the program is establishing a new schedule baseline. The program office noted the planned dates for initial capability, end operational test, and full-rate decision are tentative pending a revised acquisition program baseline. The program's top priorities for the start of operational testing are to resolve the remaining technical issues and complete airworthiness certification testing. Specifically, the program office stated that it has prioritized the flight test plan to address the top technical issues, correct other technical deficiencies, and deploy the fleet as planned in 2024.

Source: U.S. Navy.

CVN 78 Gerald R. Ford Class Nuclear Aircraft Carrier (CVN 78)

The Navy developed the CVN 78 (or Ford Class) nuclear-powered aircraft carrier to introduce new propulsion, aircraft launch and recovery, and survivability capabilities to the carrier fleet. The Ford Class is the successor to the Nimitz Class aircraft carrier. Its new technologies are intended to create operational efficiencies while enabling a 33 percent increase in sustained operational aircraft flights over legacy carriers. The Navy also expects the new technologies to enable Ford Class carriers to operate with reduced manpower.

Program Essentials

Milestone decision authority: Navy

Program office: Washington, DC

Prime contractor: Huntington Ingalls Industries

Contract types: CPFF/CPIF (CVN 79 construction preparation); CPFF/FPI (CVN 79 detail design and construction); CPFF/undefinitized (CVN 80 advance procurement); FPI (CVN 80/81 detail design and construction)

Next major milestone: Initial operational capability (July 2019)

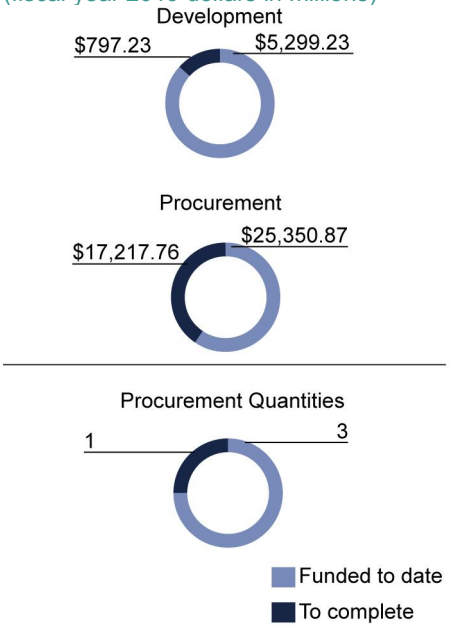
Software development approach: NA

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (04/2004)	Latest (06/2018)	Percentage change
Development	$5,378.60	$6,096.50	+13.3%
Procurement	$34,456.50	$42,568.60	+23.5%
Unit cost	$13,278.37	$12,213.29	-8.0%
Acquisition cycle time (months)	137	183	+33.6%
Total quantities	3	4	+33.3%

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at Detail Design Contract Award	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	○	●
Product design is stable	**Fabrication Start**	
• Complete basic and functional design to include 100 percent of 3D product modeling	○	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

CVN 78 Program

Technology Maturity, Design Stability, and Production Readiness

The Navy accepted delivery of the lead ship, CVN 78, in May 2017 despite challenges related to immature technologies and struggles to demonstrate the reliability of mature systems. The Navy reports that 10 of the Ford Class's 12 critical technologies are fully mature—the advanced arresting gear (AAG) and one of the ship's missile systems are not yet mature. The advanced weapons elevators are among the systems deemed mature by the Navy; however, according to Navy officials, only 2 of the 11 elevators installed on the ship can bring munitions to the flight deck—a key element of operational flights. The shipbuilder is working to correct the system during its first post-delivery maintenance period, now scheduled to end in October 2019, and the Navy plans to create a land-based site to test the elevators, which will come at an additional cost.

Shipboard testing is ongoing for several critical systems and could delay future operational testing. Those systems include the electromagnetic aircraft launch system (EMALS), AAG, and dual band radar (DBR). Although the Navy is testing EMALS and AAG on the ship with aircraft, the reliability of those systems remains a concern. If these systems cannot function safely, CVN 78 will not demonstrate it can rapidly deploy aircraft—a key requirement for these carriers. Recent shipboard testing revealed that the Navy is struggling to get DBR to operate as planned. Moreover, DBR poses a greater radiation hazard to personnel and systems on an aircraft carrier than the Navy anticipated, which could restrict certain types of flight operations.

The remaining challenges the Navy faces in maturing CVN 78's critical technologies could lead to their redesign or replacement on later ships. This would include CVN 79, which is currently 55 percent complete, as well as the third and fourth ships, CVNs 80 and 81. CVN 79 repeats the CVN 78 design with some modifications and replaces DBR with the Enterprise Air Surveillance Radar (EASR), which is in development. The Navy does not identify this new system as a critical technology in the Ford Class program because it derives from the pre-existing Air and Missile Defense Radar (AMDR) program. However, EASR is a different size and performs a different mission than the AMDR systems, which are designed for destroyers. Therefore, EASR may still require design and development efforts to function on the carrier.The Navy plans to procure two EASR units for CVNs 79 and 80 and install the CVN 79 unit during that ship's second phase of delivery. CVNs 80 and 81 will repeat the design of CVN 79.

Other Program Issues

CVN 78's procurement costs increased by 23 percent over its initial cost cap and as a result of continuing technical deficiencies, the Navy may still require more funding to complete this ship. The Navy increased the current $12.9 billion cost cap for CVN 78 by $120 million in May 2018 to account for additional post-delivery work, but added work and cost changes may result in an additional cost increase.

Costs for CVN 79 are also likely to increase as a result of optimistic cost and labor targets, putting the ship at risk of exceeding its $11.4 billion cost cap. The CVN 79 cost estimate assumes unprecedented construction efficiency—labor hours will be 18 percent lower than CVN 78. However, our analysis shows the shipbuilder is not meeting this goal and is unlikely to improve performance enough to meet cost and labor targets.

Congress raised the cost cap for CVN 80 and later ships to $12.6 billion and approved the Navy's plans to buy two carriers—CVNs 80 and 81—at the same time, based on the shipbuilder's estimate that this strategy will save the Navy over $2 billion. However, it is unclear whether the Navy can meet this cost cap, even with the estimated savings from a two-ship buy, because it assumes further reductions in subsystem costs, construction change orders, and labor hours. The Navy projects a further reduction in labor hours compared to CVN 79—about 25 percent fewer labor hours than CVN 78—will contribute to cost savings for these ships.

The program office indicated that it does not separately track or report information on software development to integrate the various subsystems of the ship. These subsystems include CVN 78's combat control systems, which rely on integrating systems through software intensive development.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that, in July 2018, CVN 78 entered a year-long maintenance period. It also said that, as of February 2019, two advanced weapons elevators are operating, and it continues to improve developmental system reliability.

The program also stated that, with CVN 79 construction 55 percent complete, shipbuilder cost performance remains stable, but slightly below the level needed to achieve production labor hour reduction targets. The program stated that the shipbuilder continues to work through the effects of material shortfalls that disrupted performance. The program said that the Navy plans to deliver a complete, deployable ship as scheduled and within the cost cap to maintain an 11-carrier fleet.

The program office also stated that the Navy awarded the CVN 80/81 procurement contract in January 2019 and expects to save $4 billion, compared to if it had purchased each ship individually. According to the program, the contract limits the Navy's liability and incentivizes the shipyard's best performance.

Source: U.S. Navy.

DDG 1000 Zumwalt Class Destroyer (DDG 1000)

The DDG 1000 destroyer is a multi-mission surface ship initially designed to provide advanced capability to support forces on land. DDG 1000 class ships feature a stealth design, integrated power system, and total ship computing environment. The Navy adopted a phased acquisition strategy, which separates delivery and acceptance of hull, mechanical, and electrical (HM&E) systems from combat system activation and testing. The Navy has recently changed DDG 1000's primary mission from land attack to offensive surface strike.

Program Essentials

Milestone decision authority: Navy

Program office: Washington, DC

Prime contractors: General Dynamics Bath Iron Works; BAE Systems; Huntington Ingalls Industries; Raytheon

Contract types: FPI/FFP/CPFF (ship construction); FPI/CPFF(advanced gun systems equipment); CPFF/CPAF (mission systems equipment)

Software development approach: Mixed

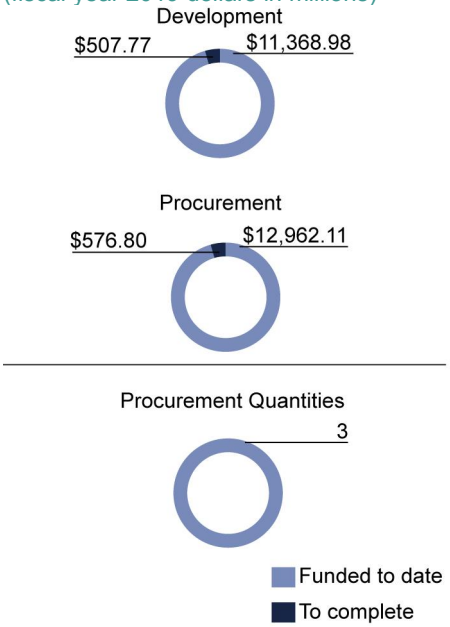
Next major milestone: Lead-ship final delivery (May 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (01/1998)	Latest (06/2018)	Percentage change
Development	$2,550.53	$11,876.75	+365.7%
Procurement	$36,414.13	$13,538.91	-62.8%
Unit cost	1,217.65	8,471.89	+595.8%
Acquisition cycle time (months)	128	273	+113.3%
Total quantities	32	3	-90.63%

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at Detail Design Contract Award	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	●	●
Product design is stable	**Fabrication Start**	
• Complete basic and functional design to include 100 percent of 3D product modeling	○	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

DDG 1000 Program

Technology Maturity and Design Stability

The DDG 1000 program has fully matured most, but not all, of its nine current critical technologies and reports a stable design. According to the Navy, the fire suppression system, hull form, deckhouse, power system, and undersea warfare suite technologies are all mature. At the same time, the vertical launch system, infrared signature, multi-function radar, and total ship computing environment technologies each continue to approach maturity. The Navy expects to fully mature these systems as it completes ship construction, certification, and testing over the next 2 years.

The program originally had 12 critical technologies, but in the last several years, the Navy removed three, including two technologies associated with the advanced gun system—the projectile and the gun—because of the projectile's high cost per round. The Navy planned to rely on these munitions for precision fires and offensive operations. Following an evaluation of five other munition options, the Navy determined that no viable replacement, guided or unguided, was feasible. As a result, the guns will remain inoperable on the ships for the foreseeable future. Lastly, the Navy will use a modified multi-function radar in place of a volume search radar, which the Navy removed from the class.

As we have previously reported, the Navy and its shipbuilders had not stabilized DDG 1000's design by lead ship fabrication start in 2009—an approach inconsistent with best practices. This approach contributed to numerous design changes after the fabrication start and significant cost increases and schedule delays. Nearly 10 years later, development and shipboard testing of technologies continues, each of which could lead to discovery that could disrupt the design stability the Navy currently claims.

The Navy plans to complete software development for the class in September 2020—a delay of 24 months since our 2018 assessment. As a result, the Navy has had to delay some testing. Also that month, the program plans to complete its cyber security vulnerability evaluation along with the remainder of a 2-year regimen of certifications and several different tests. The Navy expects this regimen to demonstrate the full functionality of the ship's systems.

Production Readiness

The DDG 1000 shipbuilder is approaching completion of the hull, mechanical, and electrical (HM&E) systems for all three ships of the class. Shipbuilder delivery of the lead ship's HM&E occurred 18 months behind schedule, in part because of problems completing electrical work associated with the ship's power system. The shipbuilder also experienced problems completing the power system for DDG 1001, the second ship in the class. Following sea trials, the Navy inspected one of the ship's main turbine generators and found that the generator was damaged by a woodscrew. The damage was extensive enough that the Navy chose to replace the engine and send it for repair. Officials report that the shipbuilder delivered the ship in April 2018 and the Navy replaced the engine in September 2018 at its expense.

The Navy has scheduled DDG 1000's final delivery, including HM&E and combat systems, for May 2019. The Navy has scheduled DDG 1001's final delivery to follow in September 2020. However, the Navy is still working to correct serious deficiencies that its Board of Inspection and Survey has identified on both ships. Specifically, the board found over 320 serious deficiencies when the shipbuilder delivered DDG 1000's HM&E in May 2016, and 246 serious deficiences after the Navy conducted acceptance trials for DDG 1001 in January and February 2018. This increases the likelihood that the ship will not be fully capable and sustainable when provided to the fleet.

To limit further delays to DDG 1000 and DDG 1001 construction, the Navy has authorized its shipbuilder to take parts from DDG 1002—the third and final ship of the class, which is under construction. The Navy does not yet know the full extent to which these actions will delay DDG 1002's construction schedule, but stated that these parts typically can be borrowed and replaced without causing a delay. The Navy has scheduled the ship's HM&E delivery in March 2020 followed by final delivery in September 2022.

Other Program Issues

In a January 2018 decision memorandum, the Navy changed DDG 1000's primary mission from land attack to offensive surface strike. Navy officials are in the process of determining the operational concept for the ship within its new mission. The Navy has yet to establish testing plans to evaluate these future mission sets. According to Navy officials, the Navy's planned modifications to support the new mission will cost about $1 billion, from non-acquisition accounts.

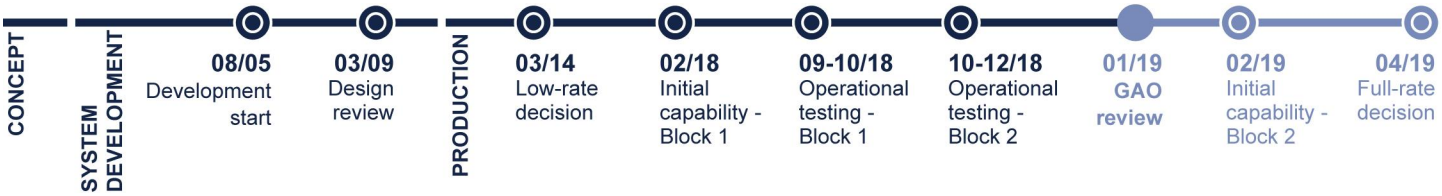
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office also stated that it is making good progress delivering the Zumwalt class. The Navy said that, since our assessment, DDG 1000 completed combat systems availability, combat tests are underway, and final delivery is now planned for September 2019. The program office also said that DDG 1001 started combat systems availability in April 2019, and DDG 1002 is 84 percent constructed. The program office further noted that future addition of new systems onto Zumwalt-class ships will provide offensive fire capabilities.

Source: U.S. Marine Corps.

Ground/Air Task Oriented Radar (G/ATOR)

The Marine Corps' G/ATOR is a three-dimensional, short-to-medium range, multi-role radar designed to detect, identify, and track threats such as incoming cruise missiles, rockets, and artillery. It will replace five legacy radars. G/ATOR is being acquired in blocks, with later blocks focused on software upgrades. We assessed Block 1, which has an air defense and surveillance role, and have made observations on Block 2, which will determine enemy firing positions and point of impact for incoming fire.



Program Essentials

Milestone decision authority: Navy

Program office: Quantico, VA

Prime contractor: Northrop Grumman

Contract type: FPI/CPFF/FFP (low-rate initial production)

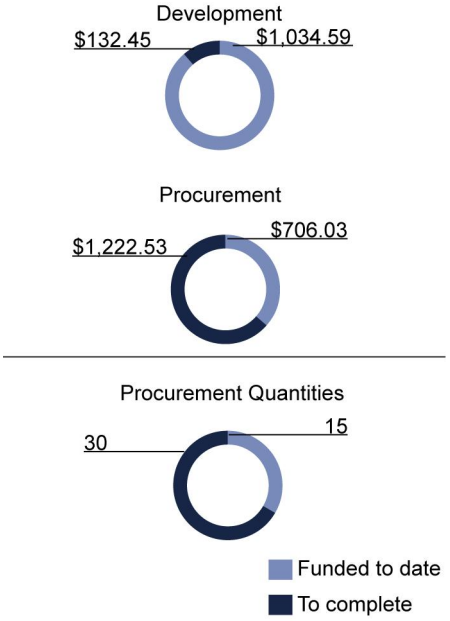
Software development approach: Incremental

Next major milestone: Initial operational capability for Block 2 (February 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (08/2005)	Latest (07/2018)	Percentage change
Development	$396.50	$1,167.00	+194.4%
Procurement	$1,244.90	$1,928.60	+54.9%
Unit cost	$25.65	$68.79	+168.2%
Acquisition cycle time (months)	61	150	+145.9%
Total quantities	64	45	-29.7%

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	…	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	…	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	●
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	●	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

G/ATOR Program

Technology Maturity, Design Stability, and Production Readiness

According to the G/ATOR program office, the radar's six critical technologies are mature, design is stable, and production processes are in control as the program approaches its full-rate production decision in April 2019. We were unable to assess G/ATOR's technology maturity at development start because the program did not generate the type of information needed for such an assessment.

The program office stated that the system is on track to demonstrate all of its key performance requirements; however, system reliability—while improved—remains a concern due mostly to software issues. The program's operational assessment, conducted from March to May 2018, raised a series of reliability and usability deficiences that the program is working to address.

Program officials stated that the Marine Corps decided to wait to field the Block 2 radar until 2019 due to the issues raised during the operational assessment. During that assessment, Marine Corps testers noted that while Block 2 radar offered greater detection ranges than current radars, those advantages were offset by reliability concerns, among other issues. According to program officials, several of the issues raised in the assessment resulted from the Marine testers being inexperienced and unfamiliar with operating the radar system. In other cases, they were due to known software problems, which the program said that it has addressed. The operational assessment resulted in eight recommendations, and program officials stated they have taken actions to address them.

The program completed operational testing, which assessed the effectiveness, suitability, and survivability of the Block 1 and Block 2 radars, in October and December 2018, respectively. The testing report for Block 1 found it to be operationally effective, suitable, and survivable. However, the testing report for Block 2 was not complete at the time of our review.

The G/ATOR program is well into low-rate initial production and its production processes have matured. At the program's March 2014 production decision, the contractor had demonstrated G/ATOR production processes to the DOD recommended level, but had not brought them into statistical control, which was inconsistent with best practices. In 2018, the program completed a production readiness review to support full-rate production and reported that its production processes are now in statistical control. The Marine Corps accepted delivery of eight production radars in 2018 as scheduled, and the contractor delivered the first two radars incorporating new semiconductor technology about one month ahead of schedule.

Beginning with radars produced in 2016, the program upgraded G/ATOR's "transmit/receive modules"—key components that process signals from and to the radar—to a new, but mature gallium nitride (GaN) semiconductor technology. The GaN semiconductors fit inside the G/ATOR system the same way as the older gallium arsenide (GaAs) semiconductors they replaced. Program officials expect the GaN technology to achieve better performance with higher reliability at lower cost by reducing the number of modules required. The program office has budgeted $19.8 million from fiscal years 2022 through 2024 to refurbish the first six GaAs radars with GaN technology, and to bring all 15 low rate initial production systems up to current full-rate production configuration. The Marine Corps also continues to fund initiatives to add new capabilities to the radar.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office stated that the G/ATOR program continues to meet its cost, schedule, and performance commitments following establishment of a new acquisition program baseline in 2010. The program office stated that it has accepted delivery of eight low-rate initial production systems and has seven additional systems under contract. According to the program office, G/ATOR has demonstrated all Block 1 and Block 2 key performance requirements. The program office stated that G/ATOR will meet initial operational capability with two Block 1 systems fielded in 2018 and four Block 2 systems fielded in 2019. According to the program office, the program is on track for a full-rate production decision in 2019 as well as delivery of the required capability to the warfighter. The program office also stated that G/ATOR's operational availability has exceeded the system's requirement and early software quality challenges addressed.

Source: U.S. Navy.

F/A-18E/F Infrared Search and Track (IRST)

The Navy is developing an infrared search and track (IRST) sensor to integrate onto the F/A-18E/F fuel tank. IRST will allow F/A-18s to detect and track objects from a distance in environments where radar is not effective. The Navy is acquiring IRST with an evolutionary acquisition approach. It used existing IRST systems to develop Block I and is implementing Block II to deliver an improved sensor, upgraded processor, and additional software. We assessed IRST Block II.

Program Essentials

Milestone decision authority: Navy

Program office: Patuxent River, MD

Prime contractor: Boeing

Contract type: CPIF (Block II development), FPIF (Block II low-rate production)

Software development approach: Mixed

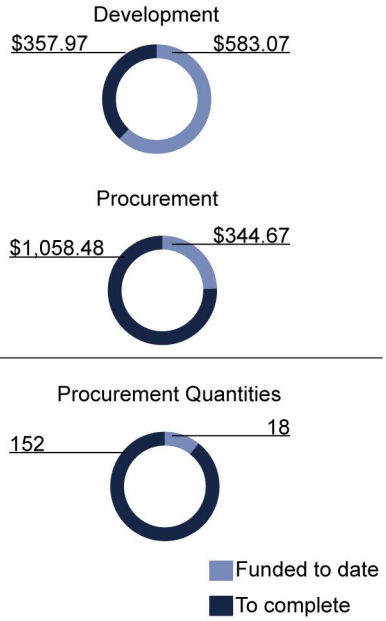
Next major milestone: Start of operational testing (August 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (02/2017)	Latest (12/2018)	Percentage change
Development	$899.00	$941.00	+4.7%
Procurement	$1,354.00	$1,403.20	+3.6%
Unit cost	$12.59	$13.55	+7.7%
Acquisition cycle time (months)	123	123	0.00%
Total quantities	179	173	-3.4%

The Navy approved a new acquisition program baseline in December 2018. Total quantities comprise 3 development quantities and 170 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions



Attainment of Product Knowledge
As of January 2019 (Block II activities only)

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	○
• Test a system-level integrated prototype	○	○
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	○	○
• Test a production-representative prototype in its intended environment	○	○

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

IRST Program

Technology Maturity, Design Stability, and Production Readiness

IRST Block II entered low-rate production in December 2018 with mature critical technologies, but an unstable design and undemonstrated critical manufacturing processes. The IRST program's only critical technology is its "passive ranging algorithm" tracking software. The program expects this software to track targets better than legacy system software. In a July 2017 technology maturation assessment, an independent review panel assessed the software as fully functional in an operational environment.

Although in production, IRST does not yet have a stable design. At the time of the program's November 2018 critical design review, the contractor had released about 77 percent of Block II design drawings—a level that falls short of the 90 percent recommended by best practices as a mark of design stability. As of January 2019, the program had increased its drawing releases to about 82 percent of planned total. The program also has yet to test a system-level integrated prototype. According to program officials, they have tested hardware and software in configurations similar to those planned for the Block II design—but short of a prototype—to validate design efforts for a future Block II system-level prototype. Our prior work has shown that carrying a stable design into production reduces the risk of costly design changes to already-produced systems.

The program also entered production without demonstrating critical manufacturing processes both on a pilot production line and within statistical process controls—inconsistent with best practices. Program officials said they will review or modify Block I manufacturing processes, which they consider mature, that are used for building Block II prototype hardware, with deliveries starting in late fiscal year 2019. The program also plans for IRST development and production to overlap in order to achieve the accelerated initial operational capability. As we have found in our evaluations of numerous other DOD programs, this type of concurrent approach increases risk of program cost increases and schedule delays.

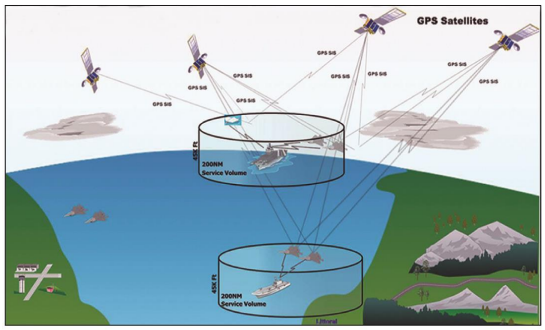
Officials reported that in December 2018, the program awarded an undefinitized contract action, under fixed-price incentive firm target terms, for low-rate initial production of six Block II units. According to the program office, this contract action supports F/A-18 operations by accelerating IRST's initial operational capability by over 2 years, from January 2024 to September 2021. The program plans to award two additional contracts—one in fiscal year 2020 for 12 units and another in fiscal year 2021 for 25 units—for low-rate initial production. Consequently, the program intends to acquire over 28 percent (43 of 152) total production quantities through low-rate initial production. If a program's low-rate initial production quantity exceeds 10 percent of the total production quantity, the program must provide a rationale for these quantities in a report to Congress. For IRST, the Navy's rationale hinges on establishing an initial production base and allowing an orderly increase in production leading to full-rate production.

Other Program Issues

A May 2014 report from DOD's Inspector General found the the Navy had inappropriately planned to use IRST procurement funds to fund Block II development activities and recommended the funds be reprogrammed. Following the reprogramming, the Navy reclassified IRST as a major defense acquisition program based on its adjusted total research, development, technology, and evaluation costs.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program had no comments on the assessment.



Source: U.S. Navy.

Joint Precision Approach and Landing System (JPALS)

JPALS is a program to develop a Global Positioning System (GPS)-based aircraft landing system that will allow aircraft such as the F-35 Lightning II and the MQ-25 Unmanned Aircraft System to operate from aircraft carriers and amphibious assault ships. With JPALS, the Navy intends to provide a reliable, sea-based precision approach and landing capability that is effective in adverse weather conditions. JPALS functionality is primarily software-based, although it will also feature off-the-shelf hardware such as antennas and racks.

Program Essentials

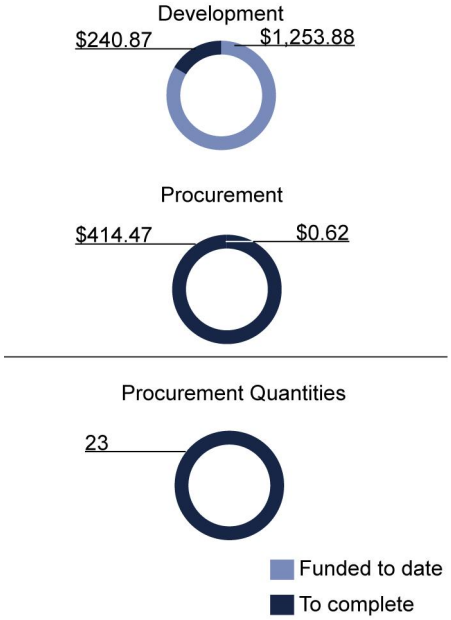
Milestone decision authority: Navy
Program office: Lexington Park, MD
Prime contractor: Raytheon
Contract type: CPIF (development)
Software development approach: Mixed
Next major milestone: Low-rate initial production (March 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (07/2008)	Latest (06/2018)	Percentage change
Development	$886.90	$1,494.70	+68.5%
Procurement	$238.80	$415.10	+73.9%
Unit cost	$30.63	$58.11	+89.7%
Acquisition cycle time (months)	77	146	+89.6%
Total quantities	37	33	-10.8%

Total quantities comprise 10 development quantities and 23 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

JPALS Program

Technology Maturity and Design Stability

Both of JPALS's two critical technologies are approaching maturity, and the program has released 100 percent of its design drawings, which corresponds with a stable design. However, as the program continues to mature its critical technologies through testing, the program may need to revise its design drawings to accommodate these changes, which could compromise design stability.

JPALS originally entered system development in July 2008 and held a critical design review (CDR) in December 2010, but the design later proved unstable. The program proceeded with development and accepted delivery of eight prototypes. As JPALS approached its original production decision in 2013, other military departments and civilian agencies decided to continue using their current landing systems instead of investing their resources in JPALS. As a result, the Navy restructured the JPALS program from seven increments to one.

Because of the restructure, the Navy revised its schedule and milestones and conducted a new system-level preliminary design review in March 2016, a new development start in June 2016, and a new CDR in May 2017. Because the program repeated these three events, our attainment of product knowledge table assesses the program's knowledge at its original development start and original CDR events, which formed the basis for the program's original business case. This methodology is consistent with how we have previously assessed JPALS and other programs that have repeated key program events.

In June 2016, Navy leadership authorized the restructured JPALS program to enter the engineering and manufacturing development phase. The program office reported that it awarded a contract in September 2016 to upgrade the eight original prototypes, as well as to procure two additional prototypes for developmental testing. The contractor delivered these prototypes during the second quarter, of fiscal year 2018, according to program officials. Both the new and upgraded prototypes are intended to be production representative. According to program officials, these prototypes will allow the program to demonstrate the JPALS critical technologies in a realistic environment, which the program plans to do prior to entering production.

Production Readiness

JPALS does not have any critical manufacturing processes, according to the program, because the hardware is primarily off-the-shelf. In December 2017, the Navy approved the JPALS program to procure the entirety of its 23 production units through low-rate initial production because it anticipates cost savings through shortening the procurement schedule. As a result, the program updated its baseline in March 2018 to reflect that it would not execute a full-rate production decision. Program officials reported that they completed an operational test readiness review in April 2018 and attained early operational capability with their prototypes in June 2018 to support F-35 Lightning II operational testing. For fiscal year 2018, program officials reported a combined total of 78 aircraft approaches for integrated and operational testing. They also stated the program successfully completed its production readiness review in December 2018 ahead of the planned March 2019 low-rate initial production decision.

Other Program Issues

Because JPALS is GPS-based, it will need to be compliant with with any updates to GPS systems, such as the integration of M-code, a new military GPS signal designed to further improve anti-jamming and secure access to GPS signals for military users. JPALS program officials stated they contracted for a trade study to determine future M-code integration and implementation options. Program officials expect the study to be delivered in early 2019.

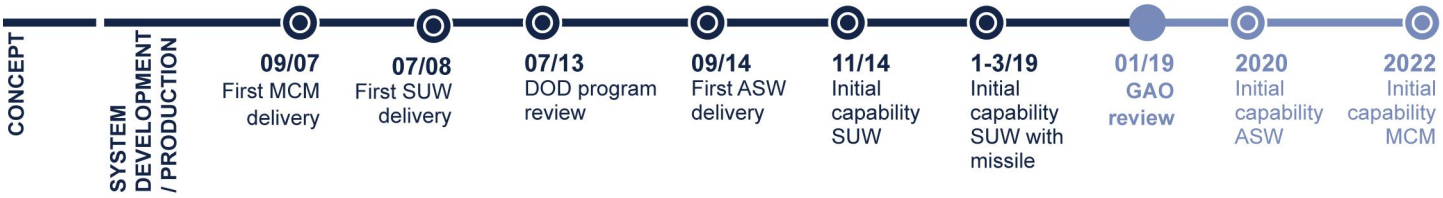
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office stated that JPALS is part of a family of systems that provide capability to naval aviation and its partners. According to the program office, in fiscal year 2018 and early fiscal year 2019, JPALS successfully deployed on the amphibious ships LHD 1 and LHD 2, supporting F-35 operational deployments. The program stated that, in fiscal year 2018, it received approval to compress the JPALS production schedule from five to four lots, which it anticipated would save costs over the program lifetime and accelerate deployment. The program also stated that JPALS entered the production and deployment phase on March 25, 2019, which it said provides authority to award a low-rate initial production contract for 23 JPALS quantities. The program said that it expects to complete some integrated testing and an operational assessment in April 2019 in support of JPALS's integrated operational test and evaluation phase. Additionally, the program stated that restructured and accelerated requirements drove changes to design drawings during JPALS development.

Source: U. S. Navy.

Littoral Combat Ship-Mission Modules (LCS Packages)

The Navy's LCS packages—weapons, helicopters, boats, and sensors launched and recovered from LCS seaframes—will provide mine countermeasure (MCM), surface warfare (SUW), and antisubmarine warfare (ASW) capabilities to the LCS seaframe. The Navy originally planned to swap mission packages among LCS, but has since decided that each LCS will be designated with a specific mission package. The Navy is currently delivering specific systems as they become available, rather than complete packages. We assessed the current capability of the delivered systems against the threshold requirements that define the baseline capabilities for the complete mission package.



Program Essentials

Milestone decision authority: Navy

Program office: Washington Navy Yard, DC

Prime contractor: Northrop Grumman

Contract types: FFP/FPI (production)

Software development approach: Incremental

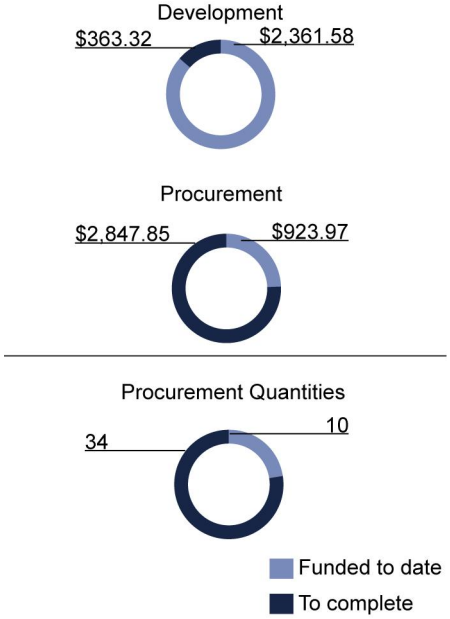
Next major milestone: Surface warfare package initial capability with surface-to-surface missile (second quarter, fiscal year 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (08/2007)	Latest (09/2018)	Percentage change
Development	NA	$2,724.90	NA
Procurement	$3,649.49	$3,771.82	+3.4%
Unit cost	NA	$133.43	NA
Acquisition cycle time (months)	NA	NA	NA
Total quantities	64	49	-23.4%

The Navy approved an acquisition program baseline for LCS Packages in September 2018. Total quantities comprise 5 development quantities and 44 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	○
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	…	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

LCS Packages Program

Mine Countermeasure

The Navy accepted systems that comprise about seven MCM packages prior to demonstrating that they meet threshold MCM requirements. It continues to fund numerous retrofits and configuration changes due to reliability and performance failures. Rather than complete packages, the Navy is now delivering MCM systems individually. Navy officials stated that they no longer plan to conduct testing to demonstrate that the packages meet MCM requirements because it believes that as long as each system meets its specific requirements, collectively it will meet overarching MCM requirements. The Navy has yet to demonstrate that meeting specific system requirements satisfies overarching MCM requirements.

The Navy projects that it will not meet its requirement for Deep Volume Focused Mine Hunting, which involves the clearing of all moored mines. Under the current requirement, the package must clear a certain number of squared nautical miles each day. Officials said that the original requirement was optimistic and that the technology has not performed as needed to meet it, despite previous claims by the Navy that the systems were fully mature. The program office is currently working with stakeholders to change the requirement and align it with operator needs. Officials said they are seeking approval for an updated requirement in March 2019.

Following our 2018 assessment, the program delayed initial operational capability (IOC) for the MCM package from 2020 to 2022. The Navy plans to start fielding eight LCS with the MCM package between 2020 and 2022. These ships will deploy with only selected MCM systems that do not provide the package's full capability. Officials stated that because of the variability within MCM missions, they can conduct some operations with the MCM systems that have already achieved IOC. Navy officials are also considering fielding these systems on other ships apart from LCS. To realize these plans, the Navy plans to procure 24 MCM packages, but will use only 15 of them on LCS.

Surface Warfare

Through operational testing completed in fiscal year 2015, the Navy met its incremental performance requirements for the SUW package and is now fielding it. To meet full performance requirements, the Navy is adding the Army's Longbow Hellfire missile to the package, which the Navy has adapted and is currently testing for use within a maritime environment. According to officials, test ship availability issues delayed IOC for the missile from the second quarter of fiscal year 2018 to the second quarter of fiscal year 2019. The Navy completed testing on one LCS variant (Freedom). The Navy plans to test the missile on the other variant (Independence) in 2020.

Antisubmarine Warfare

Following our 2018 assessment, the program delayed IOC for the package by 1 year to the end of fiscal year 2020 because of budget limitations, according to program officials. To meet this new date, the Navy accepted delivery of the Escort Mission Module test article, one of the package's main systems, and plans to begin testing in the fourth quarter of fiscal year 2019 on board LCS 3. To achieve this, the Navy needs to make alterations on LCS 3 to outfit it with the ASW package. However, the program cannot begin the alterations until LCS 3 completes ongoing maintenance and subsequent sea trials, according to ship officials. The ASW alterations are scheduled to begin in April 2019, a 2-month delay from the previous start date. At this point, the Navy has little to no schedule margin remaining between when it expects to complete the LCS 3 alterations and begin ASW package testing. Any further delays will jeopardize the Navy's ability to meet its planned ASW package testing and IOC dates.

Other Program Issues

The Navy recently reduced its procurement quantities of LCS mission packages from 64 to 44, trimming the planned 24 SUW and 16 ASW packages to 10 each. This is in line with reductions to the total number of LCS from 52 to 32. Additionally, the Navy recently decided that it will semi-permanently install mission modules on LCS seaframes—an approach that it expects will add simplicity and stability to the program but will reduce the mission flexibility that the Navy previously intended the program to have.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. Officials said that the Navy is delivering LCS capability and deploying mission package systems that have attained IOC. They stated that the Navy successfully completed surface-to-surface missile module testing 2 months early, that the missile will achieve IOC as scheduled in the second quarter of fiscal year 2019, and that it will deploy on LCS 7 in the fourth quarter of fiscal year 2019. Officials also said that the Navy took delivery of the ASW mission package in November 2019, plans for it to embark on LCS 3, and to begin formal testing of it in fiscal year 2019 to achieve the scheduled fiscal year 2020 IOC. According to the program, the Navy has established IOC for three MCM mission package airborne systems. The program stated that it expects the full package's IOC to occur in fiscal year 2022 due to funding limitations for the MCM unmanned surface vehicle.

Source: MQ-4C Triton B-5.

MQ-4C Triton Unmanned Aircraft System (MQ-4C Triton)

The Navy's MQ-4C Triton is an unmanned aircraft system, based on the design of the Air Force's RQ-4B Global Hawk air vehicle. It will be operated from five land-based sites worldwide and provide the Navy with persistent maritime intelligence, surveillance, and reconnaissance (ISR) data collection and dissemination capability. The Triton is integral to a family of maritime patrol and reconnaissance systems and part of the Navy's plan to recapitalize its airborne ISR assets by the end of the decade.

Program Essentials

Milestone decision authority: Navy

Program office: Patuxent River, MD

Prime contractor: Northrop Grumman

Contract types: Cost-sharing (development)

FPI (low-rate initial production)

FFP (low-rate initial production spares)

Software development approach: Mixed

Next major milestone: Baseline early capability (July to September 2019)

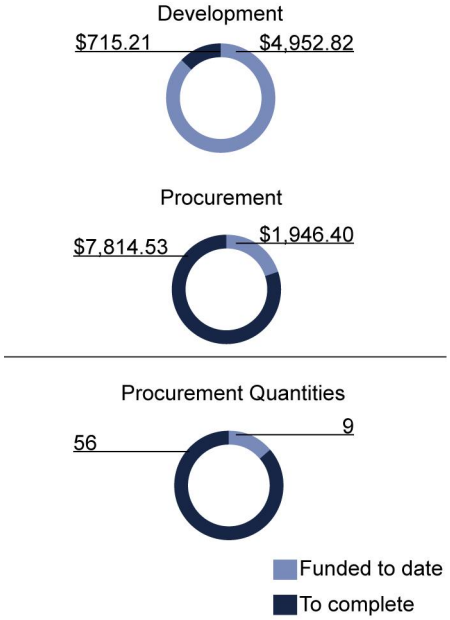
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (02/2009)	Latest (10/2018)	Percentage change
Development	$3,517.70	$5,668.00	+61.1%
Procurement	$10,439.20	$9.760.90	-6.5%
Unit cost	$205.50	$225.24	+9.6%
Acquisition cycle time (months)	92	156	+69.6%
Total quantities	70	70	0.0%

Total quantities comprise 5 development quantities and 65 procurement quantities. Since last year's report, one unit shifted from procurement to development as part of an agreement with the contractor to share cost growth.

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	NA
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	NA
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	●
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	○	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

MQ-4C Triton Program

Technology Maturity, Design Stability, and Production Readiness

The MQ-4C Triton program currently relies on no critical technologies and has stabilized its system design as it continues low-rate initial production.

Program officials acknowledged that although the wing contractor continues to improve its manufacturing processes, production remains out of statistical control, which poses continued risk to the Triton's production schedule, quality, and cost. For example, program officials said the contractor reduced defects by 68 percent between the wings manufactured for the last system development test article—the sixth aircraft to be produced—and those manufactured for the tenth aircraft. In addition, the 10th and 11th sets of wings, which are the most recently produced, were each delivered 2 to 4 weeks ahead of schedule. Program officials emphasized that continued improvement will depend on the contractor's ability to successfully implement corrective actions, such as updating engineering processes and establishing a dedicated team of mechanics to address specific quality issues.

Program officials reported the start of full-rate production has been extended an additional 2 months, until July 2021. In addition, these problems have increased the program's total number of design drawings by nearly 14 percent since receiving Milestone C approval in September 2016. The program plans to increase the quantity of aircraft acquired during low-rate initial production from 15 to 18 to maintain operational availiability requirements. However, this strategy also increases the quantity of aircraft that could require design changes due to testing discoveries as the Triton completes developmental testing and begins operational testing.

Other Program Issues

Program officials reported they potentially face further delays to the start of full-rate production after an aviation mishap—an unplanned event or series of events that results in damage to property or injury to personnel—occurred on September 12, 2018, during early operational testing. While program officials report that the Navy has completed an internal investigation that did not detect any system design deficiencies, the program paused flight test of all aircraft for 3 months out of an abundance of caution while the internal investigation was underway. The program also made updates to the training materials and operation procedures to address findings from their investigation. Program officials reported that the Triton returned to flight during the week of December 17, 2018, and early operational testing resumed on January 23, 2019.

Program officials also told us that they have taken over configuration and development of the Triton's Logistics Management System software from the contractor, as originally planned. This system, according to program officials, provides health and maintenance data on aircraft subsystems, including real-time notification of part failures as they occur during flight. While program officials stated the Navy is still designing and testing the software, the program plans for the software to be operational prior to initial operational capability in April 2021.

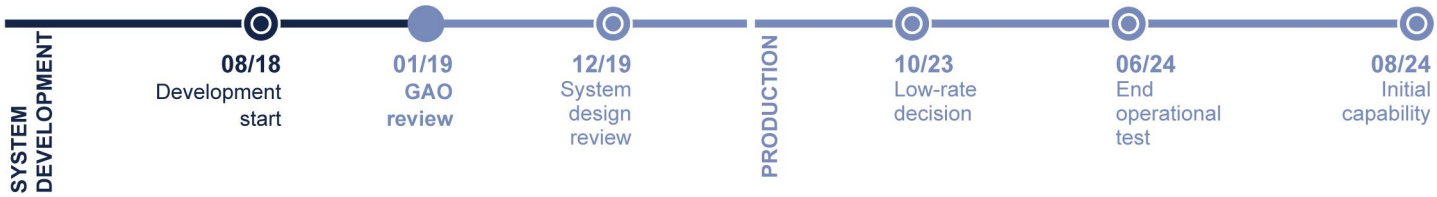
Program Office Comments

We provided a draft assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.

Source: Jeff Hobrath, Chief, USN (Ret) President, Naval Trees, LLC.

MQ-25 Unmanned Aircraft System (MQ-25 Stingray)

The Navy's MQ-25 is a catapult-launched unmanned aircraft system that will operate from aircraft carriers. The Navy expects MQ-25 to provide a refueling capability for the carrier air wing and the intelligence, surveillance, and reconnaissance capabilities needed to identify and report on surface targets, such as ships. The system is made up of an aircraft segment, a control station segment, and a carrier modification segment. The aircraft development represents about 90 percent of the Navy's planned investment in the MQ-25 system as a whole over the next 5 years.



Program Essentials

Milestone decision authority: Navy
Program office: Patuxent River, MD
Prime contractor: Boeing
Contract type: FPI (development)
Software development approach: Mixed
Next major milestone: Design review (December 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (08/2018)	Latest (08/2018)	Percentage change
Development	$3,548.60	$3,548.60	0.00%
Procurement	$8,915.00	$8,915.00	0.00%
Unit cost	$168.85	$168.85	0.00%
Acquisition cycle time (months)	72	72	0.00%
Total quantities	76	76	0.00%

The Navy approved an acquisition program baseline for the MQ-25 Stingray program in August 2018. Total quantities comprise 4 development quantities and 72 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)

Attainment of Product Knowledge
As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	○	○
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	NA	NA
• Test a system-level integrated prototype	NA	NA
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

MQ-25 Stingray Program

Technology Maturity and Design Stability

The Navy identified no critical technologies for MQ-25. The Navy approved the MQ-25 technology readiness assessment in June 2018 as part of the program's development start decision. The MQ-25 program has other critical technologies not resident in the MQ-25 aircraft. The Navy is developing those two critical technologies, which are currently approaching maturity, under its Joint Precision Approach and Landing System program. Our Attainment of Product Knowledge table accounts for these technologies. The program has initiated system design activities ahead of a planned review in December 2019. The Navy did not hold a preliminary design review for MQ-25 prior to the start of development—an approach inconsistent with best practices. Instead, the program has relied on preliminary design knowledge attained under the previous Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) program to inform MQ-25 development. Nonetheless, the Navy has set different performance requirements for MQ-25 as compared to UCLASS, which necessitates design differences between the two aircraft.

In an effort to accelerate acquisition and fielding, the Navy designated MQ-25 a Maritime Accelerated Acquisition program. This designation is intended to enable the MQ-25 program to deliver capabilities more rapidly than it could under the traditional DOD acquisition process. The Navy emphasized schedule during the source selection process, and, according to program officials, Boeing presented a schedule that would allow the program to achieve initial operational capability 2 years earlier than originally planned. Program officials stated that, as part of this acquisition approach, they plan to hold periodic design reviews as MQ-25 subsystems are completed. The reviews will conclude with a final system design review in December 2019, at which point the program expects to have completed its final design.

Production Readiness

The Navy plans to authorize MQ-25's entry into low-rate initial production in October 2023. Boeing plans to use a commercially demonstrated approach to manufacture the aircraft in modules, which program officials say will be faster and more efficient than a typical assembly line. In this approach, suppliers will use detailed models to produce the various aircraft modules, including pre-drilling holes. The suppliers will then send the completed modules to Boeing to assemble.

Under MQ-25's approach, the program could find that critical manufacturing processes reside with the suppliers responsible for module fabrication. According to program officials, Boeing intends to conduct manufacturing readiness level assessments when building the aircraft. Until the program develops the knowledge that its critical manufacturing processes are in statistical control, there is increased risk that the design may not be producible at the program's cost, schedule, and quality targets. Best practices call for programs to attain this knowledge prior to entering production.

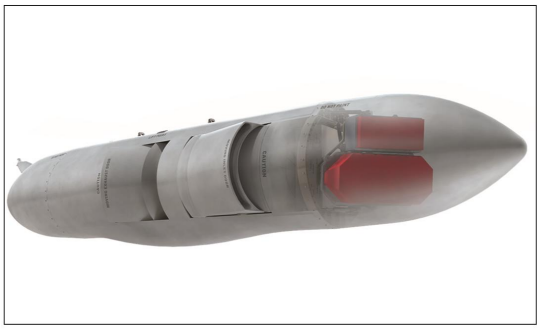
Other Program Issues

Officials reported that in August 2018, the Navy awarded a fixed price incentive development contract with a ceiling price of $805 million to Boeing, which includes four MQ-25 aircraft. Prior to the award, the Navy estimated the total development cost at $3.8 billion, and the Office of the Secretary of Defense (OSD) estimated its cost at $5.1 billion. Based on the disparity between the development contract's ceiling price and the DOD cost estimates, OSD cost estimators emphasized the importance of avoiding requirements changes that might lead to the renegotiation of the development contract's terms, including the ceiling price.

Program officials stated the development contract includes options for up to three additional test aircraft, but does not include options for any of the 72 planned production aircraft. Officials stated that while they do not plan to compete the production contract, Boeing will provide cost, technical, and programmatic data during the development phase, which is intended to help inform the Navy's negotiation of a fair and reasonable price under the production contract.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.



Source: Raytheon Corp.

Next Generation Jammer Mid-Band (NGJ Mid-Band)

The Navy's Next Generation Jammer (NGJ) is an external jamming pod system that will be integrated on EA-18G Growler aircraft. It will augment, then replace, the ALQ-99 jamming system and provide enhanced airborne electronic attack capabilities to disrupt adversaries' use of the electromagnetic spectrum for radar detection, among other purposes. The Navy plans to field the system that jams mid-band radio frequencies in 2022. The Navy has a separate program for low-band frequencies and will roll out a high-band frequencies program at a later date. We assessed the Mid-Band program.

Program Essentials

Milestone decision authority: Navy

Program office: Patuxent River, MD

Prime contractors: Raytheon; Boeing

Contract type: CPIF (development—Raytheon) (development and integration—Boeing)

Software development approach: Mixed

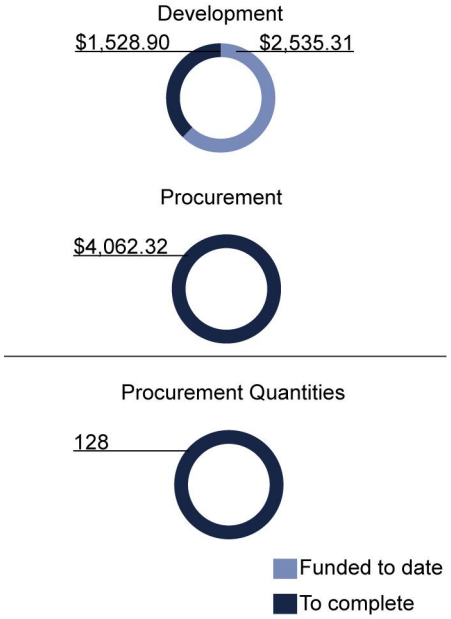
Next major milestone: Low-rate initial production (August 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (04/2016)	Latest (06/2018)	Percentage change
Development	$3,629.80	$4,064.20	+12.0%
Procurement	$4,206.20	$4,062.3	-3.4%
Unit cost	$58.10	$60.25	+3.7%
Acquisition cycle time (months)	98	110	+12.2%
Total quantities	135	135	0.00%

Total quantities comprise 7 development quantities and 128 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	○
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

NGJ Mid-Band Program

Technology Maturity and Design Stability

Nearly 3 years after development start, the NGJ Mid-Band program's seven critical technologies continue to approach maturity—an approach inconsistent with best practices. The program also reports that it has released all of its planned design drawings following a redesign of the jamming pod to address structural issues. However, until the program fully matures its critical technologies—by demonstrating each in a final form, fit, and function within a realistic environment—existing design drawings face risk of change. Further, the program has yet to test a system-level integrated prototype, which best practices hold as a key criterion for achieving design stability.

The program entered system development in April 2016 with its critical technologies approaching maturity. These technologies include two separate arrays—each with different transmit/receive modules, circulators, and apertures—as well as a power generation system. The program plans to have its critical technologies fully mature, integrated, and in testing in January 2020.

The NGJ Mid-Band program discovered design deficiencies with the jamming pod structure at its April 2017 critical design review, which caused a 1-year schedule delay and contributed to an over $400 million increase in the program's development cost. The program identified several other deficiencies in modeling, assumptions, and methodologies regarding the structural analysis and design of the pod structure, which required redesign. According to the program office, the pod redesign did not affect the program's critical technologies, subsystems, or software.

As of September 2018, the contractor had released 100 percent of the design drawings. Program officials said that they considered the design of the pod structure to be stable, although the contractor continues to make minor changes to it. In addition, the program office has yet to test a system-level integrated prototype of the jamming pod, which runs counter to the GAO-identified best practice for demonstrating design stability. The program office plans to begin testing the redesigned pod on an EA-18G in January 2020.

Production Readiness

The program office plans to demonstrate its critical manufacturing processes prior to the start of production in August 2020, which would be an approach consistent with best practices. However, the program office does not plan to test a production-representative prototype or complete system-level developmental testing (which includes demonstrating the full functionality of the system) until 7 and 15 months, respectively, after production starts. DOD policy allows some concurrency between developmental testing and initial production, but we have previously found that starting production before demonstrating that a system will work as intended increases the risk of deficiencies that require substantial and costly design changes. Program officials told us that they plan to mitigate the risk associated with the concurrency between developmental testing and initial production to what they consider to be an acceptable level by gathering extensive data about pod performance in specialized ground test chambers and through flight testing engineering development models. Further, according to program officials, the delay caused by the pod redesign will allow the program to conduct additional ground testing before committing to production.

In addition, the delay associated with the pod redesign introduced a potential production gap in between the last engineering developmental model and the first production system. The program added three additional system demonstration test articles to mitigate this gap and verify that the system can meet all its performance requirements prior to the start of operational testing in January 2022.

Other Program Issues

The Under Secretary of Defense for Acquisition, Technology, and Logistics approved NGJ Mid-Band as the first program in the "Skunk Works" pilot in September 2015, which aims to streamline processes in order to deliver capabilities on time and within budget. NGJ Mid-Band officials said that the pilot helped reduce the length of time spent on the decision making process by providing officials direct access to management and allowing them to focus on execution. Nonetheless, the program has still exceeded original estimates for development cost, unit cost, and schedule.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. According to program officials, as of January 2019, all subsystems that contain critical technologies have been manufactured and assembled and are undergoing subsystem-level tests. Program officials reported that this progress has reduced program risk to an acceptable level for system development. Additionally, program officials told us that they plan to test a system-level integrated prototype of the pod on an EA-18G in a sound- and electromagnetic-absorbent chamber beginning in the fourth quarter of fiscal year 2019.

Source: U.S. Navy.

Offensive Anti-Surface Warfare Increment 1 (OASuW Inc 1)

The Navy's OASuW Inc 1 program plans to develop an air-launched, long-range, anti-surface warfare missile to address an urgent operational need. The program is using an accelerated acquisition approach and has leveraged previous technology demonstration efforts. It fielded an early operational capability on Air Force B-1 bombers in 2018 and plans to do so on Navy F/A-18 aircraft in 2019. DOD also plans to develop an additional capability with Increment 2 to address future threats. We assessed Increment 1.

Program Essentials

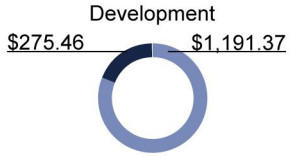
Milestone decision authority: Navy
Program office: Patuxent River, MD
Prime contractor: Lockheed Martin
Contract type: CPIF (development)
FPIF (low-rate initial production)
Software development approach: Incremental approach
Next major milestone: Early operational capability with F/A-18 (September 2019)

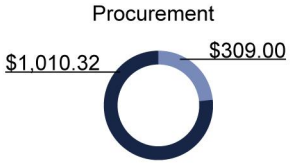
Program Performance (fiscal year 2019 dollars in millions)

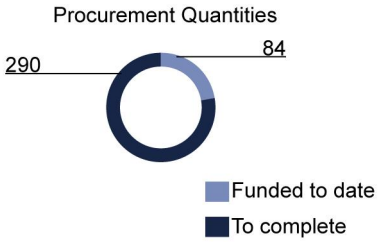
	First full estimate (03/2016)	Latest (02/2019)	Percentage change
Development	$1,263.30	$1,466.80	+16.1%
Procurement	$314.30	$1,319.30	+319.8%
Unit cost	$12.72	$7.14	-43.8%
Acquisition cycle time (months)	42	42	0.00%
Total quantities	124	390	+214.5%

We calculated acquisition cycle time using the program's early operational capability with F/A-18 as its initial operational capability. Total quantities comprise 16 development quantities and 374 procurement quantities.

Funding and Quantities
(fiscal year 2019 dollars in millions)







Attainment of Product Knowledge
As of January 2019

	Status at	Current Status
Resources and requirements match	**Development Start**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	●
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	○	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

OASuW Inc 1 Program

Technology Maturity, Design Stability, and Production Readiness

The OASuW Inc 1 program has mature technologies, a stable design, and production practices approaching maturity. The Navy chose to move forward earlier in the program without the technology, design, or production knowledge recommended by best practices. In 2016, the program office acknowledged the risk its strategy posed, but pointed to an urgent maritime warfighting need as well as steps taken to manage the risk, such as leveraging the Air Force's Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER) airframe and production facilities.

According to the program office, the Navy assessed OASuW's manufacturing processes as mature prior to production. However, the program's last formal assessment in March 2017 indicated its processes were only approaching maturity. The program's top priority has been to produce missiles to field an early operational capability on the B-1 and F/A-18 aircraft. The program delivered the last missiles needed to achieve that capability on the B-1 later than planned in 2018. Consequently, the B-1 achieved early operational capability in December 2018—3 months later than the program's goal, but 9 months earlier than required.

The program is now planning future changes to the missile to improve performance, counter evolving threats, and address parts obsolesence. Some changes will involve hardware updates that are currently in development; others will leverage upgrades from the JASSM-ER program. For example, according to program officials, they plan to incorporate an enhanced weapon data link. They expect to begin incorporating this data link into missiles starting with the fourth OASuW production lot, which the contractor is scheduled to begin in the third quarter of fiscal year 2020. The program office does not plan to upgrade already fielded missiles with this link.

Other Program Issues

The OASuW program relies on a combination of missile tests and modeling and simulation to demonstrate and characterize the system's performance. One key modeling and simulation facility, however, was not yet operational as of November 2018. According to program officials, the program uses modeling and simulation in part because replicating the operational environment is challenging. The program completed six flight tests in 2017 and 2018, among other activities to demonstrate missile performance. Navy officials stated that, because it did not have all the anticipated modelling and simulation capabilities available before fielding the OASuW early operational capability on the B-1, the program did not collect as much information as planned about the weapon's performance in a wide range of conditions. Officials expect the new modeling and simulation facility will be available to support testing for the F/A-18 early operational capability.

Since the program's 2016 development start, DOD has significantly increased OASuW Inc 1 quantities due to Increment 2 delays and evolving threats. Most recently, in February 2019, DOD increased planned procurement quantities from 110 to 374. According to program officials, the increases will provide sufficient quantities for mission needs until a future capability becomes available. Officials stated the Navy is examining options for addressing future threats and Increment 2 by building on its Next Generation Land Attack Weapon Analysis of Alternatives. The Navy plans to complete its OASuW-related analysis in 2019. The program office expects OASuW Increment 2 to achieve initial operational capability as early as fiscal year 2028.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that OASuW Inc 1 is an accelerated acquisition program intended to fill an urgent, unmet maritime warfighting requirement where schedule is a priority. The program office said that a small, integrated team of government and industry experts manages the program, including the risks it faces related to concurrent weapon system development, test, and production. It also stated that monthly executive steering boards chaired by the Assistant Secretary of the Navy for Research, Development, and Acquisition provide oversight. The program office reiterated its position that the OASuW's production processes are mature. It also stated that OaSuW successfully completed both a production readiness review and physical configuration audit, and the contractor has delivered 10 missiles to date. Additionally, the program office said that it met the early operational capability date for fielding OASuW on the B-1 bomber aircraft, and the program is ahead of schedule for fielding OASuW Inc 1 on F/A-18 fighter aircraft no later than the fourth quarter of fiscal year 2019. According to the program office, the Navy intends to procure OaSuW quantities based on the available funding, which may cause purchased quantities to differ from current projections.

Source: General Dynamics Electric Boat.

SSBN 826 Columbia Class Ballistic Missile Submarine (SSBN 826)

The Navy's Columbia class (SSBN 826) will replace its current fleet of Ohio class ballistic missile submarines, which the Navy plans to retire starting in 2027. The submarine will serve as a sea-based, strategic nuclear deterrent that will remain in service through 2080. According to the Navy's current acquisition plan, the lead ship will make its first patrol in October 2030.

Program Essentials

Milestone decision authority: Under Secretary of Defense for Acquisition and Sustainment

Program office: Washington Navy Yard, DC

Prime contractor: General Dynamics Electric Boat

Contract type: Combination of CPIF and CPFF (design and development)

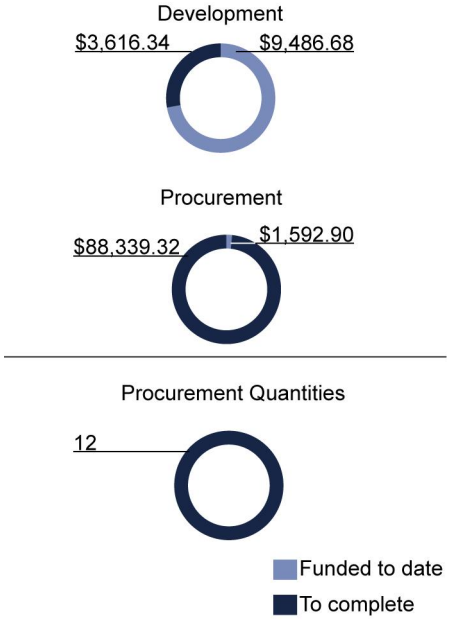
Software development approach: Mixed

Next major milestone: Design review (April 2020)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (01/2017)	Latest (06/2018)	Percentage change
Development	$13,068.90	$13,103.00	+0.3%
Procurement	$90,335.30	$89,932.20	-0.4%
Unit cost	$8,629.70	$8,599.85	-0.3%
Acquisition cycle time (months)	231	237	+2.6%
Total quantities	12	12	0.00%

Funding and Quantities
(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge
As of January 2019

	Status at Detail Design Contract Award	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	○	○
• Demonstrate all critical technologies in form, fit and function within a realistic environment	○	○
• Complete a system-level preliminary design review	●	●
Product design is stable	**Fabrication Start**	
• Complete basic and functional design to include 100 percent of 3D product modeling	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

SSBN 826 Program

Technology Maturity

The Columbia class program identified two critical technologies—a carbon dioxide removal system and the stern area system, the details of which are classified. The program expects the carbon dioxide removal system to reach full maturity in late 2019, while the stern area system is still immature.

In December 2017, we reported that several Columbia class technologies that met GAO's definition of a critical technology element were not identified by the Navy as critical technologies. Specifically, the Navy did not follow best practices for assessing critical technologies. When we applied these best practices, we identified four additional critical technologies that the Navy excluded. These include the integrated power system, the propulsor/coordinated stern, the common missile compartment (CMC), and the nuclear reactor. Of these, only the nuclear reactor is fully mature as of late 2018.

The Navy expects the CMC to reach full maturity in 2019. However, officials reported that in July 2018 the shipbuilder identified significant weld defects in CMC missile tubes from one of three suppliers after the supplier had already delivered seven tubes to the shipyard and installation work had begun, resulting in rework. Officials further report that the shipbuilder found defects affected five additional tubes. Program officials attributed these defects to inexperienced welders and weld inspectors. The Navy estimates that, as of January 2019, the CMC consumed 52 percent of its schedule margin. Should the Navy discover additional CMC deficiencies, the planned construction sequence for the lead submarine will be jeopardized.

Further, manufacturing defects have delayed delivery of the integrated power system's (IPS) first production-representative motor. The Navy plans to recover the motor's schedule margin by testing it while the supplier updates the motor's production design. Consequently, any new deficiencies discovered in testing may require the supplier to modify its design, which could delay the lead ship's IPS motor production schedule.

Design Stability

The program office plans to complete the basic and functional design prior to the lead submarine's scheduled construction start, in October 2020. However, Navy officials report the shipbuilder has already begun building sections of the submarine, with 95 percent of the basic and functional design complete—a level slightly below best practices. Further, the Navy has determined that the shipbuilder needs to complete 83 percent of the detail design—the most complex design phases down to the lowest level of the submarine—by October 2020 to meet its cost and schedule goals. Currently, the shipbuilder is behind schedule because it has yet not achieved planned efficiencies with new design software. The shipbuilder increased its design staff by 18 percent in an effort to reach the design goal on schedule. However, the program's plan for achieving design stability is premised on assumptions about the final form, fit, and function of critical technologies—and how those technologies will perform in a realistic environment—that the program has yet to demonstrate.

Production Readiness

By beginning to build sections of the submarine starting in December 2018, the Navy believes that the builder can achieve an aggressive 84-month construction schedule. However, this is 2 years prior to the planned request for fiscal year 2021 authorization to start construction of the lead ship.

Other Program Issues

In a April 2019 report, we made several recommendations to improve the program's cost estimate. Specifically, we found that the program's $115 billion procurement cost estimate is not reliable because its estimate is based on overly optimistic assumptions about the labor hours needed to construct Columbia class submarines and did not include any cost margin in case these assumptions are not met. While the Navy analyzed program cost risks, it did not include enough margin in its estimate for likely cost growth. The Navy plans to update the cost estimate for the lead ship, but it may not complete this update in time for its fiscal year 2021 budget request, which will seek authorization and funding for lead submarine construction.

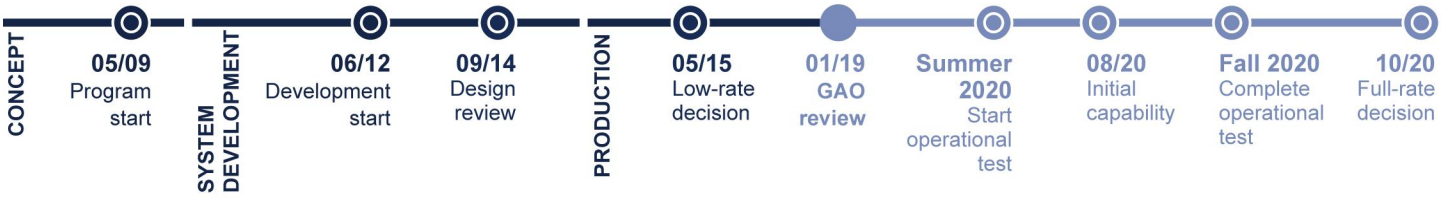
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that it intends to provide needed capabilities on schedule and at an affordable price by committing to stable requirements, achieving high design maturity at the start of construction for the lead submarine, improving manufacturing and construction readiness, and aggressively working to reduce costs. It also said it plans to complete 83 percent of the design by construction start—more than other recent submarine programs. The program also stated that it plans to update its cost estimate in 2019 to inform lead submarine funding. The program noted that the Navy recognizes its supplier base remains a high risk to construction readiness and continues to devote increased oversight on manufacturing issues and readiness assessments. The program said it continues to comply with all Navy, Department of Defense, and statutory requirements for managing critical technologies.

Source: Textron Marine and Land Systems.

Ship to Shore Connector Amphibious Craft (SSC)

The Navy's SSC is an air-cushioned landing craft intended to transport personnel, weapon systems, equipment, and cargo from amphibious vessels to shore. SSC is the replacement for the Landing Craft, Air Cushion, which is approaching the end of its service life. The SSC is designed to deploy in and from Navy amphibious ships that have well decks, such as the LPD 17 class, and will support assault and non-assault operations.



Program Essentials

Milestone decision authority: Navy

Program office: Washington, DC

Prime contractor: Textron Inc.

Contract type: FPI (detail design and construction)

CPFF (long lead materials and early production)

Software development approach: Modified waterfall

Next major milestone: Start operational testing (summer 2020)

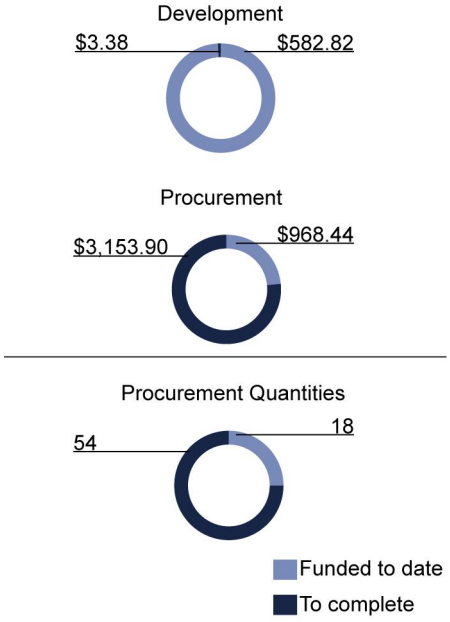
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (07/2012)	Latest (06/2018)	Percentage change
Development	$623.20	$586.20	-5.9%
Procurement	$3,782.20	$4,122.30	+9.0%
Unit cost	$60.63	$64.72	+6.7%
Acquisition cycle time (months)	135	135	0.0%
Total quantities	73	73	0.00%

Total quantities comprise 1 development quantity and 72 procurement quantities.

Funding and Quantities

(fiscal year 2019 dollars in millions)



Attainment of Product Knowledge

As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	●	●
• Complete a system-level preliminary design review	●	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	○	●
• Test a system-level integrated prototype	○	●
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	○	○
• Demonstrate critical processes on a pilot production line	●	●
• Test a production-representative prototype in its intended environment	○	○

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

SSC Program

Technology Maturity and Design Stability

SSC's one critical technology, the fire supression system, is mature. The SSC's design was not stable at its design review in 2014, but the program now reports that it has achieved stability. However, software development—a modified waterfall approach, which includes iterative testing—is not yet finished. Additionally, according to the program office, problems with two components have required design changes and delayed the start of operational testing.

The program office stated the gearbox, which had previous problems with premature wear, showed gear slippage during testing. The program is now working on separate engineering solutions for the propulsion and lift elements. This is the third iteration of design changes related to problems with the gearbox. The program expects that once the revised design is finalized and manufactured, the contractor will have to retrofit the craft already in production.

In October 2018, during pre-delivery testing, Craft 100—the test and training prototype—lost propulsion and drifted into a bridge, causing damage to one side of the craft. Program officials said the Navy found the root cause was overheating in the propulsion power control module. The prime contractor since developed a heat exchanger and, in November 2018, demonstrated it could significantly lower the module's internal temperature. The program office said it plans to apply this solution to all craft currently in production.

The program office will have the opportunity to demonstrate that the SSC design meets performance requirements through testing when the contractor delivers Craft 100, expected in late fiscal year 2019. The Navy and contractor will test Craft 100 while the contractor is producing the eight other SSC craft. This concurrency increases the risk that the program will discover deficiencies that could require costly design changes and modifications to units in production.

Production Readiness

The program entered low-rate initial production in May 2015 after demonstrating that all materials, manpower, tooling, and facilities were proven and available to meet the production schedule, as recommended by DOD guidance. However, best practices indicate programs should also demonstrate that manufacturing processes are in statistical control prior to production start, which the program has not done. Critical processes should be repeatable, sustainable, and consistent in producing parts within the quality standards, which provides confidence that the product can be produced within cost, schedule, and quality targets.

The aforementioned technical problems have caused delays to the SSC production schedule. Program officials reported nine SSC craft are currently under contract, and they are uncertain about the production schedule because solutions to the technical problems are pending. However, they expect delivery of Craft 100 in July 2019, a 15-month delay compared to last year's assessment. The program expects delivery of the second craft several months after Craft 100.

Other Program Issues

The program office will not verify in realistic operational conditions that it has fully addressed all known deficiencies until operational testing of Craft 100. However, SSC's operational testing—which cannot take place until the Navy takes delivery of Craft 100—will not begin until summer 2020. The program plans to conclude testing about 2 months before it declares initial capability in August 2020, when the first SSC craft are scheduled to deploy. Should the Navy discover deficiencies during operational testing, it may face a choice to delay initial capability or deliver SSC craft that are operationally ineffective or unsuitable, as it has done in other programs.

The program office said it has yet to award its follow-on contract for the 15 additional craft funded in fiscal years 2017, 2018, and 2019. The program delayed negotiations because of prior funding uncertainty, as well as the effort to address the gearbox problems.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that since our assessment, the program has delayed operational testing by 12 months, initial capability by 12 months, and full-rate production by 13 months from the dates shown in our program timeline. It said that the SSC program has made notable progress, but testing of Craft 100 continues to pose challenges, and electrical system stability and command, control, communications, computers and navigation integration challenges must be resolved before it can complete pre-delivery testing. The program said that Craft 100 is scheduled to complete on-water, pre-delivery testing and deliver in summer 2019, with subsequent craft delivering in late 2019. The program also stated that the Navy's 2020 budget request has reduced fiscal year 2020 craft quantities from eight craft to zero. Additionally, it said that, although one test and training craft and 72 operational craft remain the requirement, the above-mentioned change in requested funding shifts SSC's full capability to fiscal year 2032, 3 years later than previously planned. The program stated that Textron has indicated in the past that eight craft per year are necessary to achieve economies of scale, but with zero craft allotted in fiscal year 2020, the program foresees increased risk for growth in acquisition cost, lifecycle cost, and industrial base instability.

Source: General Dynamics NASSCO.

John Lewis Class Fleet Replenishment Oiler (T-AO 205)

The John Lewis Class Fleet Replenishment Oiler (T-AO 205) will replace the Navy's 15 existing Henry J. Kaiser Class Fleet Oilers (T-AO 187), which are nearing the end of their service lives. The primary mission of the oiler is to replenish bulk petroleum products, dry stores and packaged cargo, fleet freight, mail, and personnel to other vessels at sea. The Navy plans to procure a total of 20 ships. Construction of the lead ship began in September 2018. The Navy plans to proceed at a rate of one to two ships per year until 2033.

CONCEPT — SYSTEM DEVELOPMENT /PRODUCTION

- **02/11** Program initiation
- **09/17** Development/ production start
- **03/18** Design review
- **09/18** Lead ship fabrication start
- **01/19** GAO review
- **11/20** Lead ship delivery
- **07/21** Start operational test
- **10/21** End operational test
- **01/22** Initial capability/ full-rate decision

Program Essentials

Milestone decision authority: Navy

Program office: Washington Navy Yard, DC

Prime contractor: General Dynamics National Steel and Shipbuilding Company (NASSCO)

Contract type: FPI (detail design and construction)

Software development approach: NA

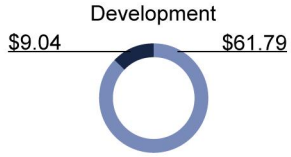
Next major milestone: Lead ship delivery (November 2020)

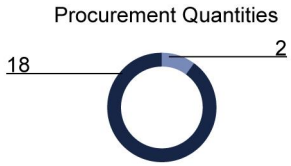
Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (09/2017)	Latest (12/2018)	Percentage change
Development	$71.00	$70.80	-0.3%
Procurement	$8,907.00	$10.735.90	+20.5%
Unit cost	$528.12	$540.34	+2.3%
Acquisition cycle time (months)	46	52	+13.0%
Total quantities	17	20	+17.6%

Funding and Quantities

(fiscal year 2019 dollars in millions)





Funded to date

To complete

Attainment of Product Knowledge

As of January 2019

	Status at	Current Status
Resources and requirements match	**Detail Design Contract Award**	
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	●	●
• Demonstrate all critical technologies in form, fit and function within a realistic environment	●	●
• Complete a system-level preliminary design review	○	●
Product design is stable	**Fabrication Start**	
• Complete basic and functional design to include 100 percent of 3D product modeling	●	●

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

T-AO 205 Program

Technology Maturity and Design Stability

The Navy has matured all Lewis class critical technologies and stabilized the ships' design. In 2014, the Navy identified three critical technologies for the Lewis class, all of which involved a new system for transferring cargo at sea. Prior to initiating detail design activities in June 2016, the Navy completed prototype tests of the critical technologies and found that they were fully mature—an approach consistent with shipbuilding best practices. In 2017, the Navy removed one critical technology—the Heavy e-STREAM cargo delivery system—from the Lewis class design. The Navy had intended to use this system to deliver F-35 Lightning II power modules. The Navy subsequently decided to deliver these by air, which precluded any need for the Heavy system.

Lead ship construction began in September 2018 with 95 percent of the ship's total design effort complete. Program officials stated that this figure meant that 100 percent of the ship's basic and functional design were by then complete—an approach consistent with best practices. Throughout detail design and now into construction, the Navy has not changed the Lewis class program's performance requirements. The Navy also leveraged commercial vessel designs to minimize design and construction risks. The Lewis class features a modern double-hull construction, an environmental-based design standard for commercial tankers, to ensure the ships can dock at ports-of-call. This design was included in the final three Kaiser class oilers.

Production Readiness

The program office has largely kept to its construction schedule to date for the first ship, but a flooding incident at a NASSCO graving dock in July 2018 has affected the delivery of future ships. The program office stated that this incident has not affected current ship fabrication activities. However, the dock's unavailability while repairs are planned and implemented has disrupted the contractor's schedule for future ships. According to the program office, the incident has resulted in some delays to certain delivery dates for ships two through six.

Other Program Issues

As part of the Navy's plan to expand the fleet, the Navy concluded that it would need an additional three Lewis class ships. The Navy's budget request for fiscal year 2019 increased its planned one-ship-per-year buy to two for fiscal years 2019, 2021, and 2023. The Congress provided appropriations for the additional fiscal year 2019 ship in support of the Navy's request. To account for the additional ships in fiscal years 2019 and 2021, the Navy plans to add two more ships to the low-rate initial production phase. Subsequently, program officials stated that they plan to compete a new contract for the remaining 12 ships using the construction knowledge gained from efforts under the existing contract.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that it continues to follow GAO shipbuilding best practices and has leveraged commercial vessel design practices to minimize risk. The program office also stated that it is currently revising its acquisition baseline to reflect the update in total quantities to 20 ships. In addition, the program office noted that, in fiscal year 2019, it fully funded the third and fourth ships and funded advance procurement for the fifth ship.

Source: USMC.

VH-92A Presidential Helicopter Replacement Program (VH-92A)

The Navy's VH-92A program provides new helicopters for safe, reliable, and timely transportation in support of the presidential airlift mission. It will replace the current Marine Corps fleet of VH-3D and VH-60N aircraft and supersedes the VH-71 program, which DOD canceled due to cost growth, schedule delays, and performance shortfalls. The VH-92A is expected to provide improved performance, survivability, and state-of-the-art communications capabilities, while offering increased passenger capacity.

Program Essentials

Milestone decision authority Navy

Program office: Patuxent River, MD

Prime contractor: Sikorsky Aircraft Corporation, a Lockheed Martin Company

Contract type: FPIF (development)

FFP (production; planned)

Software development approach: Mixed

Next major milestone: Low-rate initial production (June 2019)

Program Performance (fiscal year 2019 dollars in millions)

	First full estimate (04/2014)	Latest (06/2018)	Percentage change
Development	$2,802.00	$2,695.20	-3.8%
Procurement	$2,197.20	$2,140.00	-2.6%
Unit cost	$217.35	$210.23	-3.3%
Acquisition cycle time (months)	75	78	+4.0%
Total quantities	23	23	0.00%

Total quantities comprise 6 development quantities and 17 procurement quantities.

Funding and Quantities

(fiscal year 2019 dollars in millions)

Attainment of Product Knowledge

As of January 2019

	Status at Development Start	Current Status
Resources and requirements match		
• Demonstrate all critical technologies are very close to final form, fit and function within a relevant environment	NA	NA
• Demonstrate all critical technologies in form, fit and function within a realistic environment	NA	NA
• Complete a system-level preliminary design review	○	●
Product design is stable	**Design Review**	
• Release at least 90 percent of design drawings	●	●
• Test a system-level integrated prototype	○	○
Manufacturing processes are mature	**Production Start**	
• Demonstrate Manufacturing Readiness Level of at least 9, or critical processes are in statistical control	NA	NA
• Demonstrate critical processes on a pilot production line	NA	NA
• Test a production-representative prototype in its intended environment	NA	NA

● Knowledge attained, ○ Knowledge not attained, … Information not available, NA Not applicable

VH-92A Program

Technology Maturity and Design Stability

The VH-92A program has released all of its planned design drawings for this configuration that relies on no critical technologies. The program has a government-designed mission communications system (MCS), which consists of both government and commercial hardware and software. The program expects this system to provide the VH-92A passengers, pilot, and crew with the ability to conduct simultaneous short- and long-range secure and non-secure voice and data communications. The MCS is not in use in any other aircraft. The Navy plans to test MCS version 2.0 with the first two VH-92A developmental aircraft during an operational assessment scheduled to start in March 2019. MCS version 2.0 has limitations connecting to secure networks, following a change to the network security required protocols. For the operational assessment, the Navy intends to connect to existing networks that do not use the new security protocols. This will allow the operational assessment to proceed, but will limit the scope of testing. The program is working on the problem, which the Navy anticipates will be resolved by December 2019, about 3 months prior to the start of operational testing scheduled for March 2020. Once resolved, the Navy plans to upgrade the production representative aircraft with MCS version 3.0 retrofit kits and use this version for operational testing.

Based on new information provided by the program office, we have updated our attainment of product knowledge table to show that the program met the best practices metric of at least 90 percent of design drawings released to manufacturing at the time of its 2016 critical design review. However, the program did not test a system-level integrated prototype at the time of its critical design review, which is required by best practices to confirm design stability.

The program currently identifies two VH-92A performance attributes as high risks to the aircraft's development. Specifically, the aircraft has yet to demonstrate performance requirements related to (1) the propulsion system and (2) landing zone suitability, which includes a requirement to land on the White House south lawn without causing damage to the lawn. Additionally, the program plans to implement design changes outside the baseline program that will allow for improved visibility from one of the aircraft's doors. The aforementioned development activities are expected to be completed after the June 2019 production start. This approach introduces the potential for discovery of design deficiencies in testing at the same time that the contractor is manufacturing aircraft—an approach that could require costly rework and retrofits.

Production Readiness

The Navy is using the Federal Aviation Administration's air-worthiness certification process, including audits and inspections, to demonstrate production readiness. Further, the program plans to demonstrate manufacturing processes on a pilot production line prior to production start.

Ahead of production start, the contractor continues to outfit the four production representative aircraft with VH-92A's unique modifications. According to the contractor, despite some parts shortages, it plans to deliver each of these aircraft on or ahead of its contractual delivery date.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that, with regard to prototype testing, it expects to complete testing of a system-level integrated prototype in April 2019.

Source: Huntington Ingalls Industries, Pascagoula, MS.

DDG 51 Arleigh Burke Class Destroyer, Flight III (DDG 51 Flight III)

The Navy's DDG 51 Flight III destroyer will be a multi-mission ship designed to operate against air, surface, and underwater threats. Compared to existing Flight IIA ships of the same class, the new Flight III ships will provide the fleet with increased ballistic missile and air defense capabilities. Flight III's changes include replacing the current SPY-1D(V) radar with the Air and Missile Defense Radar (AMDR) program's SPY-6 radar and upgrading the destroyer's Aegis combat system. The Navy currently plans to procure 20 Flight III ships.

Program Essentials

Milestone decision authority: Navy

Program office: Washington, DC

Prime contractors: Huntington Ingalls Industries; General Dynamics-Bath Iron Works

Contract type: FPI (construction)

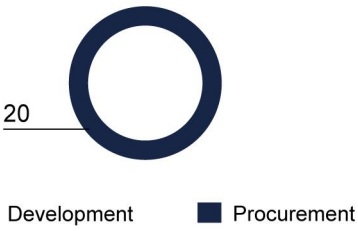
Software development approach: Mixed

Next major milestone: Fabrication start for second Flight III ship (DDG 126) (April 2019)

Estimated Program Cost

(FY 2019 dollars in millions)

Planned Quantities



Note: Cost and quantity estimates reflect amounts reported in the fiscal year 2019 President's Budget, which are procurement amounts only.

Current Status

The Navy and the shipbuilders completed Flight III detail design activities in December 2017. As compared to Flight IIA, the Flight III design included considerable changes to the ship's hull, mechanical, and electrical systems to incorporate the AMDR program's SPY-6 radar, and changes to restore ship weight and stability safety margins. To reduce technical risk, the Navy plans to field all but one—the SPY-6 radar—of the program's four mature critical technologies on other ship classes before integration with Flight III. In 2018, however, the Navy identified software-related deficiencies affecting SPY-6 that delayed delivery of a radar array for power and integration testing with the Aegis combat system by at least 1 year. Despite these delays, the Navy plans to complete testing, install the radar on the ship, and activate the combat system for shipboard testing by January 2022.

The Navy expects to complete a draft test and evaluation master plan for Flight III by early 2022. The Navy and the Director, Operational Test and Evaluation continue to disagree on whether the use of a self-defense test ship equipped with Aegis and the SPY-6 radar is necessary to validate performance during operational test and evaluation.

Huntington Ingalls began construction of the first Flight III ship in May 2018 and plans delivery in fiscal year 2023. Bath Iron Works will begin construction of the second Flight III ship in April 2019. Congress provided the Navy with multiyear procurement authority, which allows the Navy to procure up to 15 Flight III ships on one or more multiyear contracts. In September 2018, the Navy awarded multiyear procurement contracts for 10 Flight III ships: six to Huntington Ingalls and four to Bath Iron Works, with options for up to five additional ships split between the yards. The program reported that the Navy exercised one of these options in fiscal year 2019 for an 11th ship. In fiscal year 2019, the Navy added six ships to its planned Flight III quantities to work toward its goal of a 355 ship Navy.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office said that it has delivered 67 DDG 51 class ships since its inception in 1985 and the class remains in serial production at both new construction shipyards.

Source: U.S Navy.

Guided Missile Frigate (FFG(X))

The Navy's guided missile frigate program is intended to develop and deliver a small surface combatant with enhanced lethality and survivability as compared to the Littoral Combat Ship (LCS). The Navy expects FFG(X) to be an agile, multi-mission ship that provides local air defense, maximizes anti-surface and -submarine warfare capabilities, and delivers capability to protect and enable communications in hostile environments.

Program Essentials

Milestone decision authority: Navy

Program office: Washington Navy Yard, DC

Prime contractors (conceptual design): Austal USA; Bath Iron Works; Ingalls Shipbuilding; Marinette Marine Corporation; Lockheed Martin

Contract types: FFP (conceptual design); FPI (detail design and construction; planned)

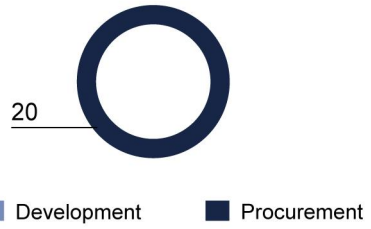
Software development approach: TBD

Next major milestone: Preliminary design review (June 2019)

Estimated Program Cost

(FY 2019 dollars in millions)

Planned Quantities



Note: Development costs include fiscal years 2019-2023 and procurement costs include fiscal years 2020-2023, covering 6 of the planned quantities. The Navy has yet to identify funding needs beyond 2023.

Current Status

The FFG(X) program continues conceptual design work ahead of planned award of a lead ship detail design and construction contract in September 2020. In May 2017, the Navy revised its plans for a new frigate derived from minor modifications of an LCS design. The current plan is to select a design and shipbuilder through full and open competition to provide a more lethal and survivable small surface combatant.

As stated in the FFG(X) acquisition strategy, the Navy awarded conceptual design contracts in February 2018 for development of five designs based on ships already demonstrated at sea. The tailoring plan indicates the program will minimize technology development by relying on government-furnished equipment from other programs or known-contractor-furnished equipment.

In November 2018, the program received approval to tailor its acquisition documentation to support development start in February 2020. This included waivers for several requirements, such as an analysis of alternatives and an affordability analysis for the total program life cycle. FFG(X) also received approval to tailor reviews to validate system specifications and the release of the request for proposals for the detail design and construction contract.

Following the development start decision, the program office will complete its evaluation of FFG(X) proposals and plans to award a contract in September 2020 to a single shipbuilder for detail design and construction of the lead frigate, with options for nine additional ships.

Attainment of Technology Maturation Knowledge

As of January 2019

Conduct competitive prototyping	○	Complete technology readiness assessment	◐
Validate requirements	◐	Complete preliminary design review	◐

● Knowledge attained, ◐ Knowledge planned, ○ Knowledge not attained, … Information not available, NA Not applicable

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office did not have any comments.

Source: U.S. Navy.

LHA 8 Amphibious Assault Ship (LHA 8)

The Navy's LHA 8, third ship of the LHA 6 class of ships, will help replace retired LHA 1 Tarawa-class amphibious assault ships. The LHA 8 incorporates significant design changes from earlier ships in the LHA 6 class to provide enhanced aviation capabilities and a well deck that can accommodate two landing craft. The ship is designed to transport about 1,350 Marines and their equipment onto hostile shores. The LHA 8 is under contract and began construction in October 2018.

Program Essentials

Milestone decision authority: Navy

Program office: Washington, DC

Prime contractor: Huntington Ingalls Industries

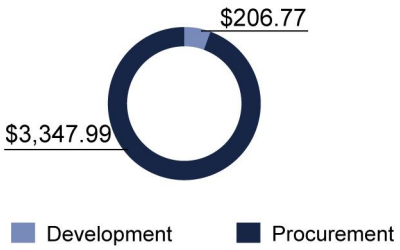
Contract type: FPI (detail design and construction)

Software development approach: Mixed

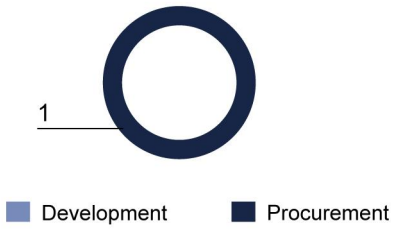
Next major milestone: LHA 8 ship delivery (January 2024)

Estimated Program Cost

(FY 2019 dollars in millions)



Planned Quantities



Current Status

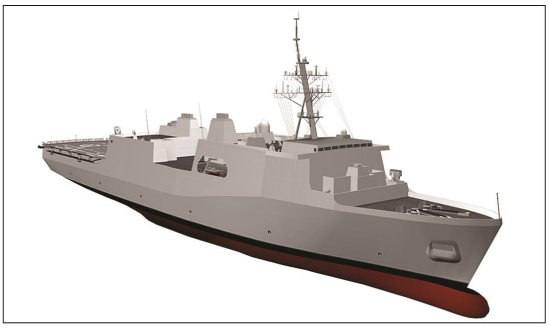
In June 2017, the Navy exercised a contract option for detail design and construction of the LHA 8. The LHA 8 incorporates significant design changes from earlier ships in the LHA 6 class, but Navy officials were unable to quantify the changes. The Navy started construction in October 2018 and LHA 8 is scheduled to be delivered in January 2024.

The LHA 8 program office has not identified any critical technologies. However, the ship is relying on technology that is currently being developed by another Navy program, the Enterprise Air Surveillance Radar (EASR), with delivery expected in August 2021. EASR, intended to provide self-defense and situational awareness capabilities, is derived from the pre-existing Air and Missile Defense Radar program, but will be a different size and will rotate. LHA 8 program officials have identified the radar as the program's highest development risk. If the radar is not delivered on schedule, Navy officials report that this could lead to out-of-sequence design and delayed installation and testing. Officials responsible for developing the radar, however, stated that the radar is approaching maturity and is on schedule to be delivered to the shipbuilder when needed.

The Navy began construction with about 61 percent of the LHA 8 product model completed—an approach inconsistent with shipbuilding best practices. These best practices call for 100 percent completion of 3D product modeling prior to construction start to minimize the likelihood of costly re-work and out of sequence work that can drive schedule delays. The Navy, however, estimates that the LHA 8 shipbuilder will not complete 100 percent of the ship's 3D product model until June 2019, almost 8 months after the start of construction.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that the Navy understands all design changes incorporated on the LHA 8, such as reintroducing the well deck and incorporating EASR. According to the program office, the Navy does not begin construction on any section of the LHA 8 ship before completing that respective section's design.



Source: Computer Science Corp (CSC) pursuant to LX(R) Design Support Contract notional concept LX(R).

LPD 17 San Antonio Class Amphibious Transport Dock, Flight II (LPD 17 Flight II) [formerly LX(R)]

The Navy's LPD 17 Flight II program will replace existing amphibious ships that the Navy is retiring. The Navy intends to use LPD 17 Flight II ships to transport Marines and equipment to support expeditionary operations ashore, as well as non-combat operations for storage and transfer of people and supplies. The Flight II ships will include a larger hull than the retiring ships, but the Navy expects them to provide similar capabilities. The Navy plans to develop Flight II incrementally over three ships and acquire 13 ships beginning in fiscal year 2019.

Program Essentials

Milestone decision authority: Navy

Program office: Washington Navy Yard, DC

Prime contractor: Huntington Ingalls Incorporated

Contract type: CPFF (long lead material purchasing)

FPI (detail design and construction)

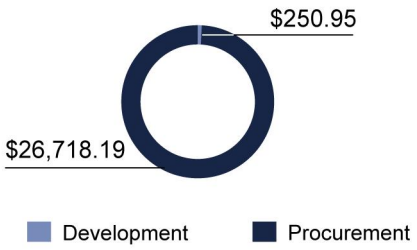
CPFF (life cycle and engineering support; planned)

Software development approach: NA

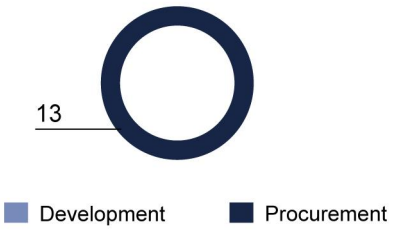
Next major milestone: Detail design and construction contract award (March 2019)

Estimated Program Cost

(FY 2019 dollars in millions)



Planned Quantities



Current Status

The Navy planned to accelerate purchase of LPD 30—the first fully configured Flight II ship—after Congress appropriated $1.8 billion above the fiscal year 2018 budget request, according to program officials. The Navy reported that it awarded contracts in August 2018 for LPD 30 long lead time materials and in March 2019 for lead ship construction.

The Navy based the Flight II design on Flight I, with modifications to reduce costs and meet new requirements. According to program officials, roughly 200 design changes will distinguish the two flights including replacing the composite mast with a steel stick. Officials stated that the design would not rely on any new technologies. However, the Navy plans to install a new radar, the Enterprise Air Surveillance Radar, which is still in development. The Navy expects live radar system testing through November 2019, with a complete radar prototype in February 2020. Although program officials consider these activities to be low risk, the Navy will make its decision to begin ship construction by December 2019 without incorporating lessons learned from radar testing into the design. Starting construction before stabilizing the design could require the Navy to absorb costly design changes and rework during ship construction.

The Navy initially pursued a limited competition for LX(R), but now has a non-competitive acquisition strategy for LPD 17 Flight II. The Navy plans to award sole-source contracts to Huntington Ingalls—the only shipbuilder of Flight I ships—for Flight II construction. Further, the program did not request a separate independent cost estimate for Flight II prior to awarding the LPD 30 detail design and construction contract. At the same time, the Navy identified no plans to establish a cost baseline specific to Flight II. Without this baseline, the Navy would report full LPD 17 program costs—rather than Flight II specific costs—constraining visibility into Flight II.

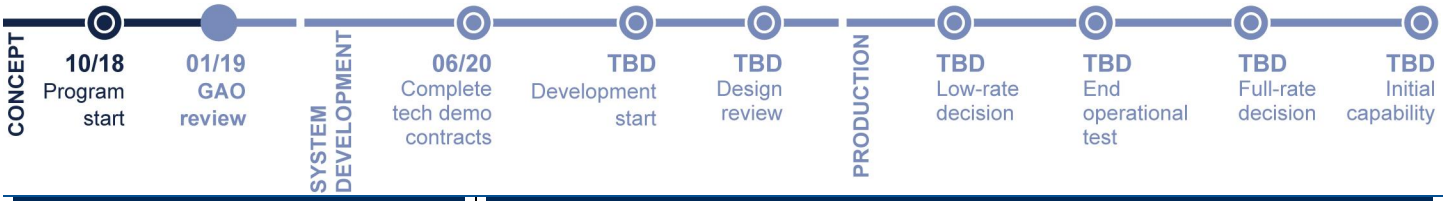
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated as appropriate The program office stated that LPD Flight II is included under the existing LPD 17 acquisition program baseline, and that no other viable contractor responded to a public notice regarding the Navy's plan to award Huntington Ingalls the LPD 30 construction contract.

Source: U.S. Navy.

Next Generation Jammer – Low Band (NGJ-LB)

The Navy's NGJ-LB is an external jamming pod system that will be fitted on EA-18G Growler aircraft. It is expected to replace the ALQ-99 jamming system and provide enhanced airborne electronic attack capabilities to disrupt adversaries' use of the electromagnetic spectrum for radar detection, among other purposes. The Navy plans to field a system that jams low-band radio frequencies. The Navy plans separate programs for mid- and high-band frequencies. We assessed the Low Band program.



Program Essentials

Milestone decision authority: Navy

Program office: Tactical Aircraft Programs, Patuxent River, MD

Prime contractor: TBD

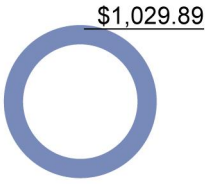
Contract type: TBD

Software development approach: TBD

Next major milestone: Completion of two demonstration of existing technologies contracts (June 2020)

Estimated Program Cost

(FY 2019 dollars in millions)



Development Procurement

Planned Quantities

Development Procurement

Current Status

The Navy is determining the acquisition strategy for the NGJ-LB program and analyzing potential solutions to meet its capability needs. In October 2018, the Assistant Secretary of the Navy (Research, Development, and Acquisition) directed the NGJ-LB program manager to proceed with planning to execute the program as a middle tier acquisition. A middle tier acquisition—also referred to as a Section 804 program—is a program that uses a streamlined acquisition process to rapidly prototype or field capabilities within a 5-year period.

In October 2018, the program awarded two demonstration of existing technologies (DET) contracts to assess maturity of technologies, identify potential materiel solutions, and inform acquisition strategy development. Both contractors—L3 Technologies and Northrop Grumman—are required to provide technology demonstration prototypes and demonstrate technology maturity in a relevant test environment. Program officials stated that the results of these demonstrations will determine whether the program will move forward as a middle tier acquisition. According to program officials, the Navy plans to conduct a preliminary design review and a technology readiness assessment in the future, but will not schedule most program events until after the DET contractors complete their work. The Navy intends to commence a follow-on development or rapid prototype program by the end of fiscal year 2020.

Attainment of Technology Maturation Knowledge

As of January 2019

Conduct competitive prototyping	●	Complete technology readiness assessment	◐
Validate requirements	●	Complete preliminary design review	◐

● Knowledge attained, ◐ Knowledge planned, ○ Knowledge not attained, … Information not available, NA Not applicable

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate.

Source: U. S. Navy.

P-8A Poseidon, Increment 3 (P-8A Increment 3)

The Navy's P-8A Increment 3 is intended to provide enhanced capabilities to the P-8A aircraft in four sets of improvements. The first two sets include communication, radar, and weapons upgrades, which will be incorporated into the existing P-8A architecture. The following sets will establish a new open systems architecture, improve the combat system's ability to process and display classified information, and enhance the P-8A's search, detection, and targeting capabilities. DOD made Increment 3 part of the P-8A baseline program in 2016.

Program Essentials

Decision authority level: Navy

Program office: Patuxent River, MD

Prime contractor: Various

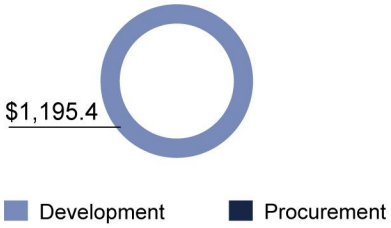
Contract type: CPFF (design and integration)

Software development approach: Mixed

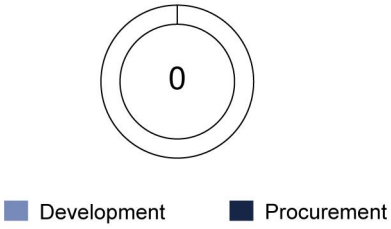
Next major milestone: Increment 3 design review (January 2020)

Estimated Program Cost

(FY 2019 dollars in millions)



Planned Quantities



Current Status

The P-8A program has delivered the first set of Increment 3 improvements and is scheduled to complete the second set in fiscal year 2019. Since our 2018 assessment, the P-8A program has delayed the development and fielding of the last two sets of capabilities in Increment 3. Specifically, the program office reports it deferred events such as platform integration contract award, P-8A Increment 3 critical design review, and fielding of remaining capabilities by 3 to 11 months. Program officials attributed these new delays to receiving 30 percent less in development funds than requested in fiscal year 2018. In total, program officials report that limited funding in the last two fiscal years has delayed the fielding of the last two sets of capabilities by 12 to 18 months.

To upgrade the combat system for P-8A Increment 3, the Navy will integrate new hardware and software on the aircraft. The P-8A acquisition program baseline provides for 117 aircraft to be retrofitted with Increment 3 capabilities. According to program officials, P-8A Increment 3 capabilities are based on mature technologies. The government will act as the lead integrator for the combat system. The combat system upgrade includes an application-based open system architecture that will allow the program to compete the development and integration of future capabilities. The program office conducted a preliminary design review for the combat system upgrade in July 2018. The program office stated that, among the issues that the review identified, it has resolved those associated with certain combat system components that exceeded their size, weight, power, and cooling allocations. According to program officials, the P-8A Increment 3 critical design review will largely focus on integration.

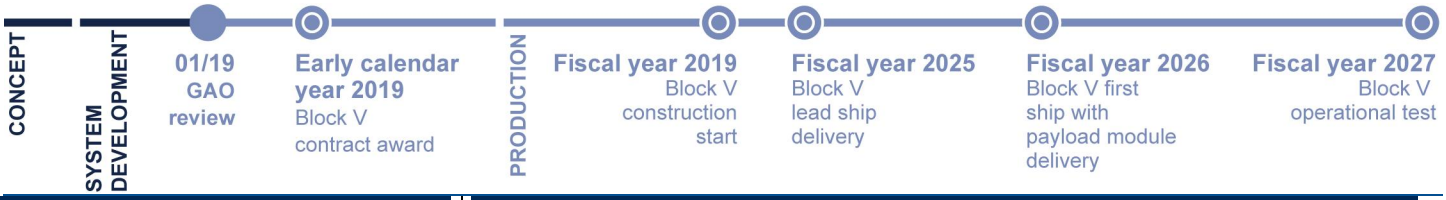
Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated as appropriate. The program office stated that P-8A Increment 3 has continued to make technical progress to support the combat system's critical design review. According to the program office, this progress includes closing all technical actions from the preliminary design review conducted in July 2018.

Source: U.S. Navy photo courtesy of Huntington Ingalls Industries.

SSN 774 Virginia Class Submarine Block V (SSN 774 Block V)

SSN 774 is a nuclear-powered attack submarine capable of performing multiple missions, with enhanced capabilities for special operations and intelligence collection and surveillance. The Navy has implemented major upgrades to the class in blocks. The most recent, Block V, includes enhanced undersea acoustic improvements called acoustic superiority, and increases strike capacity for Tomahawk cruise missiles by inserting a new mid-body section called the Virginia Payload Module (VPM).



Program Essentials

Milestone decision authority: Navy

Program office: Washington, DC

Prime contractor (planned): General Dynamics Electric Boat

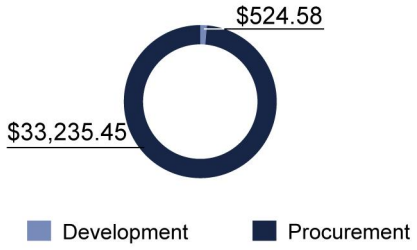
Contract type (planned): FPI (construction)

Software development approach: Other

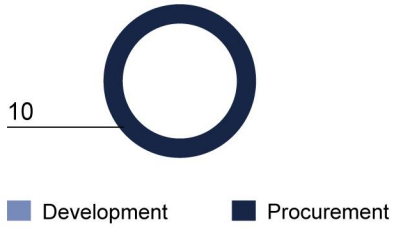
Next major milestone: Block V contract award (calendar year 2019)

Estimated Block V Cost

(FY 2019 dollars in millions)



Planned Quantities



Note: In our 2018 report, we reflected Block V estimated costs for fiscal years 2019-2022. At that time, the Navy had yet to determine funding needs beyond fiscal year 2022. The cost estimates above, however, reflect information provided by the Navy in November 2018, which include funding needs for prior years as well as fiscal year 2023.

Current Status

In 2019, the Navy plans to award a multibillion dollar, multiyear contract for construction of 10 Block V submarines. Under the Navy's plan, all Block V ships will include acoustic superiority improvements, while the VPM will be added starting with the second Block V submarine.

According to program officials, the design of Block V submarines will differ from Block IV by approximately 20 percent. Of this 20 percent, the program office considers 70 percent to constitute major changes. The program office plans to complete basic and functional designs for VPM by construction start—an approach consistent with best practices. However, the shipbuilder is currently behind schedule in completing detail design work, where (1) the design advances to the highest level of fidelity, (2) specific fabrication and installation instructions for the shipyard are developed, and (3) required production materials are identified. The program now plans to complete 76 percent of this work by construction start, compared to the 86 percent it initially planned, in part due to the shipbuilder's challenges in using a new design tool. Going forward, the Navy and shipbuilder will need to balance staffing levels for the remaining Block V design work with design efforts for the new Columbia class ballistic missile submarine. Construction of Block V and the Columbia class will coincide beginning in fiscal year 2021.This will require the Navy and its shipbuilder to manage staffing demands and other resources across both programs. In addition, program officials said vendor quality issues with welding on VPM have caused a 3.5-month delay in the schedule for the payload tubes for the first two submarines with VPM. The Navy plans to recover some time by accelerating tube manufacturing with a second vendor, but this approach may increase program costs.

The Block V effort is subsumed under the SSN 774 major defense acquisition program, and is not managed as a separate program. In 2015, the Office of the Secretary of Defense shifted the program's oversight to the Navy. SSN 774 had already completed its required defense acquisition system milestone reviews before Block V started, but program officials said the Navy continues to conduct regular oversight of the Block V.

Program Office Comments

In commenting on a draft of this assessment, the program office provided technical comments, which we incorporated where appropriate.