



September 2018

WEAPON SYSTEM SUSTAINMENT

Selected Air Force
and Navy Aircraft
Generally Have Not
Met Availability Goals,
and DOD and Navy
Guidance Need to Be
Clarified

GAO Highlights

Highlights of [GAO-18-678](#), a report to congressional committees

Why GAO Did This Study

DOD spends billions of dollars annually to sustain its weapon systems to support current and future operations. The Air Force and Navy are operating many of their fixed-wing aircraft well beyond their original designed service lives and therefore are confronted with sustainment challenges.

House Report 114-537 included a provision for GAO to evaluate the sustainment of major weapon systems. This report, among other things, (1) examines the trends in availability and O&S costs for selected Air Force and Navy fixed-wing aircraft since fiscal year 2011, including whether they met availability goals, and (2) assesses the extent that the departments documented sustainment strategies, reviewed sustainment metrics, and implemented plans to improve aircraft availability. GAO selected a nongeneralizable sample of 12 fixed-wing aircraft by considering a variety of factors, such as the type, age, and manufacturer of the aircraft, among other factors, and analyzed condition and availability data, O&S costs, and sustainment challenges from fiscal year 2011 through March 2017 for each aircraft in a “Sustainment Quick Look.” GAO also analyzed policies, strategies, and plans, and interviewed Navy and Air Force officials in program offices, squadrons, and maintenance depots.

What GAO Recommends

GAO is recommending that DOD and the Navy update or issue new policy and guidance clarifying the requirements for documenting sustainment strategies for legacy weapon systems. DOD concurred with the recommendations.

View [GAO-18-678](#). For more information, contact Zina Merritt, 202-512-5257, merrittz@gao.gov

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What GAO Found

Between fiscal years 2011 and 2016, the Air Force and Navy generally did not meet aircraft availability goals, and operating and support (O&S) cost trends for GAO’s selected fixed-wing aircraft varied. Specifically, GAO found that

- availability declined for 6 of 12 aircraft—3 from each service—between fiscal years 2011 and 2016;
- availability fell short of goals for 9 of 12 aircraft in fiscal year 2016; and
- O&S costs increased for 5 of the aircraft, and maintenance costs—the largest share—increased for 8 of 12 aircraft.

GAO found, and officials agreed, that these aircraft face similar challenges.

Sustainment Challenges Affecting Selected Air Force and Navy Fixed-Wing Aircraft

Sustainment challenges	Air Force					Navy						
	B-52	C-17	E-8C	F-16	F-22	AV-8B	C-2A	E-2C	E-2D	EA-18G	F/A-18A-D	F/A-18E-F
Delays in acquiring replacement aircraft				✓	✓	✓					✓	
Unexpected replacement of parts and repairs	✓	✓	✓		✓	✓	✓	✓			✓	✓
Delays in depot maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Shortage of depot maintainer personnel					✓	✓	✓	✓	✓	✓	✓	✓
Parts obsolescence ^a	✓		✓			✓	✓	✓	✓		✓	
Diminishing manufacturing source ^b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: GAO analysis of Air Force and Navy data. | GAO-18-678

^aObsolescence means a part is unavailable due to its lack of usefulness or it is no longer current or available for production.

^bDiminishing manufacturing sources is a loss or impending loss of manufacturers or suppliers.

The Air Force and Navy have documented sustainment strategies for some aircraft, regularly reviewed sustainment metrics, and implemented improvement plans. The Air Force has documented sustainment strategies for all aircraft GAO reviewed; however, the Navy has not documented or updated its sustainment strategies for four aircraft. Specifically, the Navy does not have a documented sustainment strategy for the C-2A, and has not updated the strategies for the E-2C, EA-18G, and F/A-18A-D since before 2012. The Navy is in the process of documenting its strategies, but Department of Defense (DOD) policy is unclear on whether a sustainment strategy is required and has to be updated every 5 years for weapon systems that are in the operations and support phase of their life cycle (i.e., legacy systems). Also, Navy guidance does not specify a requirement for legacy systems, although Air Force guidance does. Clarifying the requirements to document sustainment strategies for legacy systems, and documenting those strategies, would add additional visibility over the availability and O&S costs of DOD aircraft and any associated sustainment risks.

This is a public version of a sensitive report issued in April 2018. Information on aircraft availability and other related information was deemed to be sensitive and has been omitted from this report.

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Abbreviations

AA	Aircraft Availability
ASD (L&MR)	Assistant Secretary of Defense for Logistics and Materiel Readiness
NMCB	Not Mission Capable Both Maintenance and Supply
NMCM	Not Mission Capable Maintenance
NMCS	Not Mission Capable Supply
O&S	Operating and Support
RBA	Ready-Basic-Aircraft
RFT	Ready-For-Tasking
UPNR	Unit Possessed Not Reported
USD (A&S)	Under Secretary of Defense for Acquisition and Sustainment

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September 10, 2018

The Honorable James M. Inhofe
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Department of Defense (DOD) spends tens of billions of dollars annually to sustain its weapon systems in an effort to ensure that these systems are available to simultaneously support today's military operations and maintain the capability to meet future defense requirements. Operating and support (O&S) costs historically account for approximately 70 percent of a weapon system's total life-cycle cost—costs to operate and sustain the weapon system from initial operations through the end of its life—and include costs for repair parts, depot and field maintenance, contract services, engineering support, and personnel, among other things.¹ Weapon systems are costly to sustain in part because they often incorporate a complex array of technical subsystems and components and need expensive repair parts and logistics support to meet required readiness levels. In addition, as we reported in 2014,

¹There are two levels of DOD maintenance: field level and depot level. Field-level maintenance includes organizational and intermediate maintenance and requires fewer skills, but it occurs more frequently. Depot-level maintenance occurs less frequently but requires greater skills. Specifically, depot maintenance is an action performed on materiel or software in the conduct of inspection, repair, overhaul, or modification or rebuild of end items, assemblies, subassemblies, and parts that, among other things, requires extensive industrial facilities, specialized tools and equipment, or uniquely experienced and trained personnel that are not available in other maintenance activities. Depot maintenance is independent of any location or funding source and may be performed in the public or private sectors. See GAO, *Depot Maintenance: Executed Workload and Maintenance Operations at DOD Depots*, [GAO-17-82R](#) (Washington, D.C.: Feb. 3, 2017), for additional information on the workload executed across the military services' depots as well as challenges confronted by each of DOD's 17 depots.

military operations have increased the wear and tear on many weapon systems, including fixed-wing aircraft, and escalated their O&S costs beyond peacetime levels.²

The Departments of the Air Force and Navy are operating many of their fixed-wing aircraft well beyond their original designed service lives, and some of these legacy systems are confronted with sustainment challenges that affect aircraft availability.³ The Air Force and Navy forecast needed aircraft availability and associated goals to ensure that fixed-wing aircraft can meet operational and training requirements. In 2017, senior Air Force, Navy, and Marine Corps officials testified before the House Armed Services Committee regarding, among other things, the maintenance and sustainment issues relating to aging aircraft that are affecting the readiness of their forces.⁴ Additionally, over the past several years, we have conducted work on a number of issues that affect the ability of DOD to sustain its weapon systems, an overview of which can be found in appendix I.

We conduct annual assessments of DOD's major defense acquisition programs and report on the cost, schedule, and performance of those programs.⁵ To complement our acquisition-related work on major weapon systems, the House Armed Services Committee in House Report 114-537

²GAO, *Weapon Systems Management: DOD Has Taken Steps to Implement Product Support Managers but Needs to Evaluate Their Effects*, [GAO-14-326](#) (Washington, D.C.: Apr. 29, 2014).

³The Departments of the Air Force and Navy operate the majority of DOD's fixed-wing aircraft. The Department of the Navy includes the Navy and the Marine Corps. Naval Air Systems Command manages both Navy and Marine Corps aviation systems. While the Department of the Army also operates some fixed-wing aircraft, we did not include the Army in our review. We also excluded rotary-wing aircraft, such as helicopters, from the scope of this review. In this report, we define "legacy systems" as those fixed-wing aircraft that are currently in the operations and support phase of the acquisition life cycle and generally are no longer in production.

⁴See *The State of the Military: Hearing before the H. Comm. on Armed Services*, 115th Cong. (2017) (statements of Admiral William F. Moran, Vice Chief of Naval Operations, and General Stephen W. Wilson, Vice Chief of Staff of the Air Force); and *Aviation Readiness: What's the Flight Plan*, Hearing before the Subcomm. on Readiness of the H. Comm. on Armed Services, 115th Cong. (2017) (statements of Vice Admiral Troy M. Shoemaker, Commander, Naval Air Forces, and Lieutenant General Steven R. Rudder, Deputy Commandant for Aviation, United States Marine Corps).

⁵See GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, [GAO-17-333SP](#) (Washington, D.C.: Mar. 30, 2017), for our most recent annual assessment.

accompanying a bill for the National Defense Authorization Act for Fiscal Year 2017 included a provision for us to evaluate the sustainment, availability, and costs of major weapon systems, among other things.⁶ This report (1) examines trends in aircraft availability and O&S costs for selected Air Force and Navy fixed-wing aircraft since fiscal year 2011, including whether the aircraft met availability goals; (2) describes the sustainment challenges that affect aircraft availability and O&S costs across the selected fixed-wing aircraft; and (3) assesses the extent that the Air Force and Navy have documented sustainment strategies, reviewed sustainment metrics, and implemented plans to improve aircraft availability for the selected fixed-wing aircraft. Additionally, in appendixes II–XIII we provide “Sustainment Quick Looks” for each of the fixed-wing aircraft we reviewed. These “Sustainment Quick Looks” include additional information for each of the fixed wing aircraft we reviewed.

This report is a public version of a sensitive report that we issued on April 25, 2018.⁷ The sensitive report included an objective related to the trends in aircraft availability. DOD deemed some of the information, such as aircraft availability, not mission capable status, number of aircraft in depots, and budgeted and executed flight hours, to be sensitive (i.e., For Official Use Only), which must be protected from public disclosure. This public report omits the information that DOD deemed to be sensitive. Although the information provided in this report is more limited, it addresses the same objectives and uses the same methodology as the sensitive report.

For objective one, we selected a nongeneralizable sample of 12 types of fixed-wing aircraft managed by the Air Force and Navy and reviewed aircraft availability and other sustainment data calculated based on the number of aircraft and period of time and O&S costs from fiscal years 2011 through 2016, the last fiscal year for which complete data were available at the time of our work. We selected this period so we could identify and obtain insight on historical data trends regarding aircraft availability and O&S costs for the selected fixed-wing aircraft.⁸ We compared the availability data over this period to Air Force and Navy

⁶H.R. Rep. No. 114-537, at 114 (2016).

⁷GAO, *Weapon System Sustainment: Selected Air Force and Navy Aircraft Generally Have Not Met Availability Goals, and DOD and Navy Guidance Need Clarification*, [GAO-18-146SU](#) (Washington, D.C.: April 25, 2018).

⁸O&S costs are adjusted for inflation and presented in fiscal year 2016 constant dollars.

availability goals associated with each aircraft fleet. To select the fixed-wing aircraft for our review, we considered a number of factors, such as the type of aircraft (fighters, bombers, cargo, etc.), the size and age of the inventory, and whether the aircraft were sustained organically by DOD or through contract arrangements, such as public-private partnerships or performance-based logistics contracts.⁹ For the Air Force, we selected five fixed-wing aircraft—the B-52 Stratofortress, C-17 Globemaster III, F-16 Fighting Falcon, F-22 Raptor, and E-8C Joint Surveillance and Target Attack Radar System (JSTARS). For the Navy, including the Marine Corps, we selected seven fixed-wing aircraft: the AV-8B Harrier, C-2A Greyhound Logistics Aircraft, E-2C Hawkeye Early Warning and Control Aircraft, E-2D Advanced Hawkeye Early Warning and Control Aircraft, EA-18G Growler, F/A-18A-D Hornet Strike Fighter, and F/A-18E-F Super Hornet. For the selected aircraft, we obtained and reviewed the aircraft availability, sustainment, and O&S data for accuracy and completeness, interviewed officials regarding their data-collection processes, and reviewed available related policies and procedures associated with the collection of the data. We found the information to be sufficiently reliable for the purposes of presenting sustainment metrics, such as aircraft availability and O&S costs.

For objective two, we reviewed sustainment metrics, performance briefings, and other relevant documentation to identify specific challenges for each of the 12 aircraft in our review. We also reviewed ongoing and planned actions to address those challenges. We interviewed program officials, depot officials, field maintainers, and squadrons to obtain their views on the challenges they face in sustaining the aircraft and the actions they take to mitigate those challenges. In some instances, we visited depots and squadrons to observe aircraft undergoing maintenance, discuss the respective maintenance processes, and discuss challenges and mitigation actions with officials.

For objective three, we obtained and analyzed the sustainment strategies, performance management frameworks (i.e., sustainment metrics collected and monitored as well as the levels of management review),

⁹DOD defines a public-private partnership as a cooperative arrangement between an organic product support provider and one or more private-sector entities to perform DOD or defense-related work or to utilize DOD depot facilities and equipment, or both. A performance-based logistics contract is outcome-based product support, where outcomes are acquired through performance-based arrangements that deliver the requirements contracted for and that incentivize product support providers to reduce costs through innovation.

and improvement plans for each of the 12 selected fixed-wing aircraft. We also identified and reviewed DOD, Air Force, and Navy guidance to analyze the departments' efforts in sustaining these aircraft.¹⁰ Specifically, we reviewed the Air Force and Navy guidance to determine whether it was consistent with DOD policy and federal standards for internal control that deal with management defining objectives in specific terms.¹¹ Additionally, we identified whether the Air Force and Navy had documented sustainment strategies for each selected fixed-wing aircraft, including a life-cycle sustainment plan, postproduction support plan, or an in-service support plan, among other types of documented strategies. Further, we determined whether the sustainment strategy for each selected fixed-wing aircraft had been updated within time frames identified in DOD policy. Appendix XIV provides further information on our scope and methodology.

The performance audit upon which this report is based was conducted from September 2016 to April 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate, evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. We subsequently worked with DOD from April 2018 to September 2018 to prepare this unclassified version of the original sensitive report for public release. This public version was also prepared in accordance with these standards.

¹⁰DOD Instruction 5000.02, *Operation of the Defense Acquisition System* (Jan. 7, 2015) (incorporating Change 3, Aug. 10, 2017); Air Force Instruction 63-101/20-101, *Integrated Life Cycle Management* (May 9, 2017); Secretary of the Navy Manual (SECNAV M-) 5000.2, *Acquisition and Capabilities Guidebook* (May 9, 2012); Secretary of the Navy Instruction (SECNAVINST) 5000.2E, *Department of the Navy Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System* (Sept. 1, 2011); and SECNAVINST 5400.15C, *Department of the Navy (DON) Research and Development, Acquisition, Associated Life-Cycle Management, and Logistics Responsibilities and Accountability* (Sept. 13, 2007) (Change Transmittal 1, Dec. 2, 2011).

¹¹GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 10, 2014).




Background

Information on Selected Air Force and Navy Fixed-Wing Aircraft

The inventories of the selected Air Force and Navy fixed-wing aircraft in our review totaled 2,823 aircraft and required approximately \$20 billion to operate and support in fiscal year 2016. The inventory, aircraft status, initial operational capability, and service life forecast for each of the 12 selected fixed-wing aircraft are shown in figure 1.

Figure 1: Information on Selected Air Force and Navy Fixed-Wing Aircraft

	Aircraft	Total inventory ^a	Status ^b	Service life
Air Force	B-52 Stratofortress	76	Legacy system	1952 - Beyond 2040
	C-17 Globemaster III	222	Legacy system	1991 - Beyond 2040
	E-8C JSTARS	16	Legacy system	1997 - 2034
	F-16 Fighting Falcon	947	Legacy system	1979 - 2040
	F-22 Raptor	186	Legacy system	2005 - 2060
Navy	AV-8B Harrier	123	Legacy system	1985 - 2026
	C-2A Greyhound Logistics Aircraft	34	Legacy system	Unknown - 2028
	E-2C Hawkeye Early Warning and Control Aircraft	42	Legacy system	1964 (Group I) - 1992 (Group II) - 2026
	E-2D Advanced Hawkeye Early Warning and Control Aircraft	20	In production	2014 - To be determined
	EA-18G Growler	115	In production	2009 - 2045
	F/A-18A-D Hornet Strike Fighter	537	Legacy system	1983 (A/B models) - 1987 (C/D models) - Beyond 2030
	F/A-18E-F Super Hornet	505	In production	2001 - 2045
Total		2,823		

 10 aircraft
 Initial operational capability
 Service life forecast
 JSTARS: Joint Surveillance and Target Attack Radar System

Source: GAO analysis of Air Force and Navy data. | GAO-18-678

^aAir Force and Navy inventory data as of the end of fiscal year 2016. The Navy inventory data do not include aircraft that are supporting research and development or that are stored.

^bIn this report, we define “legacy systems” as those fixed-wing aircraft that are currently in the operations and support phase of the acquisition life cycle and generally are no longer in production.

Policy and Guidance for the Sustainment of Fixed-Wing Aircraft

Sustainment of fixed-wing aircraft and other weapon systems comprises the logistics and personnel services required to maintain and prolong operations, and DOD policy provides direction to service components on sustainment planning across the life cycle of the weapon system.¹² Specifically, DOD policy requires the services to develop and implement a sustainment strategy, such as a Life-cycle Sustainment Plan, for sustaining its weapon systems. According to DOD's policy, this strategy should be the basis for all sustainment efforts, including sustainment metrics mapped to key performance parameters and key system attributes, such as aircraft availability, to manage sustainment performance. The policy states that, after initial operating capability, programs should update the sustainment plan whenever there are major changes to its strategy for sustaining the weapon system, or every 5 years, whichever occurs first. The Air Force and the Navy also have guidance that implements the requirements of the DOD guidance.¹³ These services' guidance include sustainment-planning requirements for life-cycle sustainment and assurance of affordability.

Roles and Responsibilities for the Sustainment of Fixed-Wing Aircraft

There are a variety of DOD offices that have roles and responsibilities related to sustaining fixed-wing aircraft. For instance, the Under Secretary of Defense for Acquisition and Sustainment (USD [A&S]), is the principal staff assistant and advisor to the Secretary of Defense for all matters concerning acquisition and sustainment.¹⁴ Specifically, USD (A&S) is responsible for establishing policies for logistics, maintenance, and sustainment support for all elements of DOD, including fixed-wing aircraft. The Assistant Secretary of Defense for Logistics and Materiel Readiness (ASD [L&MR]) serves as the principal staff assistant and advisor to the USD (A&S) on logistics and materiel readiness within DOD. Specifically,

¹²DOD Instruction 5000.02, *Operation of the Defense Acquisition System*.

¹³Air Force Instruction 63-101/20-101, SECNAV M-5000.2, SECNAVINST 5000.2E, and SECNAVINST 5400.15C.

¹⁴In response to Section 901 of the National Defense Authorization Act for Fiscal Year 2017 (Pub. L. No. 114-328), DOD restructured the office of the Under Secretary of Defense for Acquisition, Technology, and Logistics [USD (AT&L)]. Effective February 1, 2018, USD (AT&L) reorganized into two separate offices: the Under Secretary of Defense for Research and Engineering advises the Secretary on key investments to retain technical superiority based on the analytical rigor and understanding of risk associated with these technologies; and the Under Secretary of Defense for Acquisition and Sustainment advises the Secretary on all matters regarding acquisition and sustainment and be involved in the oversight of individual programs as required.

the ASD (L&MR) is responsible for (1) establishing DOD policies and procedures for logistics, maintenance, materiel readiness, strategic mobility, and sustainment support; (2) providing related guidance to the Secretaries of the military departments, including developing the Life-cycle Sustainment Plan outline; and (3) monitoring and reviewing programs associated with these areas, among other duties and responsibilities.

For the Air Force, the Air Force Materiel Command develops, acquires, and sustains weapon systems through research, development, testing, evaluation, acquisition, maintenance, and program management of the systems and their components. This command provides acquisition and life-cycle management services and logistics support, among other things. The Air Force Life Cycle Management Center within the Air Force Materiel Command is responsible for the life-cycle management of weapon systems from inception to retirement. A Program Executive Officer—responsible for managing a specific portfolio of weapon systems—is responsible for each of the selected fixed-wing aircraft. The Program Executive Officer oversees the program office that manages each weapon system.

For the Navy and Marine Corps, the Naval Air Systems Command is responsible for providing the full life-cycle support of naval aviation aircraft, weapons, and systems. This support includes research, design, development and systems engineering; acquisition; test and evaluation; training facilities and equipment; repair and modification; and in-service engineering and logistics support. As with the Air Force, Program Executive Officers oversee their assigned program managers.

DOD relies on program managers to lead the development, delivery, and sustainment of individual weapon systems through their life cycles. The program managers are the designated individuals with responsibility for and authority to accomplish the program's sustainment objectives to meet the users' operational needs. Product support managers, who work within the program offices, are responsible for developing and implementing support strategies for weapon systems that maintain readiness and control life-cycle costs. Weapon systems are sustained under various arrangements that may include contractors, DOD organic facilities, or some combination of the two. For example, the Air Force Sustainment Center provides depot maintenance through its Air Logistics Complexes

for weapon systems.¹⁵ Naval Air Systems Command is responsible for the Navy Fleet Readiness Centers, which provide depot-level maintenance for Navy and Marine Corps fixed-wing aircraft.¹⁶ Additionally, the Air Force Sustainment Center and the Navy Supply Systems Command, as well as the Defense Logistics Agency, manage inventories of repair parts, and individual weapon systems programs are typically supported by a complex supplier network that includes a prime contractor, subcontractors, and various tiers of parts suppliers. On the other hand, sustainment responsibilities—in their entirety or particular elements—may be contracted out as part of a public-private partnership or a performance-based logistics agreement, such as with the F-22 Raptor.

Key Sustainment Metrics for Fixed-Wing Aircraft

The Air Force and Navy monitor the readiness status of selected fixed-wing aircraft through numerous performance metrics. Specifically, the Air Force measures how well a fleet is performing by calculating the availability of the fleets' aircraft, which is the number of aircraft that are available for flight operations. The Navy measures its aircraft availability through two metrics: (1) Ready-Basic-Aircraft (RBA)—the number of aircraft that are able to safely fly—and (2) Ready-for-Tasking (RFT)—the number of aircraft that are able to conduct specific missions. Both the Air

¹⁵The Department of the Air Force operates three Air Logistics Complexes at Ogden, Utah; Oklahoma City, Oklahoma; and Warner Robins, Georgia, that perform depot-level maintenance. Each has been designated as a Center for Industrial and Technical Excellence (CITE) to focus on the maintenance and repair of specific aircraft, systems, and equipment. Ogden is a CITE for missiles, landing gear, and fighters including the F-16, and F-22. Oklahoma City is the CITE for Airborne Warning and Control Systems, engines, tankers, and bombers including the B-52. Warner Robins is the CITE for aviation electronics and cargo aircraft including the C-17. The E-8C's logistics support is contracted and not conducted at an Air Logistics Complex. The E-8C's depot maintenance is performed by Northrop Grumman at its Technical Operations Center in Lake Charles, Louisiana.

¹⁶The Department of the Navy operates three major Fleet Readiness Centers in Cherry Point, North Carolina (East); Jacksonville, Florida (Southeast); and North Island, California (Southwest) that perform depot-level maintenance. As with the Air Force, each has been designated as a CITE, and all three are CITEs for sea-based and maritime aircraft and the related aeronautical systems. Specifically, Fleet Readiness Center East conducts maintenance related to the AV-8B; Fleet Readiness Center Southeast conducts maintenance related to the F/A-18A-G; and Fleet Readiness Center Southwest conducts maintenance on the AV-8B, C-2A, E-2C/D, and F/A-18A-G.

Force and Navy have established goals associated with aircraft availability.¹⁷

In addition to measuring the availability of the aircraft against the associated goals, the Air Force and Navy track the reasons for aircraft not being available or able to conduct missions. Specifically, the Air Force and Navy track the following:

- **Aircraft in depot:** Aircraft unavailable to conduct missions because of scheduled or unscheduled depot maintenance or modification.
- **Not mission capable maintenance:** Aircraft that are not in depot and not capable of performing any of their assigned missions because of maintenance.
- **Not mission capable supply:** Aircraft that are not in depot and not capable of performing any of their assigned missions because of the lack of a repair part.

In addition to these three metrics, the Air Force also tracks the following:

- **Not mission capable for both supply and maintenance:** Aircraft that are not in depot and not capable of performing any of their assigned missions because of both maintenance and the lack of a repair part.
- **Units possessed not reported:** Aircraft that are not available for use for reasons other than depot and not mission capable status, but possessed by the squadron.

¹⁷The Air Force aircraft-availability goals, established by the aircraft's lead command—Global Striker Command (B-52), Air Combat Command (E-8C, F-16, and F-22) and Air Mobility Command (C-17)—are calculated annually through identifying the number of mission-capable aircraft needed to fly the hours necessary to train and sufficiently execute the tasked missions. When setting the goals annually, the lead command does not consider prior-year performance, but rather bases the goal solely on its determined requirement. Additionally, the Navy calculates goals for aircraft availability on a monthly basis based on predicted readiness goals, which correspond to the resources required to meet an expected readiness rating.

Operating and Support Costs for Major Weapon Systems

There are various costs associated with operating and supporting weapon systems. DOD's *Operating and Support Cost-Estimating Guide* provides direction to the service components on developing estimates to support various analyses and reviews throughout the program life cycle.¹⁸

According to the guide, as a program matures, it remains necessary to continue to track and assess O&S costs and trends to ensure that the program remains sustainable, affordable, and properly funded. Each military department maintains a database that collects historical data on the O&S costs for major fielded weapon systems.¹⁹ DOD's Office of Cost Assessment and Program Evaluation provides policy guidance on this requirement, known as the Visibility and Management of Operating and Support Costs program; specifies the common format in which the data are to be reported; and monitors its implementation by each of the military departments. O&S costs are categorized using the following six overarching elements:²⁰

- unit level manpower—cost of operators, maintainers, and other support manpower assigned to operating units;
- unit operations—cost of unit operating materiel such as fuel, and training material, unit support services, and unit travel;
- maintenance—cost of system maintenance including depot- and intermediate-level maintenance;
- sustaining support—cost of system support activities that are provided by organizations other than the system's operating units;
- continuing system improvements—cost of system hardware and software modifications; and

¹⁸Department of Defense, Office of Cost Assessment and Program Evaluation, *Operating and Support Cost-Estimating Guide* (March 2014).

¹⁹The Air Force uses the Air Force Total Ownership Cost system, and the Navy uses the Navy Visibility and Management of Operating and Support Costs system to collect and report on historical weapon system O&S costs.

²⁰These six elements are further classified into additional subcategories. For example, the Navy's maintenance cost element is further classified into five subcategories including consumable materials and repair parts, depot-level reparable, depot maintenance, intermediate maintenance, and other maintenance; and the Air Force's maintenance cost element is further classified into six subcategories including consumable materials and repair parts, contractor logistics support, depot-level reparable, depot maintenance, interim contractor support, and other maintenance.

-
- indirect support—cost of activities that provide general services that lack the visibility of actual support to specific force units or systems.

Air Force and Navy Fixed-Wing Aircraft Availability and O&S Costs Have Varied, and Aircraft Availability Goals Generally Were Not Met

For the selected Air Force and Navy fixed-wing aircraft in our review, aircraft availability and O&S cost trends varied over the 6-year period between fiscal years 2011 and 2016, and the aircraft generally did not meet availability goals. We found that 6 of 12 fixed-wing aircraft—3 from each service—experienced decreased aircraft availability between fiscal years 2011 and 2016. One aircraft met availability goals each year between fiscal year 2011 and 2016. Conversely, six aircraft met the goals in some years but not others, and five aircraft did not meet the goals in any year. In the latest year included in our review—fiscal year 2016—9 of 12 of the fixed-wing aircraft did not meet their associated availability goals. With respect to O&S costs, the overall O&S total for all 12 aircraft was about \$20 billion annually over the 6-year period; some aircraft experienced increases while the costs to operate and support others decreased. The reasons for changes in costs included increases in maintenance costs for 8 of 12 fixed-wing aircraft. Below we summarize these trends, and the “Sustainment Quick Looks” in appendices II–XIII provide detailed information on the trends associated with each of the 12 fixed-wing aircraft and appendix XV provides additional information on operating and support cost per aircraft.

Air Force Aircraft Availability and O&S Cost Trends Varied across the Selected Fixed-Wing Aircraft

Air Force Aircraft Availability Trends Varied, and Three of Five Aircraft Did Not Meet Availability Goals since 2011

Our analysis found that:

- between fiscal years 2011 and 2016, aircraft availability for two of five selected Air Force fixed-wing aircraft fluctuated and for three decreased;
- between fiscal 2011 and 2016, two aircraft met availability goals in some years, and three aircraft did not meet availability goals in any of the years; and
- in fiscal year 2016, four of the five aircraft did not meet availability goals.

Specific details regarding aircraft availability and not mission capable status for maintenance, supply, and both maintenance and supply were omitted because DOD deemed this information as sensitive (i.e., For Official Use Only).

According to officials, when aircraft availability goals are not met, training and operational missions may not be fulfilled as timely as needed. For example, F-22 squadron officials explained that the lack of available aircraft creates a shortage of trained pilots. F-22 pilots need extensive training to fulfill their air-superiority role. Further, command officials explained that when aircraft availability goals are not met, there may not be enough aircraft to respond to contingency requirements. Officials expressed concern that, given the capability and expectation of the F-22 to be available to create air superiority in any operation, missions may not be met. Additionally, E-8C program office officials stated that missions are often limited to top priority, which means supported combatant commands may not obtain all needed capabilities, such as the E-8C not being able to provide surveillance capability to particular combatant commands.²¹

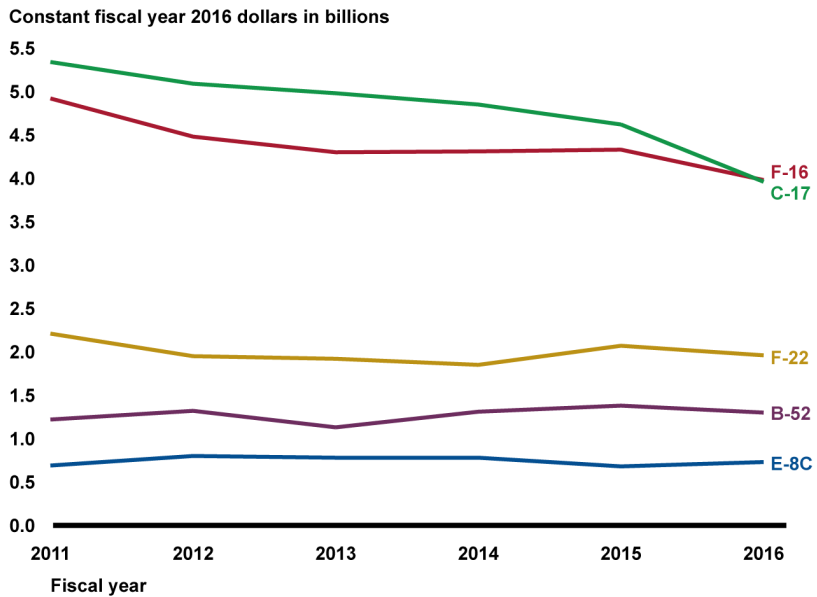
Air Force O&S Cost Trends Have Varied, and Maintenance Costs Generally Increased since 2011

From fiscal years 2011 through 2016, O&S costs for the Air Force aircraft in our review totaled about \$13 billion annually. These costs decreased for the C-17, F-16, and the F-22, but increased for the B-52 and E-8C, as shown in figure 2. For example, the F-16's total annual O&S costs decreased by about \$943 million (or about 19 percent) because of decreases in all cost elements—the largest decrease being unit operations—except sustaining support. According to officials, the decrease in unit operations can be attributed to the retiring of aircraft and the consolidation of squadrons.²² The C-17's and F-22's O&S costs decreased mainly because of decreases in two cost elements: continuing system improvements and unit operations. In contrast, the B-52's and the E-8C's O&S costs increased, by \$76 million (or about 6 percent) and \$41 million (or about 6 percent), respectively. The increases occurred because two of the cost elements—continuing system improvements and maintenance costs—increased more than the other costs elements decreased.

²¹Geographic combatant commands manage all military operations in designated areas of responsibility: they include U.S. Africa Command, U.S. Central Command, U.S. European Command, U.S. Northern Command, U.S. Pacific Command, and U.S. Southern Command.

²²From fiscal years 2011 through 2016, the total available inventory decreased by 7 percent (68 aircraft).

Figure 2: Operating and Support Costs for Selected Air Force Fixed-Wing Aircraft, Fiscal Years 2011 through 2016

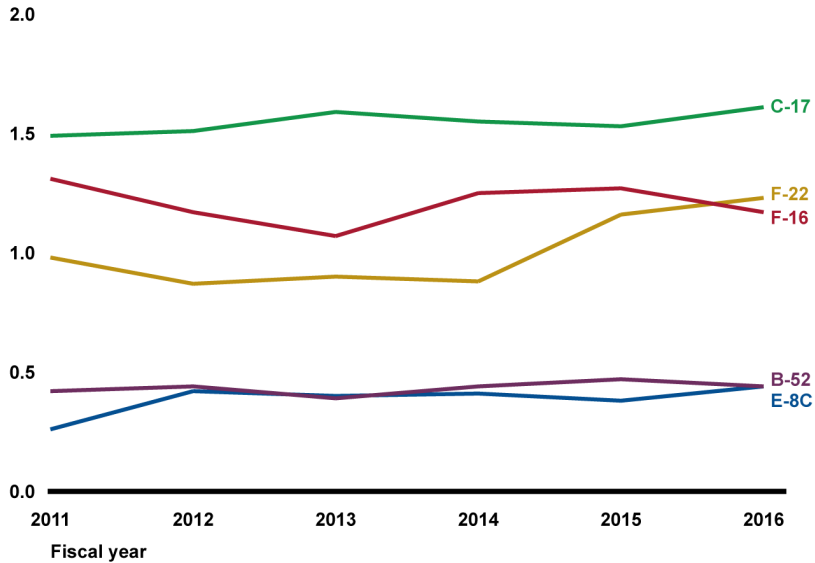


Source: GAO analysis of Air Force data. | GAO-18-678

Based on our analysis of the O&S cost elements, maintenance cost generally is one of the largest portions—on average about 36 percent—of total O&S costs for each aircraft. As shown in figure 3, maintenance costs for four of the five aircraft generally have increased from fiscal years 2011 through 2016. Specifically, maintenance costs for the C-17, E-8C, and F-22 increased because of additional depot maintenance needs. B-52 maintenance costs fluctuated year to year, but increased overall during this period. The overall maintenance costs for the F-16 decreased by approximately \$140 million. According to our analysis, even though there was an increase in some of the F-16 maintenance cost elements, the fleet's executed flying hours decreased. Therefore, the flying hour depot-level reparable costs decreased by approximately \$123 million and engine repair decreased by \$115 million, causing the overall maintenance cost to decrease.

Figure 3: Maintenance Costs for Selected Air Force Fixed-Wing Aircraft, Fiscal Years 2011 through 2016

Constant fiscal year 2016 dollars in billions



Source: GAO analysis of Air Force data. | GAO-18-678

Navy Aircraft Availability Trends and O&S Cost Trends Varied across the Selected Fixed-Wing Aircraft

Navy Aircraft Availability Trends Varied, and Five of Seven Aircraft Generally Did Not Meet Availability Goals since 2011

Our analysis found that:

- between fiscal years 2011 and 2016, aircraft availability increased for three of the seven Navy fixed-wing aircraft, fluctuated for one, and decreased for the remaining three aircraft;
- between fiscal 2011 and 2016, one aircraft met aircraft availability goals in each year, and four aircraft met goals in some years, while two aircraft did not meet goals in any of the years; and
- in fiscal year 2016, the Navy did not meet aircraft availability goals for five of the seven aircraft.

Specific details regarding aircraft availability and not mission capable status for maintenance and supply were omitted because DOD deemed this information as sensitive (i.e., For Official Use Only).

To address decreases in aircraft availability, the Navy has moved available aircraft between squadrons to help ensure deploying squadrons are fully equipped for their assigned missions. In November 2017, the Commander of Naval Air Forces testified before the House Armed Services Committee that to equip the air wings with the required number of mission capable aircraft for the deployment of three aircraft carriers in 2017, the Navy had to transfer 94 strike fighters to and from the maintenance depots or between squadrons.²³ This transfer included pulling aircraft from fleet replacement squadrons, where the focus should be on training new aviators.

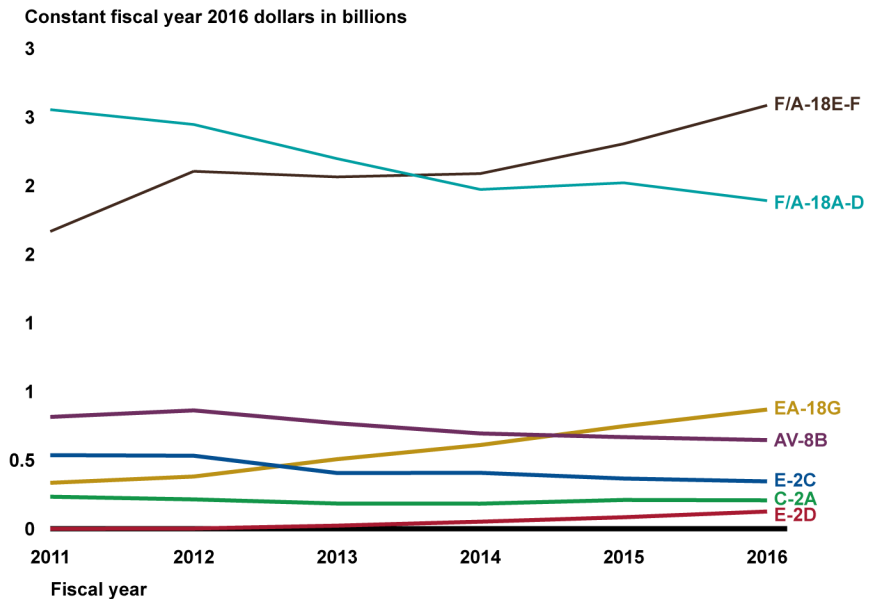
The Commander of Naval Air Forces, in his November 2017 testimony, summarized the issue: “That strike fighter inventory management, or shell game, leaves non-deployed squadrons well below the number of jets required to keep aviators proficient and progressing toward their career qualifications and milestones, with detrimental impacts to both retention and future experience levels.” Furthermore, based on our analysis, F/A-18A-D squadrons have underexecuted their flight hours by an average of 4 percent from fiscal years 2011 through 2016. According to officials, this is largely due to low aircraft availability. Additionally, placing further strain on aircraft availability, the F/A-18A-D inventory has decreased from 581 aircraft in fiscal year 2011 to 537 aircraft in fiscal year 2016.

The Navy’s O&S and
Maintenance Cost Trends
Varied

From fiscal years 2011 through 2016, O&S costs for the Navy’s seven selected fixed-wing aircraft totaled about \$7 billion annually. Also, the Navy has experienced varying O&S and maintenance costs since fiscal year 2011 for these aircraft. Specifically, annual O&S costs decreased for the AV-8B, C-2A, E-2C, and F/A-18A-D, and increased for the E-2D, EA-18G, and F/A-18E-F, as shown in figure 4.

²³ *Aviation Readiness: What’s the Flight Plan?* (statement of Vice Admiral Troy M. Shoemaker, Commander, Naval Air Forces).

Figure 4: Operating and Support Costs for Selected Navy Fixed-Wing Aircraft, Fiscal Years 2011 through 2016



Source: GAO analysis of Navy data. | GAO-18-678

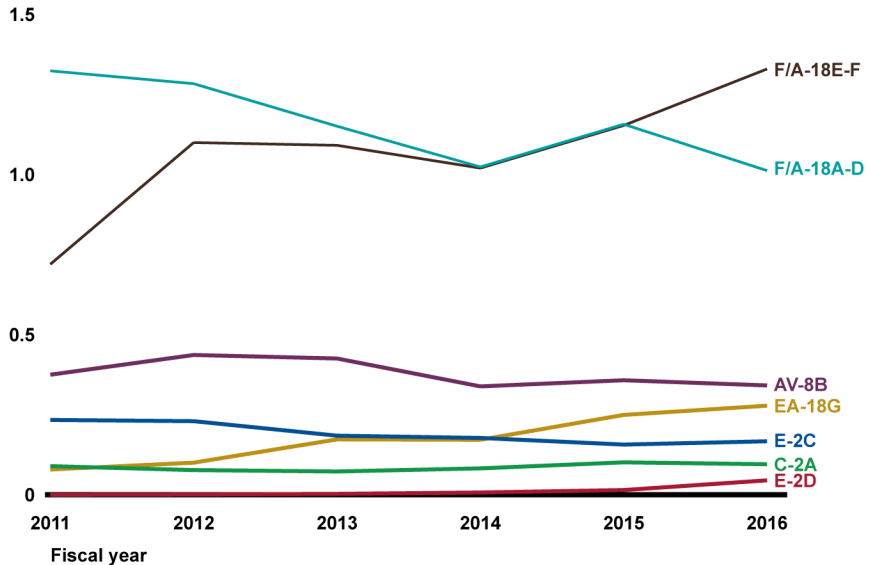
We found that O&S costs for the F/A-18A-D decreased by about 22 percent from about \$3.1 billion in fiscal year 2011 to about \$2.4 billion in fiscal year 2016. According to officials, this decrease can be attributed to the decrease in inventory as aircraft are retired and squadrons transition to the F-35 Joint Strike Fighter. In another example, O&S costs for the E-2D increased from about \$1.6 million in fiscal year 2012 to about \$125 million in fiscal year 2016.²⁴ The size of the fleet has increased by 17 aircraft—from 3 to 20 since fiscal year 2011. According to officials, this aircraft remains in production with a projected fleet size of 75; as inventory increases, so will O&S costs.

Based on our analysis of the O&S cost elements, maintenance cost generally is one of the largest portions—about 42 percent—of total O&S costs for the seven aircraft in our review. Annual maintenance costs have increased for the C-2A, E-2D, EA-18G, and F/A-18E-F, and decreased for the AV-8B, E-2C, and F/A-18A-D, as shown in figure 5.

²⁴Minor O&S cost was reported for the E-2D in fiscal year 2011 (\$388); however, fiscal year 2012 was the first year that the E-2D began to incur significant O&S cost.

Figure 5: Maintenance Costs for Selected Navy Fixed-Wing Aircraft, Fiscal Years 2011 through 2016

Constant fiscal year 2016 dollars in billions









Source: GAO analysis of Navy data. | GAO-18-678

We found that maintenance cost for the C-2A increased by about 7 percent from about \$89 million in fiscal year 2011 to about \$95 million in fiscal year 2016. According to officials, the increase in maintenance cost can be attributed to increased demand for outer wing panels, which resulted in a \$16 million increase in depot-level repair costs and a more than 10 percent increase in executed flight hours, among other things. In another example, maintenance cost for the AV-8B decreased by about 9 percent from about \$375 million in fiscal year 2011 to about \$341 million in fiscal year 2016. According to officials, these decreases can be attributed to the AV-8B no longer being used in Operation Enduring Freedom in 2012, the loss of six aircraft, and the transition of AV-8B squadrons to the F-35 Joint Strike Fighter.

The Air Force and Navy Face Similar Sustainment Challenges That Affect Aircraft Availability and O&S Costs across the Selected Fixed-Wing Aircraft

The Air Force and Navy face similar sustainment challenges that relate to aging, maintenance, and supply support that affect aircraft availability and O&S costs for the 12 aircraft selected in our review, as shown in figure 6.

Figure 6: Sustainment Challenges Affecting Selected Air Force and Navy Fixed-Wing Aircraft

Aircraft	Aging aircraft		Maintenance		Supply support	
	 Delays in acquiring replacement aircraft	 Unexpected replacement of parts and repairs	 Delays in depot maintenance	 Shortage of depot maintainer personnel	 Parts obsolescence ^a	 Diminishing manufacturing source ^b
Air Force	B-52	✓	✓		✓	✓
	C-17		✓	✓		✓
	E-8C		✓	✓		✓
	F-16	✓		✓		✓
	F-22		✓	✓	✓	✓
Navy	AV-8B	✓	✓	✓	✓	✓
	C-2A		✓	✓	✓	✓
	E-2C		✓	✓	✓	✓
	E-2D			✓	✓	✓
	EA-18G			✓	✓	✓
	F/A-18A-D	✓	✓	✓	✓	✓
	F/A-18E-F		✓	✓	✓	✓

Source: GAO analysis of Air Force and Navy data. | GAO-18-678

^aObsolescence is a lack of availability of a part due to its lack of usefulness or it is no longer current or available for production.

^bDiminishing manufacturing sources is a loss or impending loss of manufacturers or suppliers of items.

Specifically, 10 of 12 aircraft are experiencing sustainment challenges related to aging; all 12 are experiencing challenges related to maintenance; and all 12 are also experiencing challenges related to supply support. Below is a brief overview of these challenges:

- **Aging:** A number of these aircraft are aging and operating beyond their planned service life, partly because of delays in replacement aircraft. Specifically, the Air Force and Navy plan to replace the F-16, AV-8B, and F/A-18A-D with the F-35 Joint Strike Fighter. The Navy is expected to transition the F/A-18A-D through 2030 and the Marine Corps is planning to use the F/A-18A-D beyond 2030 (although these time frames have been extended several times already). The Navy plans to retire the AV-8B in 2026. On the other hand, the Air Force is not expected to retire the F-16 until at least 2040. Because of aging, according to officials, there are parts on some aircraft that need to be repaired and replaced that were not accounted for during initial sustainment analysis. To mitigate some challenges associated with the age of the fixed-wing aircraft, the Air Force and Navy program officials have decided to extend the service life of some aircraft by repairing and overhauling airframes and components, as well as developing the engineering specifications for parts that were never planned to be repaired or replaced.
- **Maintenance:** Delays in getting aircraft into and through depot maintenance, as well as shortages of skilled maintainers, are contributing to some aircraft missing their availability goals. Both services reported losing experienced maintainers, either to retirement or to other programs such as the F-35 Joint Strike Fighter. To address maintenance challenges, program offices for the selected aircraft have improved the efficiency and speed of depot maintenance, as well as are working to ensure there are sufficient numbers of trained maintainers.
- **Supply Support:** Some aircraft are encountering supply shortages as a result of parts not being available, in some cases due to obsolescence issues or diminishing manufacturer sources. Overcoming part shortages through either searching for replacement parts or reengineering parts takes time, which can contribute to aircraft being unavailable for longer periods. To mitigate supply challenges, officials have proactively upgraded aircraft before

obsolescence occurs or located available parts and reengineered parts that are no longer in production, as well as identified suitable manufacturers in advance, among other things.

For more specific information on sustainment challenges related to aging aircraft, maintenance, and supply support for each of the fixed-wing aircraft, see the “Sustainment Quick Looks” in appendixes II–XIII.

Sustainment Strategies Were Documented for Some but Not All Aircraft, and the Air Force and Navy Have Other Efforts to Review and Improve Aircraft Availability

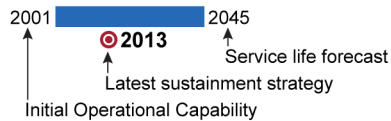
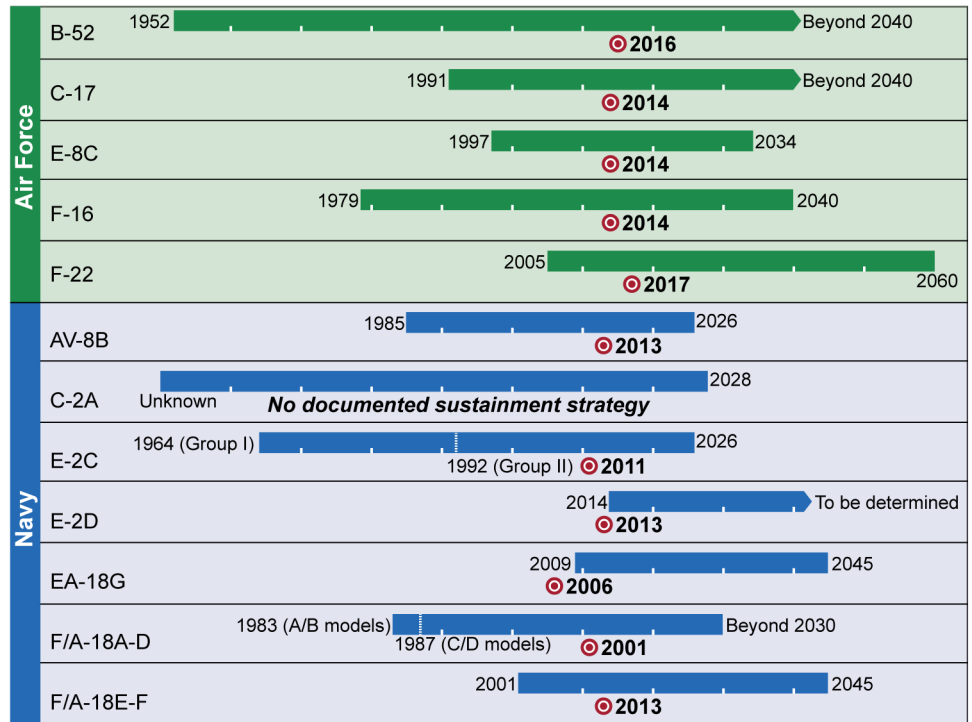
The Air Force has documented sustainment strategies for its five selected aircraft in our review, but the Navy has not documented sustainment strategies or updated the strategies for four of seven of its aircraft in our review. The Air Force and Navy also regularly reviewed sustainment metrics and have implemented plans to improve aircraft availability.

The Air Force Has Documented Sustainment Strategies, but Some of the Navy’s Strategies Are Not Documented or Up-to-Date

The Air Force has documented sustainment strategies for the five selected fixed-wing aircraft and updated them in accordance with Air Force guidance.²⁵ However, the Navy has not documented a sustainment strategy or updated the strategies for four of the seven aircraft in our review since 2012. See figure 7 for the year of the most recent update to the sustainment strategy for the aircraft in our review.

²⁵Air Force Instruction 63-101/20-101, *Integrated Life Cycle Management*.

Figure 7: Dates of Latest Sustainment Strategies for Selected Air Force and Navy Fixed-Wing Aircraft



Source: GAO analysis of Air Force and Navy data. | GAO-18-678

While sustainment strategies do not guarantee successful outcomes, they serve as a tool to guide operations as well as support planning and implementation of activities through the life-cycle of the aircraft. Specifically, at a high-level the strategy is aimed at integrating requirements, product support elements, funding, and risk management to provide oversight of the aircraft. For example, these sustainment strategies can be documented in a life-cycle sustainment plan, postproduction support plan, or an in-service support plan, among other types of documented strategies. Additionally, program officials stated that an aircraft’s sustainment strategy is an important management tool for the sustainment of the aircraft by documenting requirements that are known by all stakeholders, including good practices identified in sustaining each aircraft. For example:

-
- The strategy for the Air Force B-52 has been updated several times in recent years because of several major modifications. For example, in 2014 the Air Force issued an updated sustainment plan within the life-cycle management plan to update the combat network communications technology program because the B-52's communications system is still the original from the 1950s and has limitations related to making mission or target changes in flight. The plan addresses the testing, resource management, and numerous program performance indicators and requirements of the system.
 - The strategy for the Air Force F-16 outlines plans for the aircraft's service life extension and includes proactive measures and data forecasting to bundle depot modifications in order to minimize fleet-wide effects on aircraft availability. The service life extension for the F-16 is designed to extend the service life of 300 F-16 aircraft from 8,000 to 13,856 flight hours at an estimated cost of \$740 million (as of June 2016).
 - The strategy for the Navy E-2D provides a systematic approach to ensure that a comprehensive support package is in place to support the sustainment of the aircraft. Also, it describes the overall plan for the management and execution of the product support package by communicating the sustainment strategy to stakeholders in the acquisition, engineering, and logistics communities.

However, the Navy had not documented a sustainment strategy for the C-2A because a strategy was not required when the aircraft, now a legacy system, was going through the acquisition process prior to 1965.²⁶

According to Navy officials, while they have not documented a strategy for the C-2A, they are undertaking efforts, such as updating technical publications, performing maintenance analysis on the landing gear, and evaluating depot tasks to decrease turnaround time, among other efforts, to sustain the aircraft. However, a documented sustainment strategy for the C-2A would help guide the planning and implementation of these efforts, as well as serve as a management tool by documenting these requirements that are known by all stakeholders.

In addition, the Navy's sustainment strategies for the E-2C (2011), EA-18G (2006), and F/A-18A-D (2001) were developed prior to 2012 and

²⁶The C-2A did not meet the Navy's aircraft availability goals from fiscal year 2011 through fiscal year 2016, with an average gap of 1 aircraft. In some months the C-2A's gap was as high as 6 (December 2012, February 2014, May 2015, June 2015, December 2015, January 2016, and September 2016) or 7 (July 2015) aircraft.

thus have not been updated in over 5 years. With respect to the EA-18G, Navy officials told us that the sustainment strategy should be updated in accordance with DOD's acquisition policy—DOD Instruction 5000.02—since the EA-18G is still in the acquisition process, as it continues to be produced.²⁷ For the E-2C and F/A-18A-D, Naval Air Systems Command officials and program office officials told us that they were not required to document sustainment strategies because these aircraft were legacy systems at the time the requirement to develop and maintain a sustainment strategy was implemented. Therefore, according to these officials, the DOD requirements to document and update sustainment strategies every 5 years in DOD Instruction 5000.02 were not applicable.

DOD Instruction 5000.02 requires weapon systems to have some form of a sustainment strategy that is not older than 5 years; however, it is unclear whether this policy is applicable to legacy weapon systems. Specifically, the policy states that program managers for all programs are responsible for developing and maintaining a sustainment strategy, such as a Life-cycle Sustainment Plan, beginning at the risk-reduction decision point (i.e., Milestone A of the acquisition process).²⁸ However, based on our discussions with Navy program officials for our selected aircraft and our review of the policy, it is unclear whether the policy—as currently written—is applicable to legacy systems that were no longer in production and thus had completed the risk-reduction decision point (or Milestone A) prior to the requirement to update a sustainment strategy every 5 years. According to DOD officials, the intent of the policy is for all programs, including legacy weapon systems, to develop and maintain a sustainment strategy; however, the policy does not explicitly state that legacy systems are expected to fulfill this requirement.

In May 2017, the Air Force updated its sustainment guidance to require sustainment strategies for legacy systems and for those strategies to be updated every 5 years. Air Force officials told us that they did this because the DOD policy was unclear whether it was applicable to legacy systems and it was a good practice to ensure the guidance was explicit

²⁷DOD Instruction 5000.02.

²⁸The risk-reduction decision point, also known as Milestone A, occurs early in the acquisition phase of the life cycle of weapon systems. It is the decision point where an investment decision is made on whether to pursue specific product or design concepts, and to commit the resources required to mature technology and reduce any risks that must be mitigated prior to decisions committing the resources needed for development leading to production and fielding.

for all weapon systems to document and update a sustainment strategy.²⁹ This instruction explicitly states that the requirement to document a sustainment strategy and update it every 5 years is applicable to all weapon systems, including legacy systems that are in the O&S phase of their life cycles. Additionally, the Air Force Instruction states that these legacy systems are not required to retroactively meet requirements identified for previous phases of the acquisition life-cycle, but should meet the requirements needed for continued operations of the system.

However, the Navy has not made the requirement explicit for legacy systems in its guidance. Specifically, Navy guidance does not explicitly state that documenting a sustainment strategy and updating that strategy every 5 years is a requirement for legacy systems.³⁰ While Navy guidance requires the development and use of sustainment metrics for legacy systems and requires the Naval Air Systems Command be responsible for aviation weapon systems in sustainment, the Navy does not address any requirement for sustainment strategies for legacy systems.

The lack of clarity in DOD Instruction 5000.02 and the Navy guidance regarding whether legacy systems are required to document a sustainment strategy and update that strategy every 5 years has resulted in confusion regarding sustainment planning requirements among Navy program offices and could cause confusion with other weapon system program offices across DOD. *Standards for Internal Control in the Federal Government* state that management should define objectives in specific terms so they are understood at all levels of the entity. The standards also state that guidance should clearly define what is to be achieved, who is to achieve it, how it will be achieved, and the time frames for achievement.³¹ As indicated by the Air Force's 2017 update to its sustainment guidance, clarifying DOD and Navy guidance and the applicability of sustainment strategy requirements to legacy systems could be done through very small additions and clarifications to the applicable guidance documents. Until DOD and the Navy update or issue new guidance clarifying the requirements for documenting sustainment strategies for legacy systems, weapon system program offices, such as those for fixed-wing aircraft, as well as Naval Air Systems Command and

²⁹Air Force Instruction 63-101/20-101.

³⁰SECNAV M-5000.2, SECNAVINST 5000.2E, and SECNAVINST 5400.15C.

³¹GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: Sept. 10, 2014).

DOD may not have full visibility of necessary requirements to achieve program objectives or any related risks associated with the sustainment of these weapon systems.

While the DOD policy and Navy guidance is unclear, Naval Air Systems Command and Navy program offices for the four aircraft—C-2A, E-2C, EA-18G, and F/A-18A-D—that either do not have a sustainment strategy or have not updated the strategy within the last 5 years are taking actions to document or update the sustainment strategies for these aircraft. According to Naval Air Systems Command officials, once it was brought to their attention that the intent of DOD Instruction 5000.02 was for legacy systems to have an updated documented sustainment strategy, they began to take action to develop or update the respective sustainment strategies. Specifically, according to C-2A, E-2C, and E-2D program officials, they are currently updating the E-2D strategy for its 5-year update, which is due in fiscal year 2018, and it will include updates for the C-2A and E-2C since the airframe for all three aircraft are very similar. Also, program officials for the EA-18G and F/A-18A-D told us that they are currently updating the strategies for these aircraft and are expected to complete the process in fiscal year 2018.³² Given that the Navy is already taking action to update its sustainment strategies and has established timelines for these updates, we are not making any recommendations to the Navy regarding updating the respective sustainment strategies.

The Air Force and Navy Regularly Reviewed Sustainment Metrics and Implemented Improvement Plans to Address Aircraft Availability

The Air Force and the Navy have (1) regularly reviewed sustainment metrics for fixed-wing aircraft and (2) implemented improvement plans to address aircraft availability.

The Air Force and Navy Have Conducted Regular Reviews of Sustainment Metrics

The Air Force and Navy have regularly monitored the condition of their fixed-wing aircraft, which includes measuring aircraft availability against planned goals as well as monitoring other sustainment metrics. Specifically, the Air Force Materiel Command monitors aircraft availability

³²Officials also told us that they are currently updating the sustainment strategy for the F/A-18E-F. The F/A-18E-F sustainment strategy was last updated in 2013 and thus is due to be updated by the end of fiscal year 2018. The Navy officials told us they expect to complete the update by the midpoint of fiscal year 2018.

and other sustainment metrics through quarterly Weapon System Enterprise Review (WSER) briefings. The program office in conjunction with the Air Force Life Cycle Management Center generates the WSER, which is briefed through Air Force Materiel Command and the Program Executive Offices to the Air Force Chief of Staff. The WSER delivers insight into the comprehensive health of a system by flagging gaps in performance and identifying mitigating actions, which is used to conduct crosscutting enterprise analysis and provide input into readiness reviews. In addition to the WSER, the program offices manage their performance through their Health of the Fleet briefs. These briefs—conducted monthly or quarterly depending upon the aircraft—include readiness assessments that provide insight on maintenance and management practices. The assessment is delivered by the program’s maintenance group, and includes aircraft performance metrics, issues, actions, and schedules to inform program leadership on fleet status and to help prioritize and make decisions concerning the issues.

The Navy monitors aircraft availability through its aircraft status dashboard for each aircraft, which provides specific information, such as goals, actual availability, and gaps between the two. More specifically, the Navy tracks the status of each of its aircraft through the dashboard, including those aircraft that are available (i.e., Ready-Basic-Aircraft [RBA]), are in depot maintenance, or are not mission capable due to maintenance or supply, among other metrics. The dashboard is updated monthly, and there are weekly meetings with key stakeholders, including Naval Air Systems Command officials, industry partners, and depot officials, to monitor the performance of each aircraft and make adjustments to improve aircraft availability. Additionally, all program offices have processes in place to manage the fleet within their portfolios, including semiannual or annual program reviews such as Program Management Reviews and Executive Steering Reviews. These reviews focus on readiness, cost drivers, and initiatives to address program risk and ways to resolve issues affecting each aircraft. Further, the Marine Corps Commandant for Aviation leads biannual Executive Steering Summits to assess readiness issues affecting Marine Corps aircraft.

The Air Force and Navy Have Implemented Improvement Plans to Address Aircraft Availability

The Air Force and Navy have implemented improvement plans to address aircraft availability for each of the selected fixed-wing aircraft. Air Force program offices for the fixed-wing aircraft in our review have plans for improving availability. Since 2005, the Air Force Materiel Command has had an annual process to improve aircraft availability, which is known as the Aircraft Availability Improvement Program. The process enables the program offices to assess and limit risk, incorporate available support

funding, and specifically address where there are effects on availability, such as aircraft in depot. This process also incorporates projecting historical and goal rates in order to leverage scheduled and modernization maintenance. Program offices create plans, known as aircraft availability improvement plans, based on these projections to forecast improvements that can facilitate increased availability and reduction of costs, among other things. The Air Force provides guidance in the form of a template to ensure consistency amongst the plans, which typically must include improvement initiatives with milestone goals. This information includes projected aircraft availability rates for mission capable, units possessed not reported,³³ not mission capable for supply, not mission capable for maintenance, and depot possession. Officials noted that the program office creates an improvement plan each year, regardless of whether it is short of its availability goal, since the plan serves as a forecasting measure.³⁴ The program is designed to ensure the program offices have plans in place to meet target goals, and the information and milestones laid out in the plans feed into the WSER briefings to senior management. For example:

- The B-52 plan for fiscal year 2017 discusses the process and milestones for replacing actuator seals for the fleet, the costs of the repair, and the expected benefit to B-52 availability—1.05 percent improvement to the not mission capable supply metric.
- The C-17 plan for fiscal year 2017 identifies the current and future modifications, timelines for beginning and completion, and the effect on availability. For example, the future replacement of a legacy computer system with a modernized system and display is set to begin in fiscal year 2019 with an estimated completion date of 2026. This replacement is planned to be done concurrently with other maintenance, and to prevent future declines in the C-17's availability.
- The F-22 plan for fiscal year 2017 identifies several projects taking place between 2016 and 2021 that are expected to improve availability by almost 2 percent.

Further, officials said they are currently working with the Assistant Secretary of the Air Force (Acquisition) to develop an Air Force manual

³³Unit possessed not reported aircraft are those that are not available for use for reasons other than depot and not mission capable status, but are possessed by the squadron.

³⁴Officials said that they do not task smaller fleets to produce these plans because the benefits would be minimal due to the smaller inventory size.

that would make developing an Aircraft Availability Improvement Plan a requirement. This manual will become a supplement to Air Force Instruction 63-101/20-101, according to the officials.

Navy program offices for all seven fixed-wing aircraft in our review also have plans for improving availability. According to Navy officials, they started preparing “summary playbooks,” which is the Navy’s term for improvement plans, in late 2015 and started implementing these plans in early 2016 to increase aircraft availability. Officials told us that there was a limitation in funding because of sequestration prior to fiscal year 2017, which hampered their ability to fully implement the playbooks. At a broad level, the Navy’s playbooks include efforts such as maintenance planning, supply support, aircraft material condition and management, and technical data, among other things. These efforts are linked to specific initiatives such as working with the manufacturer and contractors to provide maintenance support, identifying obsolete parts, conducting aircraft fatigue analysis, and updating technical publications, among other things, which have been identified by the program office as ways to improve aircraft availability. Additionally, these playbooks include the extent to which these initiatives are funded, underfunded, or partially funded and the appropriation account that would fund each initiative. The playbooks include the status of each initiative, and some of the playbooks also provide an approximate time frame for implementing each initiative. For example:

- The playbook for the C-2A has a fatigue analysis initiative focused on analyzing the landing gear to update its design, provide a depot repair manual, and increase its service life, among other things. This initiative is considered funded, is expected to improve aircraft availability, and has an estimated time frame for implementation between fiscal years 2017 and 2021.
- The playbook for the E-2D contains a maintenance initiative focused on improving the maintenance planning process of the C-2A, E-2C, and E-2D aircraft by completing elements of the product support package, such as training, publications, support equipment, and tools, among others. This initiative is considered partially funded, is expected to improve aircraft availability by decreasing the not mission-capable rates related to maintenance and supply and decreasing maintenance down time, and has an estimated time frame for implementation between fiscal years 2017 through 2019.
- The playbook for the F/A-18A-D includes a product improvement initiative to conduct a case study to assess the condition of the wiring

of the aircraft in the fleet. This initiative is considered funded and is expected to help to sustain aircraft availability. However, there is no time frame for implementing this initiative.

- The playbook for the F/A-18E-F contains a service life modification initiative focused on extending the service life of the aircraft through modifications. According to officials, this initiative is considered partially funded, is expected to help to sustain aircraft availability, and is expected to help the fleet realize an 80 percent cost avoidance because the Navy will not have to pay the cost to replace these aircraft. Also, this initiative has an estimated time frame for implementation between fiscal years 2018 through 2040.

Conclusions

The Departments of the Air Force and Navy spend tens of billions of dollars each year to sustain their fixed-wing aircraft, which need expensive logistics support, including maintenance and repair, to meet goals for availability. The departments spent at least \$20 billion annually since 2011 to sustain the 12 aircraft that we examined. The Air Force and Navy share a variety of sustainment challenges, including the age of their aircraft as well as maintenance and supply support issues. These challenges have led to half (6 of 12) of the aircraft in our review experiencing decreasing availability and to the aircraft in general not being able to meet aircraft availability goals. For example, 9 of 12 aircraft did not meet availability goals in fiscal year 2016. These trends are occurring even though the Air Force and Navy regularly review sustainment metrics for the aircraft and are implementing plans for improving aircraft availability. However, DOD's policy and the Navy's guidance are not clear on whether the services should have a current sustainment strategy for legacy weapon systems, including fixed-wing aircraft, and on whether the strategies are required to be updated every 5 years. Without clarity about whether the DOD instruction and the Navy guidance apply to legacy systems, program officials will not know whether they are required to have a sustainment strategy or are required to update the plan for their respective fixed-wing aircraft. Furthermore, the program offices, the services, and DOD may not have full visibility of necessary requirements to document program objectives, related risks, and the effectiveness of the program, ultimately jeopardizing the sustainability and affordability of each of the programs.

Recommendations for Executive Action

We are making the following two recommendations to DOD:

The Secretary of Defense should ensure that the Under Secretary of Defense for Acquisition and Sustainment updates or issues new policy clarifying the requirements for documenting sustainment strategies for legacy weapon systems, including fixed-wing aircraft. (Recommendation 1)

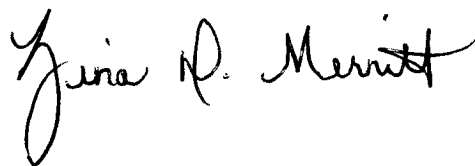
The Secretary of the Navy should update or issue new guidance clarifying the requirements for documenting sustainment strategies for legacy weapon systems, including fixed-wing aircraft. (Recommendation 2)

Agency Comments and Our Evaluation

We provided a draft of the sensitive report to DOD for review and comment. In written comments that are reproduced in appendix XVI, DOD concurred with our recommendations and noted planned actions to address each recommendation. The Air Force and Navy also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees; the Secretary of Defense; the Secretaries of the Navy and Air Force; the Commandant of the Marine Corps; the Under Secretary of Defense for Acquisition and Sustainment; and the Director, Defense Logistics Agency.

In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>. If you or your staff have questions about this report, please contact me at merritt@gao.gov or (202) 512-5257. GAO staff who made key contributions to this report are listed in appendix XVII.



Zina D. Merritt
Director
Defense Capabilities and Management

Appendix I: GAO's Recent Prior Work on Sustainment Issues within the Department of Defense

Over the past several years, we have conducted work on a number of issues that affect the ability of the Department of Defense (DOD) to sustain its weapon systems. In September 2017, we found that several factors were important to the success of Product Support Managers. These factors included teamwork and collaboration, early implementation of the Product Support Manager position, and organizational support and emphasis on sustainment.¹ We also found that in response to our 2014 recommendations regarding the implementation of the Product Support Manager position, DOD had developed a comprehensive career path and associated guidance to develop, train, and support future Product Support Managers. Additionally, DOD revised guidance to define roles, responsibilities, and reporting relationships between support staff and Product Support Managers.² However, DOD was still in the process of implementing our other three recommendations, such as issuing clear, comprehensive, centralized guidance regarding the roles and responsibilities of PSMs and collecting and evaluating information on the effects, if any, that Product Support Managers are having on life-cycle sustainment decisions for their assigned weapon systems.

In September 2017, we also found that DOD does not have complete information to identify and manage single-source-of-supply risks.³ Specifically, some parts are provided by a single source of supply (e.g., one manufacturing facility), and if that single source were no longer able to provide the part, DOD could face challenges in maintaining weapon systems. DOD concurred with our six recommendations focused on improving the completeness of information for single-source-of-supply risks, including issuing department-wide policy that clearly defines

¹GAO, *Weapon Systems Management: Product Support Managers' Perspectives on Factors Critical to Influencing Sustainment-Related Decisions*, [GAO-17-744R](#) (Washington, D.C.: Sept. 12, 2017).

²GAO, *Weapon Systems Management: DOD Has Taken Steps to Implement Product Support Managers but Needs to Evaluate Their Effects*, [GAO-14-326](#) (Washington, D.C.: Apr. 29, 2014). In 2009, as part of legislation aimed at improving the life-cycle management of major weapon systems, Congress required DOD to assign a PSM to each major weapon system program. National Defense Authorization Act for Fiscal Year 2010, Pub. L. No. 111-84, § 805(b)(1) (2009), *repealed by* National Defense Authorization Act for Fiscal Year 2013, Pub. L. No. 112-239, § 823(b) (2013) (codifying life-cycle management and product support in 10 U.S.C. § 2337). Codified as amended in 10 U.S.C. § 2337, the statute mandates that the Secretary of Defense require that each major weapon system be supported by a PSM.

³GAO, *Defense Supply Chain: DOD Needs Complete Information on Single Sources of Supply to Proactively Manage the Risks*, [GAO-17-768](#) (Washington, D.C.: Sept. 27, 2017).

requirements of Diminishing Manufacturing Sources and Material Shortages management, and details responsibilities and procedures to be followed to implement the policy.⁴ DOD is in the process of taking action to implement these recommendations.

In June 2016, we found that the Defense Logistics Agency and the military services have not adopted metrics to measure the accuracy of planning factors, such as the accuracy of part lists, or the costs created by backorders.⁵ As a result, depot maintenance may not be efficient or cost-effective, resulting in unnecessary delays in the repair of weapon systems. DOD concurred with our six recommendations to develop metrics to monitor the accuracy of demand planning factors and disruption costs created by the lack of parts at depot maintenance sites and is in the process of taking action to implement these recommendations. For a listing of relevant past GAO work, see the Related GAO Products list at the end of this report.

⁴DOD's Diminishing Manufacturing Sources and Material Shortages Program is intended to predict and respond to the loss, or impending loss, of manufacturers or suppliers of items, raw materials, or software.

⁵GAO, *Defense Inventory: Further Analysis and Enhanced Metrics Could Improve Service Supply and Depot Operations*, [GAO-16-450](#) (Washington, D.C.: June 9, 2016).



Source: Defense Video Imagery and Distribution System | GAO-18-146SU

Appendix II

B-52 Stratofortress Sustainment Quick Look

Common Name: B-52

Lead Service: Air Force

Program Essentials

Manufacturer: Boeing

Sustainment: Depot maintenance conducted organically at the designated air logistics complex and contractually for some depot-level repairs at contractor facilities.

Program Office: Tinker Air Force Base, Oklahoma

Fiscal Year 2016 Data

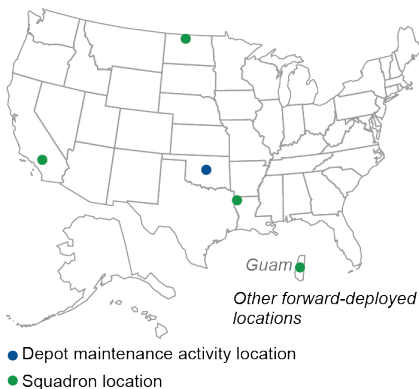
Average age: 56

Average number of flying hours: 18,846 hours per aircraft

Inventory: 76

Operating and support cost: \$1.3 billion

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

The B-52 faces sustainment challenges related to its age and, according to officials, replacement parts are difficult to obtain. Several modernization efforts are under way (communications, engines, etc.), and is working with vendors and its own service engineers to identify problem areas and plan ahead so that replacement parts will be available.

Background

The B-52 is a long-range, heavy bomber that can perform a variety of missions, including strategic attack, close air support, air interdiction, maritime operations, and offensive counter-air missions. It can carry nuclear or precision-guided conventional ordnance with worldwide precision navigation capability. However, the B-52s are some of the oldest aircraft in the Air Force's fleet, and will continue to operate until at least 2040 (see fig. 8). Operating and support (O&S) costs for the B-52s have remained relatively steady, generally fluctuating around \$1.2 billion–\$1.3 billion per year. As a predominantly military-maintained system, most of that O&S cost is related to maintenance and manpower, with depot maintenance and depot-level reparable—direct labor and materials for item repairs, transportation, and storage, among other things—accounting for most of the maintenance cost.

Figure 8: Life Cycle of the B-52 Stratofortress



Sustainment Strategy

- The core sustainment of the fleet is accomplished through programmed depot maintenance, which is performed on a 4-year cycle with 17 aircraft entering the program depot maintenance each fiscal year. The B-52 maintenance package includes inspections of critical structure and systems, with repair conducted as needed along with known incoming defects requiring repair or replacement. The current B-52 program depot maintenance package includes over 30,000 hours of work.
- Life Cycle Management Plan for B-52 Network Communications Technology Program (2014) is focused on upgrading outdated communications technology. The communications modification requires 7,000 hours of work and is estimated to be complete by 2020. The fleet has active sustainment plans for other components of the aircraft, such as the B-52 Anti-skid Replacement Life Cycle Sustainment Plan (2015), which is estimated to cost over \$40 million and be completed by 2019.
- Depot maintenance on the B-52 is managed by the program office and conducted at Oklahoma City Air Logistics Complex depot.

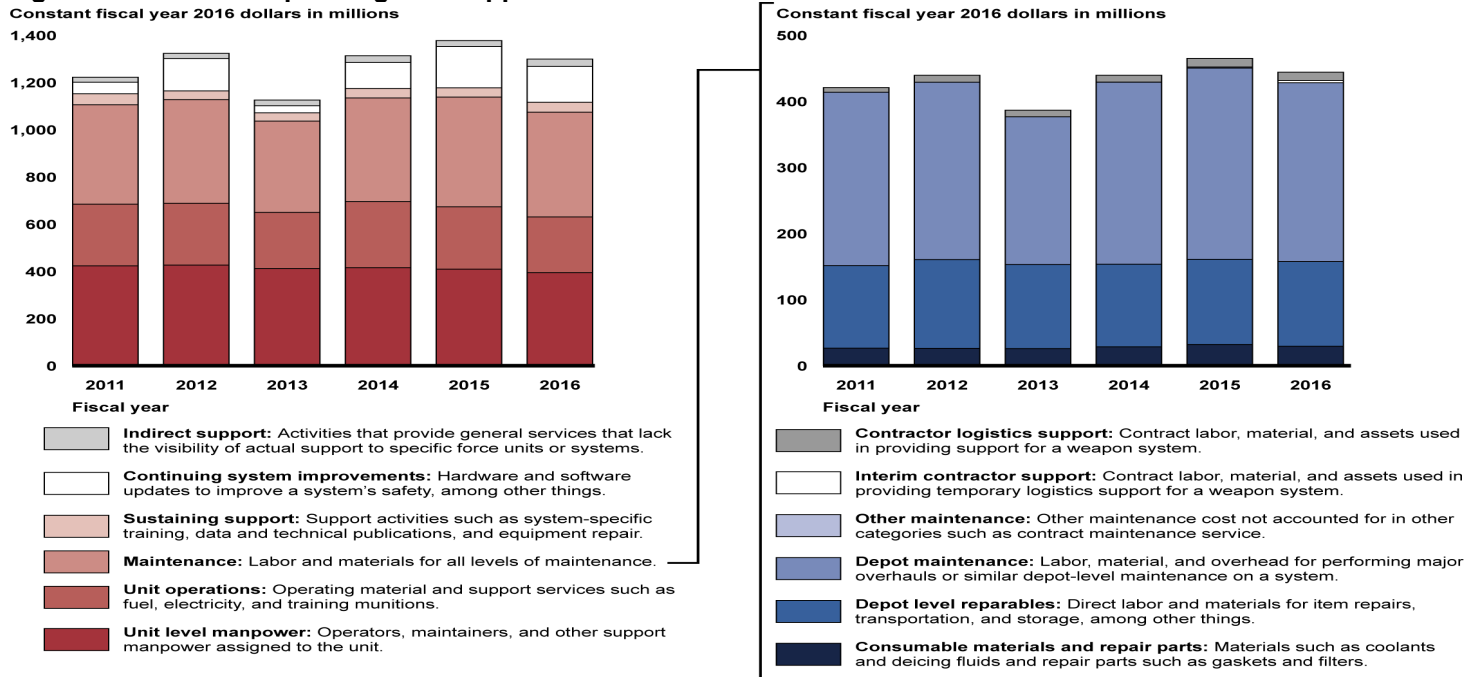
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support Costs

Figure 9 illustrates that both manpower and maintenance are large cost drivers (approximately \$400 million to \$500 million per year) for the B-52. However, costs have remained relatively stable over the past 6 fiscal years. As an organically maintained system, depot maintenance and depot-level reparable are the major maintenance cost drivers for the B-52, accounting for 90 percent or more of the costs each year.

Figure 9: B-52 Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Air Force data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: The aging B-52 is experiencing stress and fatigue in its airframe and components. For example, officials cited a 40 percent increase in landing gear structure cracks in the past couple of years. Also, maintainers are finding cracks in the lower segment, a beam providing airframe structural support. Ongoing and planned actions include continuing to gain efficiency in their repair processes. Maintainers said the first repair of the landing gear structure took 90 days but is now taking about 30 days. Also, they plan to continue working with vendors and their engineering support to find solutions for issues like the lower segment in order to buy repair parts in advance.

Maintenance: The B-52 is one of the oldest systems in the Air Force. Its communications suite was first designed in the 1940s, and officials said the upgrade to the new system requires 7,000 man-hours. Also, many of the stress and fatigue issues require an engineering solution because manufacturers and vendors are either no longer available or not cost-effective. The B-52 also has issues with stress and fatigue on its component parts, such as the engine. In January 2017, an engine failed in flight. Ongoing and planned actions include refining a gated process to track the stages of maintenance and improve the speed and efficiency of the process. Also, officials are attempting to address several issues at once—such as programmed maintenance, communications suite upgrade, and reengining—so that the effect on availability is kept to a minimum.

Supply Support: Department of Defense (DOD) supply-chain managers sometimes have difficulty finding sources of supply because original manufacturers may not make the parts, and obtaining repair parts can sometimes take years. Ongoing and planned actions include identifying and forecasting the need for parts and working either with vendors or organic engineering sources to produce solutions.

Program Office Comments

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



Source: Defense Video Imagery and Distribution System. | GAO-18-146SU

Appendix III

C-17 Globemaster III Sustainment Quick Look

Common Name: C-17

Lead Service: Air Force

Program Essentials

Manufacturer: Boeing

Sustainment: Boeing is responsible for sustainment activities including material management and depot maintenance support

Program Office: Robins Air Force Base, Georgia

Fiscal Year 2016 Data

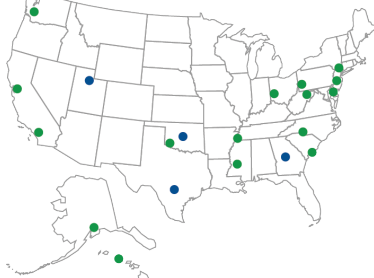
Average age: 13 years

Average number of flying hours: 13,141 hours per aircraft

Inventory: 222 aircraft

Operating and support cost: \$4.0 billion

Depot maintenance activity and squadron locations:



● Depot maintenance activity location
● Squadron location

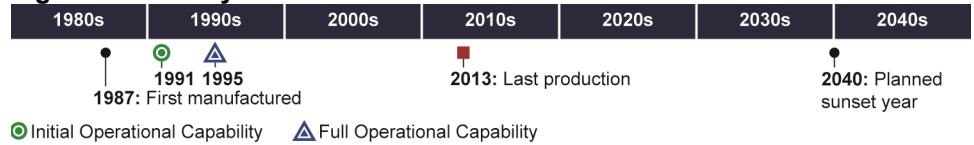
Sustainment Challenges and Mitigation Actions

The C-17 is an aircraft being modified to meet its requirements as well as to address maintenance and supply issues. The Air Force's actions to mitigate these challenges include processes to increase the service life of the aircraft, allowing managers to quickly hire skilled workers for critical positions, and locating other vendor source for parts.

Background

The C-17 is a long-range, heavy logistic transport aircraft powered by four F-117 turbofan engines with air-refueling capability that was first manufactured in 1987 (see fig. 10). It is capable of rapid strategic delivery of troops and all types of cargo to main operating bases or to bases in any forward deployment area. The C-17 can perform tactical airlift and airdrop missions and can transport ambulatory patients during aeromedical evacuations, when required. The C-17 can carry virtually all air-transportable equipment. Total operating and support (O&S) costs for the C-17 have decreased from about \$5.3 billion in fiscal 2011 to about \$4.0 billion in fiscal year 2016. Specifically, unit operations decreased, while maintenance costs have generally increased during this period due to contractor logistics support because the C-17 is a predominantly contractor-managed aircraft.

Figure 10: Life Cycle of the C-17 Globemaster III



● Initial Operational Capability ▲ Full Operational Capability

Source: GAO analysis of Air Force information. | GAO-18-678

Sustainment Strategy

- The C-17 Enterprise Life Cycle Management Plan and Life Cycle Sustainment Plan (2014) documents current and future acquisition, sustainment, and integration efforts of the aircraft. It also addresses contractual arrangements and partnership support agreements between Air Force, Boeing, and other service providers for aircraft sustainment.
- Boeing provides continued sole-source life-cycle support for the C-17 under the terms of the Globemaster Integrated Sustainment Program (2013). Under this program, Boeing is responsible for sustainment, to include material management and depot maintenance support.
- The C-17 participates in a virtual fleet arrangement, a global network of 43 additional C-17 aircraft, which allows participants total aircraft parts access from any fleet participant worldwide.
- Boeing has oversight on C-17 depot maintenance at Warner Robins Air Logistics Complex, and at its facility in San Antonio; landing gear overhaul occurs at Ogden Air Logistics Complex, and engine overhaul occurs at Oklahoma City Air Logistics Complex in partnership with Pratt & Whitney, the original equipment manufacturer on the F-117 turbofan engine.

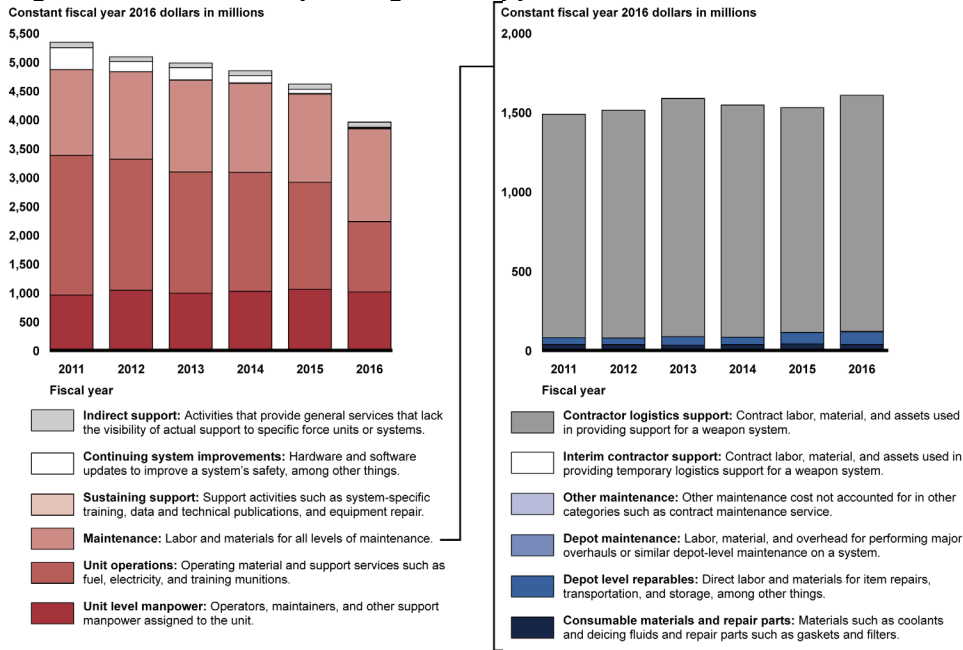
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the C-17's total O&S costs decreased (as shown in fig. 11). Unit operations and maintenance costs accounted for the largest share of O&S costs over the period, averaging about \$2.0 billion and about \$1.6 billion per year, respectively. While the cost of unit operations has decreased, maintenance costs have generally increased. The decrease in cost can be attributed to the decrease in executed flight hours, and, according to officials, maintenance costs have increased because aging aircraft require additional maintenance. Also, contractor logistics support is the most significant contributor to costs, averaging about \$1.5 billion per year, because the C-17 is managed under Boeing's Globemaster Integrated Sustainment Program.

Figure 11: C-17 Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Air Force data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: The C-17 has been and will continue to be modified to meet its requirements. The Air Force's ongoing and planned actions, according to officials, include establishing specific teams, such as the weapon system integrity program, that are responsible for creating a plan to better sustain the C-17 and increase its service life.

Maintenance: The C-17 requires depot modifications to keep it viable, such as upgrading the communications system and other capability modifications, which increase the length of time that the aircraft is not available for training and mission requirements, according to officials. Also, there has been an increase of corrosion found on the aircraft, requiring intensive sheet metal work. Additionally, there was a shortage of depot maintenance personnel due to attrition, inability to retain skilled workers, and hiring freezes. The Air Force's ongoing and planned actions include evaluating the possibility of extending inspection and depot maintenance intervals from 120 to 180 days and from 5 to 6 years, respectively. This action may increase aircraft availability and reduce cost; however, the extent of implementation of these actions will be better defined in fiscal year 2018. Also, repairing for corrosion while the aircraft is undergoing other heavy maintenance or repairs at a designated base helps to minimize aircraft down time. Additionally, the Air Force is working to hire skilled workers using its direct hiring authority, which allows managers to quickly hire qualified candidates for critical positions.

Supply Support: The C-17 could experience a shortage of parts because vendors are no longer willing to produce parts. The Air Force's ongoing and planned actions, according to officials, include upgrading aircraft systems before they become obsolete, locating another vendor source, redesigning parts, purchasing additional parts to maintain a supply source, and accessing the virtual fleet program managed by Boeing to acquire parts from around the world.

Program Office Comments

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



Source: Defense Video Imagery and Distribution System. | GAO-18-146SU

Appendix IV

E-8C Joint Surveillance Target Attack Radar System Sustainment Quick Look

Common Name: JSTARS

Lead Service: Air Force

Program Essentials

Manufacturer: Northrup Grumman

Sustainment: Depot maintenance conducted by Northrup Grumman, and field maintenance conducted organically, by the National Guard.

Program Office: Robins Air Force Base, Georgia

Fiscal Year 2016 Data

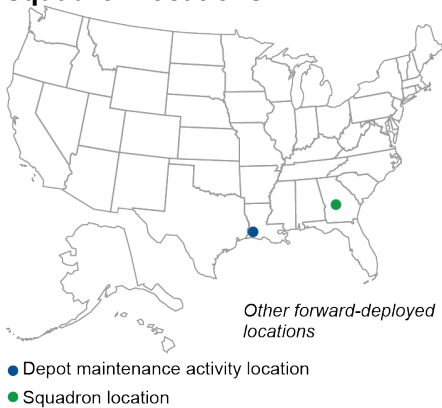
Average age: 48

Average number of flying hours: 58,927 hours per aircraft

Inventory: 16 aircraft

Operating and support cost: \$734 million

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

The E-8C is an aircraft with significant maintenance and supply issues according to Air Force officials. The Air Force's actions to mitigate these challenges include updating the Maintenance Plan and the Corrosion Plan for the E-8C (formerly a commercial airframe) to bring them in line with military standards.

Background

The E-8C Joint Surveillance Target Attack Radar System (E-8C) was first manufactured in 1967 (see fig. 12). Its primary mission is to provide theater ground and air commanders with ground surveillance to support attack operations and targeting that contributes to the delay, disruption, and destruction of enemy forces. Total operating and support (O&S) costs for the E-8C have generally increased from about \$686 million in fiscal year 2011 to about \$734 million in fiscal year 2016. Specifically, maintenance cost has increased partly because of increases in contractor logistics support since the E-8C is maintained by Northrup Grumman.

Figure 12: Life Cycle of the E-8C Joint Surveillance Target Attack Radar System



Sustainment Strategy

- JSTARS Life Cycle Management Plan (2014) provides comprehensive insight into the implementation of the program strategies, including the life-cycle sustainment plan. As the program matures, strategies evolve and new increments of capability have developed. Those strategies are included in separate Life Cycle Sustainment Plans, such as a plan for the modification to a multiagency communication capability.
- The fleet's sustainment support and depot maintenance is provided through a Total System Support Responsibility contract with Northrup Grumman, which runs until 2022 and is valued at \$7 billion, according to program office officials. As of September 2017, \$3.2 billion has been spent. Northrup Grumman's award fee is based on the contractor's performance against the contract requirements, which provides incentives to motivate the contractor.
- E-8C aircraft were formerly used as commercial airliners and purchased by the Air Force. Therefore, the exact usage of the aircraft was unknown with any degree of specificity. The program office has utilized new analysis conducted by Boeing to develop an improved method of determining and tracking service life for the E-8C aircraft. The new method uses a quantitative analysis capability to identify safety of flight structural concerns, allowing for planning and execution of risk mitigation.

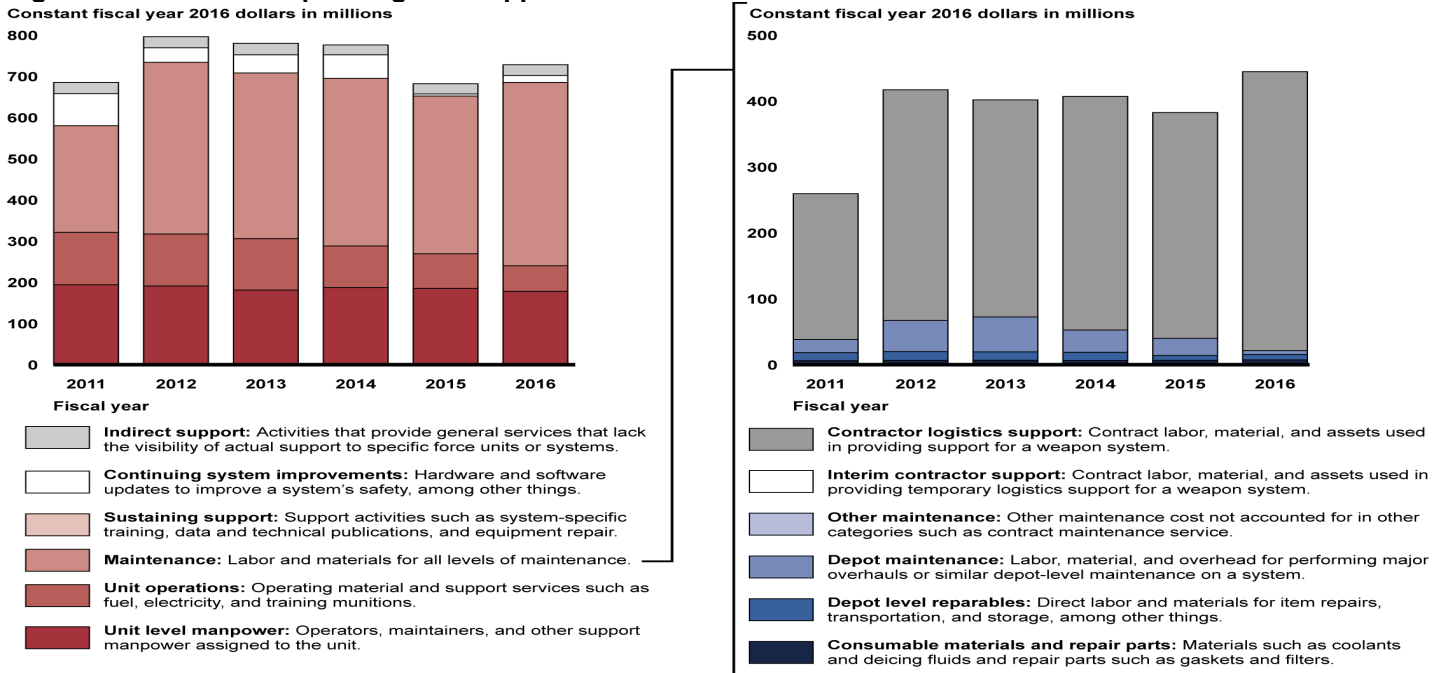
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support (O&S) Costs

Figure 13 shows that maintenance was the most significant O&S cost element for E-8C, at about \$400 million per year during fiscal years 2012–2016. Sustainment of the aircraft is performed through contractor logistics support, and the age of the aircraft and modification requirements mean the aircraft is often down for maintenance. From fiscal year 2011 through 2016, maintenance costs for E-8C have generally increased due to the increase in contractor logistics support. While depot inductions were down, the time the aircraft spent in depot increased, which caused the cost increase. In fiscal year 2016, when both maintenance costs overall and contractor logistics support peaked, contractor logistics support represented \$423 million of the \$445 million maintenance total—95 percent. As a result, maintenance costs have risen for the fleet by almost \$200 million since fiscal year 2011, an increase of 72 percent.

Figure 13: E-8C Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Air Force data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: The E-8C airframe has been in operation commercially since 1967, and corrosion is prevalent with the system. According to officials, military use exposes the fleet to more extreme circumstances than commercial use, causing corrosion to be more problematic. Ongoing and planned actions include implementing a E-8C corrosion plan revised to military standards and contracting for corrosion-specific engineering analysis.

Maintenance: E-8C faces maintenance issues because of poor depot performance. Officials explained that the contractor utilizes a commercial-based maintenance plan, which does not focus on long-term structural issues that require inspection and maintenance, instead of a military-based plan. Therefore, the current plan has inefficiencies in discovering and repairing unplanned issues. Ongoing and planned actions include rewriting and implementing the depot maintenance plan to military standards. Also, to improve the time the aircraft spends in depot, the contractor adopted a gated process in 2016 to track the stages of repair and ensure issues are identified as early as possible.

Supply Support: Officials informed us that E-8C is undergoing the replacement of a pylon mid-spar fitting as a result of a Federal Aviation Administration directive. However, there is no established supply chain for the part, so lack of availability is extending the maintenance time. Additionally, diminishing manufacturing sources and vanishing vendors are an issue for other parts, such as those affecting the aircraft's secure data capabilities, which can affect mission effectiveness. Ongoing and planned actions include creating a pylon mid-spar fitting facility with dedicated space and personnel, developing a process to swap pylons between aircraft, and changing the parts-ordering methodology. Also, the Air Force maintains a diminishing manufacturing source plan with options to mitigate, upgrade, or obtain waivers for parts.

Program Office Comments

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



Source: Defense Video Imagery and Distribution System. | GAO-18-146SU

Appendix V

F-16 Fighting Falcon Sustainment Quick Look

Common Name: F-16

Lead Service: Air Force

Program Essentials

Manufacturer: Lockheed Martin

Sustainment: Depot maintenance conducted organically at the designated air logistics complex, and field maintenance conducted organically and by contractors.

Program Office: Hill Air Force Base, Utah

Fiscal Year 2016 Data

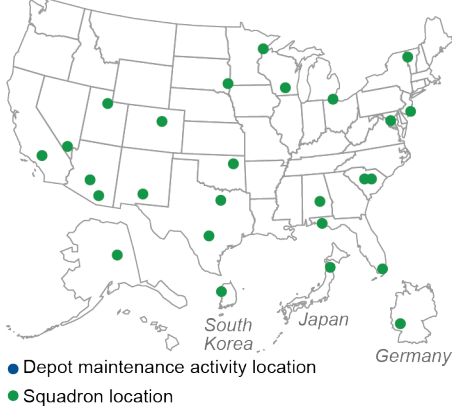
Average age: 27 years

Average number of flying hours: 6,433 hours per C model aircraft and 5,899 per D model aircraft

Inventory: 947 aircraft

Operating and support cost: \$4 billion

Depot maintenance activity and squadron locations:



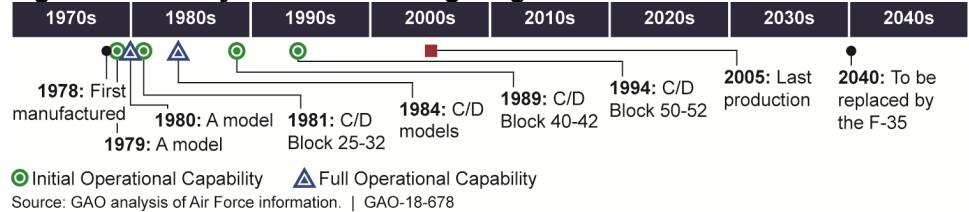
Sustainment Challenges and Mitigation Actions

The F-16 is an aircraft operating beyond its service life with maintenance and supply challenges. The Air Force's actions to mitigate these challenges include extending the service life of the aircraft, identifying all parts that need to be replaced during the inspection phase of maintenance, and identifying alternate vendors for parts.

Background

The F-16 Fighting Falcon is a compact, single-engine, multirole fighter aircraft first manufactured in 1978 (see figure 14). It is highly maneuverable and participates in air-to-air combat and air-to-surface attack. There are four versions of the F-16: A, single-seat model; B, two-seat model with tandem cockpits; C and D, single- and two-seat models, respectively, incorporating newer capabilities. Total operating and support (O&S) cost for the F-16 decreased from about \$5 billion in fiscal year 2011 to about \$4 billion in fiscal year 2016 because of a 6 percent reduction of inventory. Specifically, maintenance cost has generally decreased during this same period as a result of a decrease in cost of depot maintenance.

Figure 14: Life Cycle of the F-16 Fighting Falcon



Sustainment Strategy

- F-16 Service Life Extension Program Life-Cycle Sustainment Plan (2014) documents the operations and support planning of the life extension plan for the system, including the sustainment performance and funding requirements.
- The aircraft are maintained organically and through contract maintenance at the designated air logistics complex and field locations. For example, depot-level repair and software upgrades are performed organically, while contractors are used to conduct some maintenance, such as field maintenance repair at Nellis Air Force Base. Additionally, contractor depot-level maintenance is conducted in Belgium and Korea.
- The Air Force implemented a Service Life Extension Program in 2011 to extend the service life of 300 F 16 aircraft from 8,000 to 13,856 flight hours by (1) identifying life-limiting structural components through durability testing and analysis, (2) developing modifications and repair designs, (3) validating modification and a repair kit, and (4) implementing the modifications and repairs through 2026, with an estimated cost of \$740 million (as of June 2016).

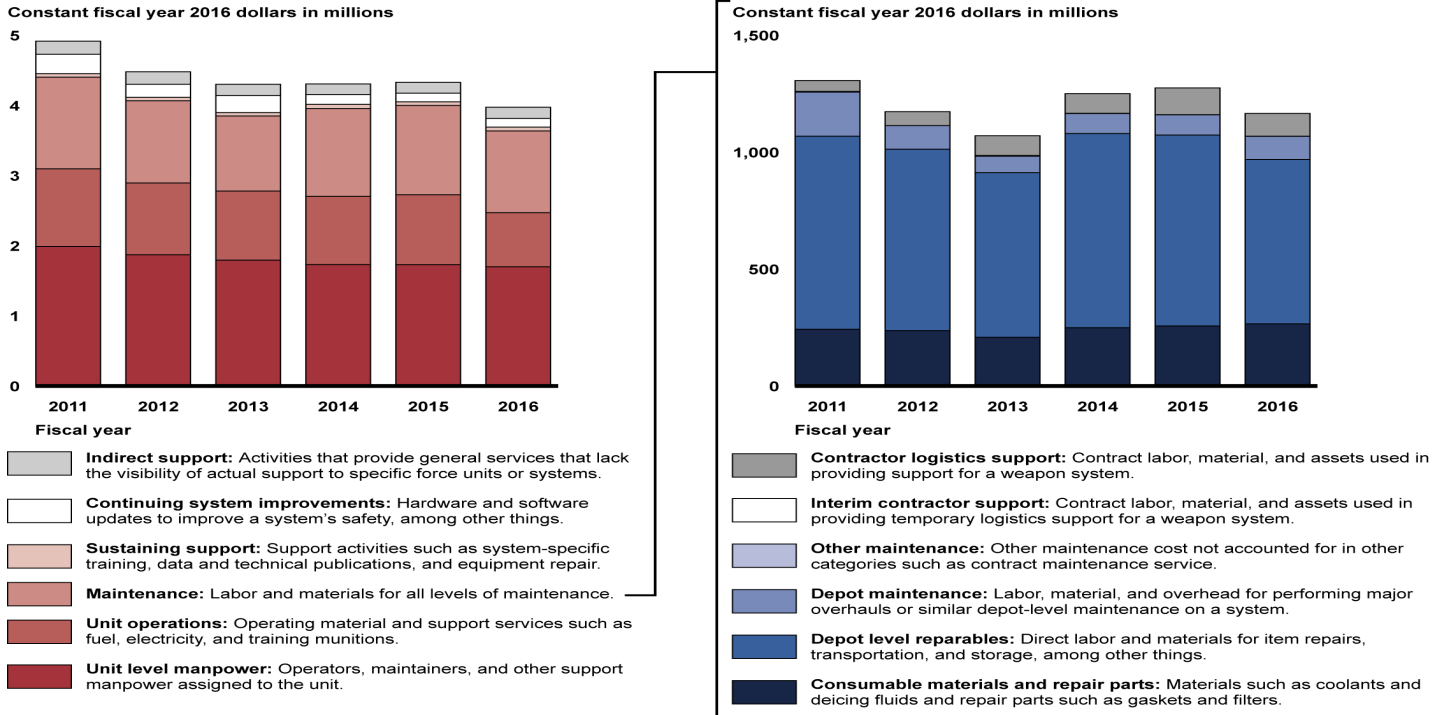
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support Costs

From fiscal year 2011 to fiscal year 2016, the F-16's overall O&S costs generally decreased, as shown in figure 15. Maintenance was the second largest O&S cost, averaging \$1.2 billion. While maintenance costs decreased overall from fiscal year 2011 through 2016, it increased in fiscal years 2014 and 2015. The increase is attributed to the rise in repair needs. Depot-level reparable, the most significant contributor to maintenance costs, averaged about \$776 million a year, while consumable materials and repair parts averaged \$243 million a year.

Figure 15: F-16 Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Air Force data. | GAO-18-678

Challenges and Mitigation Actions

Aging: The Air Force plans to keep the F-16 fleet flying until 2046 through a service life extension. This is vital to maintaining the Air Force's air superiority mission, since officials explained that F-35 aircraft are not being delivered as quickly as originally anticipated. This delay has prolonged the requirement for the F-16 fleet. The Air Force's ongoing and planned actions include extending the service life of 300 F-16 aircraft by 5,856 flight hours beyond its planned 8,000 flight-hour service life, using a phased approach. This Service Life Extension Program began in December 2016 and is scheduled to last through 2026 at an estimated cost of \$740 million.

Maintenance: Officials stated that, as the F-16 ages, it is requiring additional maintenance for repairs that were not originally planned, such as replacing the bulkhead, longerons, and skins (i.e., repair of major structural elements that may exhibit areas of cracking related to stress concentrations and number of flight hours on the aircraft). Therefore, maintenance activities are taking longer, and aircraft downtime has increased. The Air Force's ongoing and planned actions include mitigation efforts to counter corrosion by identifying all parts and components that need to be repaired and replaced during the phase inspection, and discussion of issues monthly at F-16 Health of Fleet meetings to identify causes and possible solutions.

Supply Support: The F-16 is experiencing shortages of parts because of diminishing manufacturing sources and increasing need for low-demand items. The Air Force's ongoing and planned actions include identifying alternate vendors, reverse-engineering parts, and cannibalizing parts from other aircraft.

Program Office Comments

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



Source: Defense Video Imagery and Distribution System. | GAO-18-146SU

Appendix VI

F-22 Raptor Sustainment Quick Look

Common Name: F-22

Lead Service: Air Force

Program Essentials

Manufacturer: Lockheed Martin and Boeing

Sustainment: Performance-based logistics contract with depot maintenance subcontracted to Ogden Air Logistics Complex, Utah, and field maintenance performed organically.

Program Office: Wright-Patterson Air Force Base, Ohio

Fiscal Year 2016 Data

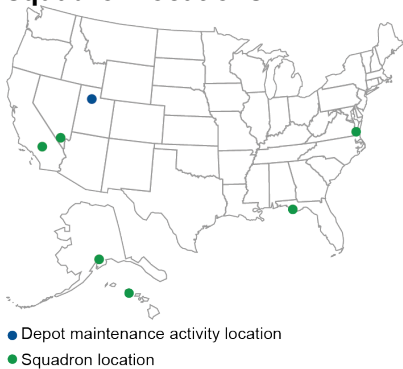
Average age: 9 years

Average number of flying hours: 1,286 hours per aircraft

Inventory: 186 aircraft

Operating and support cost: \$2 billion

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

The F-22 faces issues with its low-observable coating and supply funding. Actions to mitigate these challenges include contracting a repair facility to conduct coating reversion repair and securing additional spares funding.

Background

The F-22 Raptor is one of the newest Air Force fighter aircraft (see fig. 16). It is a unique combination of stealth, supercruise, maneuverability, and integrated avionics, coupled with improved supportability, which no other aircraft possess. The F-22 performs both air-to-air and air-to-ground missions and is designed to project air dominance, rapidly and at great distances, and defeat threats. Overall operating and support costs (O&S) for the F-22 have decreased about \$248 million overall since fiscal year 2011. Maintenance issues continue to be an area of concern for the aircraft, and these costs increased approximately \$255 million from fiscal years 2011 to 2016, due to increases in contractor logistics costs.

Figure 16: Life Cycle of the F-22 Raptor



Sustainment Strategy

- F-22 Life Cycle Management Plan (2012) documents plans to execute the program, which include a strategy ensuring that short-term initiatives support long-term objectives, while lowering costs, improving quality, and reducing process and lead time. This plan also includes the system sustainment strategy, which describes the phased approach of maintaining the system.
- To provide sustainment support to the F-22, the program office entered into a performance-based logistics contract with Lockheed Martin. Beginning in 2008, this integrated partnership was valued at \$8.5 billion for the 10-year lifespan and will end in December 31, 2017. While Lockheed Martin is responsible for supporting the sustainment of the aircraft, the Air Force conducts the depot maintenance. Additionally, engine sustainment for the fleet is provided by a separate contractor—Pratt & Whitney—at Tinker Air Force Base.
- The program office has various initiatives to support sustainment, such as maintaining a comprehensive diminishing manufacturing sources program and proactively supporting the continued sustainment of component parts of the aircraft through various replacement programs, such as the F-22 Reliability and Maintainability Maturation. This initiative is an ongoing effort to drive continuous improvement in availability.

Availability and Condition

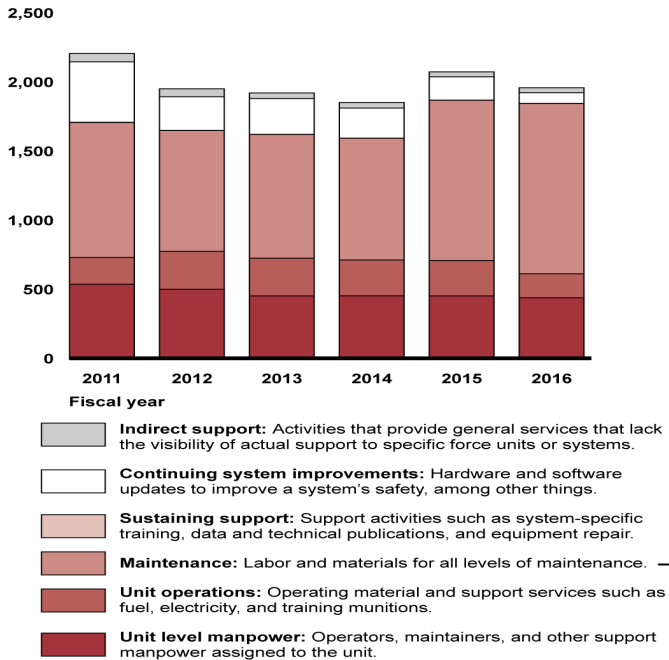
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Operating and Support Costs

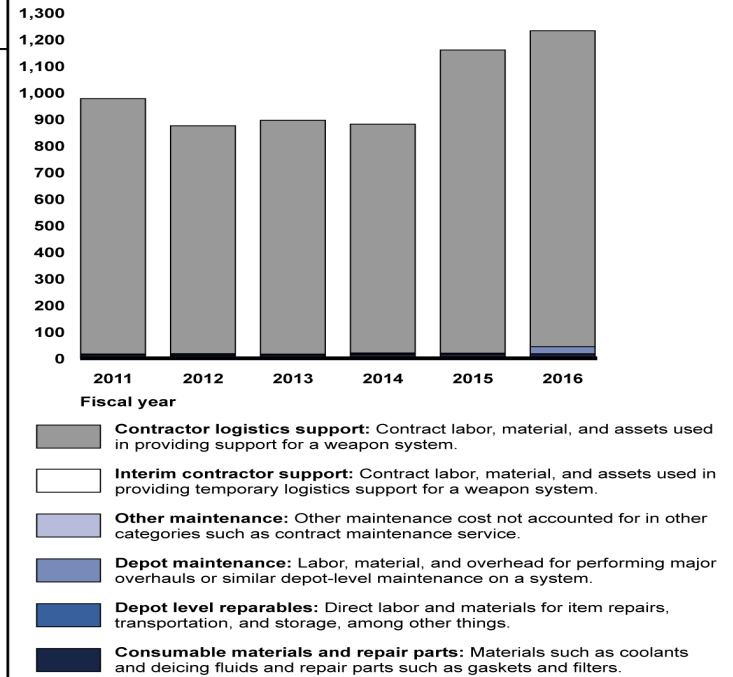
From fiscal years 2011 through 2016, F-22's overall O&S costs fluctuated some, but stayed roughly around \$2 billion (as shown in fig. 17). Maintenance accounted for the largest share of O&S costs over the period, averaging about \$1 billion per year, but these costs increased in fiscal year 2015 by about \$280 million. Maintenance costs increased due to the rise in costs for contractor logistics support, which, according to program office officials, was caused by additional repair of the low-observable coating and increased supply funding to address increases in flying hours.

Figure 17: F-22 Total Operating and Support Costs and Maintenance Cost Elements

Constant fiscal year 2016 dollars in millions



Constant fiscal year 2016 dollars in millions



Source: GAO analysis of Air Force data. | GAO-18-678

Challenges and Mitigation Actions

Aging and Maintenance: As the F-22 ages, it requires additional maintenance for repairs, such as repairs for corrosion and the aging of its low-observable coating. Also, according to program office officials, there is a shortage of maintenance personnel due to attrition, inability to find skilled workers, and a hiring freeze. The Air Force has ongoing and planned actions to counter (1) corrosion, by identifying all parts that need to be repaired and replaced during the inspection phase; (2) the low observable issue, by depot reversion repair and an Inlet Coating Repair Speedline; and (3) a skilled worker shortage, by piloting a robotic solution to apply the low-observable coating.

Supply Support: According to officials, the F-22 is experiencing shortages of parts because vendors are not producing some items and were not positioned to support the increase in flying hours from 2014 to 2016 and supply spares are underfunded. Ongoing actions include (1) maintaining a comprehensive Diminishing Manufacturing Sources program to minimize material shortages and (2) receiving an out-of-cycle supply funding increase.

Program Office Comments

The program office provided technical comments, which were incorporated as appropriate. The program noted the following: The Air Force and supporting industry are aggressively addressing sustainment challenges by investing in improvements to improve durability and maintainability, to include the low-observable coating. Additionally, for fiscal year 2017, 14.5 percent of not mission capable for maintenance aircraft have been available for pilots to fly. Also, supply chains are built on a network of partnerships that optimally thrive on consistent and predictable workflows. When unplanned changes occur in budgets, the forecasted flying hours, or major target objectives like AA, it creates major effects on the supply networks and there is rarely a quick fix. Another challenge affecting F-22 sustainment cost-effectiveness and responsiveness is the exit of many second- and third-tier suppliers driven by a lower business demand due to a significantly reduced fleet size (186 from the original 750 planned). The program office expects sustainment costs to stabilize as investments in fleet-wide repair processes and improved materials come to fruition.



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

AV-8B Harrier Sustainment Quick Look

Common Name: AV-8B

Lead Service: Marine Corps

Program Essentials

Manufacturer: Aircraft: McDonnell Douglas, British Aerospace, Boeing, and BAE Systems; Engine: Rolls Royce

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers, and field maintenance conducted by Navy maintainers

Program Office: Program Manager–Air (PMA) 257, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

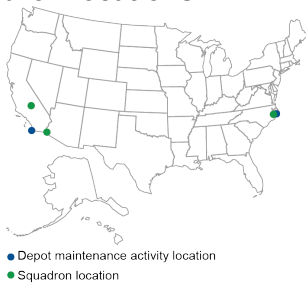
Average age: 21 years

Average number of flying hours: 4,711 hours per aircraft

Inventory: 123 aircraft

Operating and support cost: \$646 million

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

The AV-8B is operating beyond its planned service life with maintenance and supply issues. The Marine Corps' actions to mitigate these challenges include moving aircraft to deploying squadrons, upgrading aircraft components, and locating other vendor sources for parts.

Background

The AV-8B Harrier (AV-8B) is a Vertical/Short Take-off and Landing attack aircraft first manufactured in 1984 (see fig. 18). The AV-8B has the capability of conducting close air support using conventional weapons for intermediate range intercept and attack missions. The AV-8B is capable of deploying and operating on aircraft carriers and other suitable seagoing platforms, advanced bases, expeditionary airfields, and remote tactical landing sites. Total operating and support (O&S) costs for the AV-8B have decreased from about \$815 million in fiscal year 2011 to about \$646 million in fiscal year 2016. Specifically, unit-level manpower and operations as well as maintenance costs have decreased partly because the inventory is decreasing as AV-8B squadrons transition to the F-35 Joint Strike Fighter.

Figure 18: Life Cycle of the AV-8B Harrier



Sustainment Strategy

- AV-8B Program Strategic Sustainment and Warfighting Relevance Plan (2013) addresses strategic sustainment and warfighting requirements to ensure relevance, reliability, safety, and sustainability through five pillars: recruit and retain high-quality people, develop a comprehensive readiness and sustainment plan, meet combatant commander requirements, retain and sustain government and industry agencies to support engineering and logistics requirements, and integrate capabilities to remain tactically relevant and operationally effective.
- AV-8B is maintained organically at Navy Fleet Readiness Centers under planned maintenance intervals occurring every 1,500 flight hours; supply support is provided organically by Naval Supply Systems Command and Defense Logistics Agency; contractor support services are provided by Boeing.

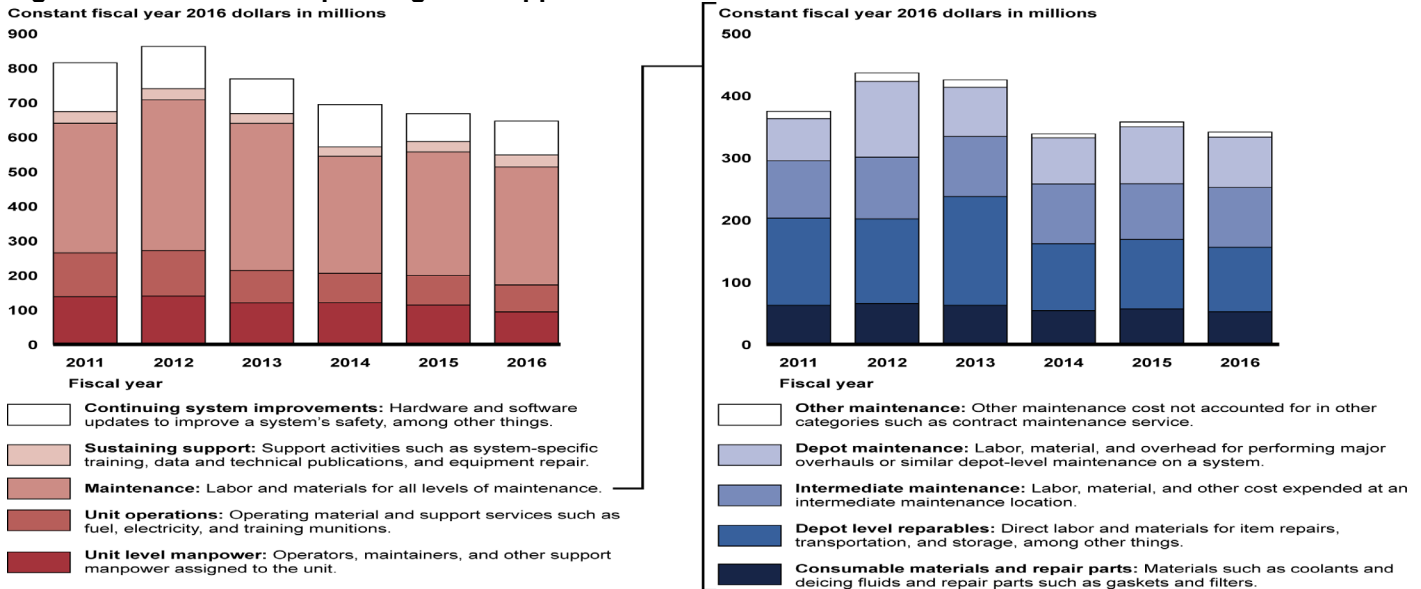
Availability and Condition

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Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the AV-8B's total O&S costs decreased (as shown in fig. 19). Maintenance accounted for the largest share of O&S costs over the period, averaging about \$379 million per year, but maintenance costs have generally decreased since 2011. According to officials, these decreases can be attributed to the AV-8B no longer being used in Operation Enduring Freedom in 2012, the loss of 6 aircraft, and the transition of AV-8B squadrons to the F-35 Joint Strike Fighter. Also, officials told us that the increase in O&S and maintenance costs in fiscal year 2012 can be attributed to the cost of reconstituting aircraft after Operation Enduring Freedom. Additionally, the cost of depot-level reparable is the most significant contributor to maintenance costs, averaging about \$129 million a year, while the "other" maintenance cost accounted for the smallest share of maintenance costs, averaging about \$10 million a year.

Figure 19: AV-8B Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Navy data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: Originally expected to remain in service only through 2015, the AV-8B is operating beyond its planned service life of 6,000 flight hours, until it will be replaced by the F-35 Joint Strike Fighter. The Marine Corps' ongoing and planned actions, according to officials, include strategies focusing on the engine to make sure the aircraft can continue meeting Marine Corps missions, and moving aircraft between squadrons to meet the requirements of deploying missions.

Maintenance: The AV-8B is requiring additional maintenance for repairs that were not originally planned due to the aging airframe, maintenance activities are taking longer to perform, and it has vulnerability to foreign-object damage given the age of the airframe. Also, there is a shortage of depot and field maintenance personnel because of attrition, inability to find skilled workers, and hiring freezes. The Marine Corps' ongoing and planned actions, according to officials, include identifying all parts and components that need to be repaired and replaced during the inspection phase, keeping up with maintenance schedules, conducting analyses on major components and upgrading as needed, and increasing awareness of maintainers and other personnel to mitigate foreign-object damage. Also, to reduce maintenance backlogs, depot and field maintainers are being trained at Fleet Readiness Centers to be proficient in repairing all parts of the aircraft.

Supply Support: The AV-8B is experiencing shortages of parts that suppliers are no longer producing. Also, there are not enough contracts in place to increase demand for manufacturers to keep production lines open. The Marine Corps' ongoing and planned actions, according to officials, include locating additional vendor sources, hardware and software upgrades, reverse engineering, programs that allow the removal of parts from damaged aircraft for use on operating aircraft once the parts have been inspected and approved for use, and continuing engineering analysis to identify items that can be used from the procurement of the GR-9 British equivalent of the AV-8B.

Program Office Comments

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



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

Appendix VIII

C-2A Greyhound Logistics Aircraft Sustainment Quick Look

Common Name: C-2A

Lead Service: Navy

Program Essentials

Manufacturer: Grumman Corporation (acquired by Northrop Grumman)

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers, and field maintenance conducted by Navy maintainers

Program Office: Program Manager–Air (PMA) 231, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

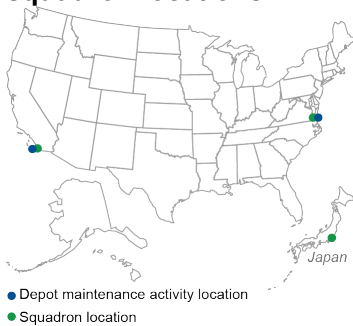
Average age: 29 years

Average number of flying hours: 10,117 hours per aircraft

Inventory: 34 aircraft

Operating and support cost: \$207 million

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

The C-2A is operating beyond its planned service life with maintenance and supply issues. The Navy's actions to mitigate these challenges include moving aircraft to deploying squadrons, training maintainers to transition to vacated positions, and locating other vendor sources for parts.

Background

The C-2A Greyhound Logistics Aircraft (C-2A) is a high-wing, twin-engine monoplane cargo aircraft first manufactured in 1965 (see fig. 20). It is designed to land on aircraft carriers, with a primary mission of providing critical logistics support to Carrier Strike Groups by transporting high-priority cargo, mail, and passengers between carriers and shore bases. The original C-2A aircraft were overhauled to extend their operational life in 1973 and again from 2004 through 2011. Total operating and support (O&S) costs for the C-2A have generally decreased from about \$233 million in fiscal year 2011 to about \$207 million in fiscal year 2016. Specifically, unit-level manpower, unit operations, and continuing system improvements have decreased, while maintenance costs have increased.

Figure 20: Life Cycle of the C-2A Greyhound Logistics Aircraft



It is unknown when the C-2A Greyhound reached initial operational capability and full operational capability.

Source: GAO analysis of Navy information. | GAO-18-678

Sustainment Strategy

- Sustainment planning focused on major components, such as the engine, landing gear, and avionics system, among others. The Navy will include an appendix for the C-2A when it updates the sustainment strategy for the E 2D for its 5-year update.
- C-2A completed a service life extension program from 2004 through 2011 to increase flight hours from 10,000 to 15,000 and landings from 16,020 to 36,000, among other things.
- Aircraft are maintained organically by field maintainers and at Navy Fleet Readiness Centers under a planned maintenance interval cycle with three planned maintenance interval events occurring consecutively every 24 months, and supply support is provided organically by the Naval Supply Systems Command and Defense Logistics Agency.

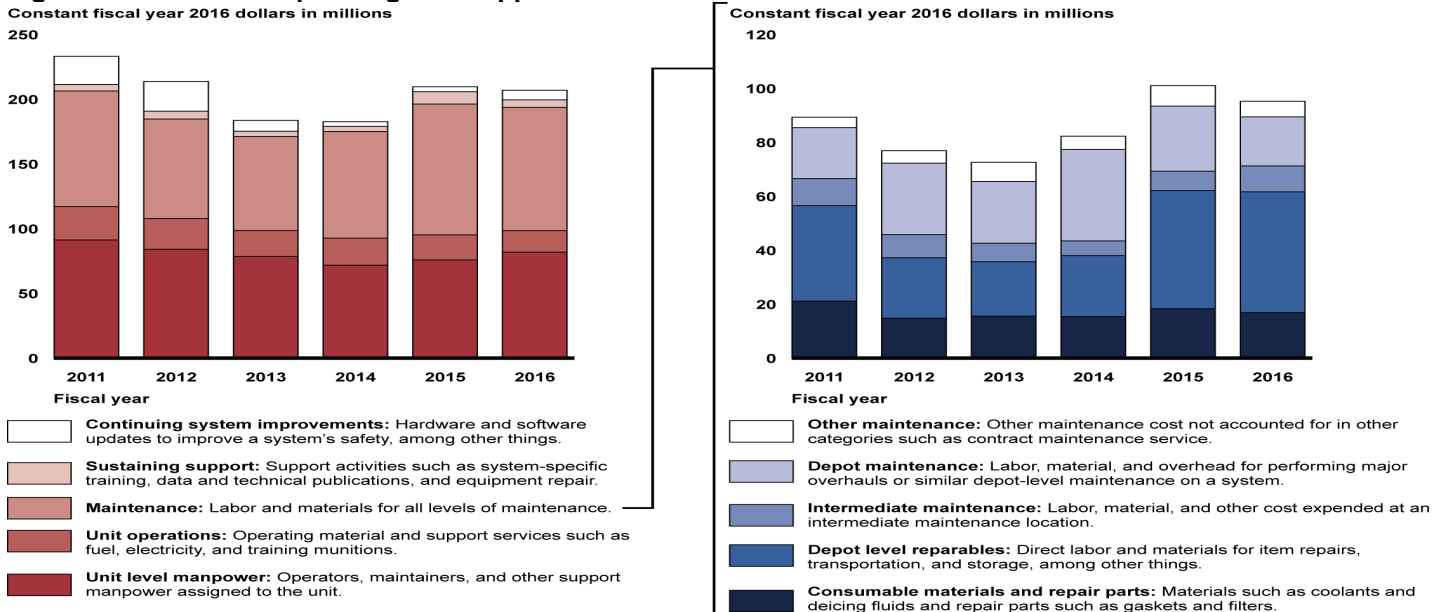
Availability and Condition

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Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the C-2A's total O&S costs fluctuated (as shown in fig. 21). Maintenance accounted for the largest share of O&S costs over the period, averaging about \$86 million per year, but these costs have also fluctuated. According to officials, this fluctuation can be attributed to differences in executed flight hours, military personnel, fuel prices, and planned depot maintenance, among other things. Officials also told us that the increases in fiscal years 2014 and 2015 were due to an increased demand for outer wing panels because these parts are reaching their life limit of 7,500 flight hours and were required to be replaced. Also, the cost of depot-level reparables is the most significant contributor to maintenance costs, averaging about \$32 million a year, while the "other" maintenance cost accounted for the smallest share of maintenance costs, averaging about \$6 million a year.

Figure 21: C-2A Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Navy data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: The C-2A has been in operation for close to 50 years. Currently, the oldest aircraft is about 32 years, and the newest is about 27 years old. The C-2A completed its most recent service life extension program from 2004 through 2011 to increase flight hours and landings, among other things. According to officials, there is high demand for these low-density (i.e., low-inventory) aircraft. The Navy's ongoing and planned actions include moving aircraft between squadrons to meet the requirements of deploying missions.

Maintenance: As the C-2A ages, it is requiring additional maintenance for repairs that were not originally planned, such as repairs for the propeller system and outer wing panels, which are nearing their 7,500 flight hour limit. Also, maintenance for these aircraft is taking longer because more parts need to be repaired and replaced. Additionally, there is a shortage of depot and field maintenance personnel due to attrition, inability to find skilled workers, and hiring freezes. The Navy's ongoing and planned actions include: conducting system performance studies to identify maintenance tasks to mitigate potential failures, identifying all parts and components that need to be repaired and replaced during the inspection phase, training depot and field maintainers and other personnel to transition to vacated positions and to be proficient in repairing all parts of the aircraft, and allowing depot and field maintainers to work overtime to keep up with maintenance schedules.

Supply Support: The C-2A is experiencing shortages of parts because vendors are no longer producing these parts. Also, there is not enough demand for manufacturers to keep production lines open or to propose redesigns of parts. The Navy's ongoing and planned actions include locating another vendor source, hardware and software upgrades, reverse engineering, cannibalizing parts (i.e., removing serviceable parts from one aircraft and installing them in another aircraft), or waiting until the part is available.

Program Office Comments

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



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

Appendix IX

E-2C Hawkeye Early Warning and Control Aircraft Sustainment Quick Look

Common Name: E-2C

Lead Service: Navy

Program Essentials

Manufacturer: Northrup Grumman Aerospace Corporation

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers, and field maintenance conducted by Navy maintainers

Program Office: Program Manager–Air (PMA) 231, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

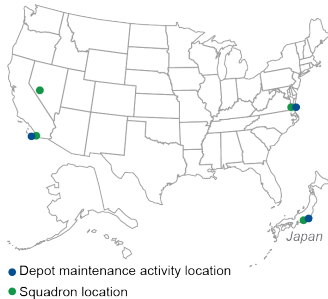
Average age: 16 years

Average number of flying hours: 5,839 hours per aircraft

Inventory: 42 aircraft

Operating and support cost: \$345 million

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

The E-2C is operating beyond its planned service life with maintenance and supply issues. The Navy’s actions to mitigate these challenges include transitioning E-2C squadrons to the E-2D fleet, conducting studies to identify maintenance tasks to mitigate potential failures, and waiting for parts to be available.

Background

The E-2 Hawkeye (E-2C) is the Navy’s all-weather, carrier-based tactical battle management, surface surveillance coordination and airborne early warning, command and control aircraft, with a planned sunset in 2026 when the last E-2D is delivered (see fig. 22). The E-2 is a twin-engine, five-crewmember, high-wing turboprop aircraft with a 24-foot diameter radar rotodome attached to the upper fuselage. Total operating and support (O&S) costs for the E-2 have decreased from about \$536 million in fiscal year 2011 to about \$345 million in fiscal year 2016. Specifically, unit manpower and maintenance costs have decreased, partly because E-2C inventory is decreasing as E-2C squadrons transition to the E-2D fleet.

Figure 22: Life Cycle of the E-2 Hawkeye Early Warning and Control Aircraft



It is unknown when Group I was first manufactured and reached full operational capability.

● Initial Operational Capability ▲ Full Operational Capability

Source: GAO analysis of Navy information. | GAO-18-678

Sustainment Strategy

- Post Production Support Plan (2011) documents seamless and comprehensive sustainment logistics, engineering programs, and financial resources necessary to ensure continued platform sustainment and attainment of readiness and safety operations. The Navy will include an appendix for the E-2C when it updates the sustainment strategy for the E-2D for its 5-year update.
- E-2C is maintained organically by field maintainers and at Navy Fleet Readiness Centers under a planned maintenance interval cycle: initial planned maintenance interval is performed by field maintainers at 42 months and the second cycle is performed at a Fleet Readiness Center 46 months after the initial planned maintenance interval. Supply support is provided organically by the Naval Supply Systems Command and Defense Logistics Agency; contractor support services are provided by General Dynamics and Wyle Labs.

Availability and Condition

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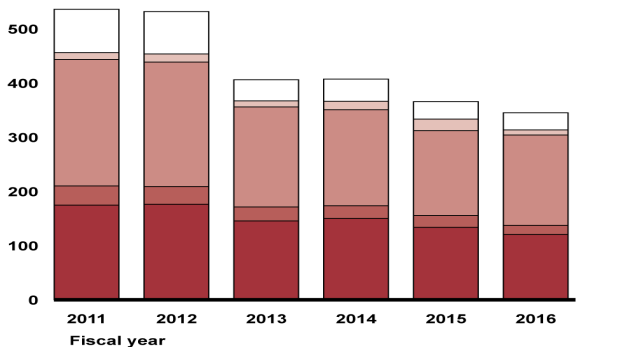
Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the E-2C's overall O&S costs decreased (as shown in fig. 23). Maintenance accounted for the largest share of O&S costs over the period, averaging about \$191 million per year, but maintenance costs have also decreased since 2011. According to officials, these decreases can be attributed to a consistent decrease in executed flight hours from fiscal year 2011 through fiscal year 2016, and to the disestablishment of the E-2C reserve squadron in fiscal year 2013. Depot maintenance cost is the most significant contributor to maintenance costs, averaging about \$60 million a year, while the "other" maintenance cost accounted for the smallest share of maintenance costs, averaging about \$11 million a year.

Figure 23: E-2C Total Operating and Support Costs and Maintenance Cost Elements

Constant fiscal year 2016 dollars in millions

600

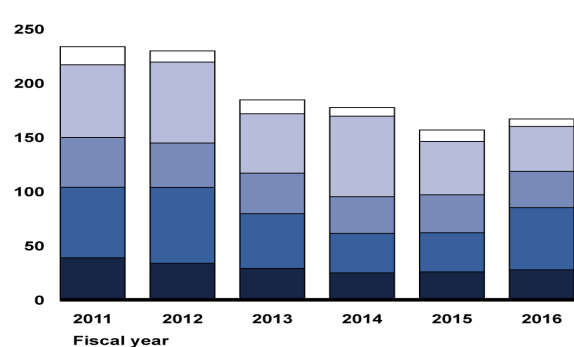


- Continuing system improvements:** Hardware and software updates to improve a system's safety, among other things.
- Sustaining support:** Support activities such as system-specific training, data and technical publications, and equipment repair.
- Maintenance:** Labor and materials for all levels of maintenance.
- Unit operations:** Operating material and support services such as fuel, electricity, and training munitions.
- Unit level manpower:** Operators, maintainers, and other support manpower assigned to the unit.

Source: GAO analysis of Navy data. | GAO-18-678

Constant fiscal year 2016 dollars in millions

300



- Other maintenance:** Other maintenance cost not accounted for in other categories such as contract maintenance service.
- Depot maintenance:** Labor, material, and overhead for performing major overhauls or similar depot-level maintenance on a system.
- Intermediate maintenance:** Labor, material, and other cost expended at an intermediate maintenance location.
- Depot level reparables:** Direct labor and materials for item repairs, transportation, and storage, among other things.
- Consumable materials and repair parts:** Materials such as coolants and deicing fluids and repair parts such as gaskets and filters.

Sustainment Challenges and Mitigation Actions

Aging: A variant of the E-2C has been in operation since the 1960s. Currently, the oldest aircraft of the current variant is about 27 years and the newest is about 7 years old. However, officials told us there is high demand for these low-inventory aircraft because of the unique mission capabilities of these aircraft to support the Navy's mission. The Navy's ongoing and planned actions, according to officials, include transitioning E-2C squadrons to the E-2D fleet and permanently transitioning aircraft out of service, as well as moving aircraft between squadrons to meet the requirements of deploying missions.

Maintenance: As the E-2C ages, it is requiring additional maintenance for repairs that were not originally planned. Also, maintenance for these aircraft is taking longer because more parts need to be repaired and replaced. Additionally, according to officials, there is a shortage of depot and field maintenance personnel due to attrition, inability to find skilled workers, and a hiring freeze. The Navy's ongoing and planned actions, according to officials, include conducting system performance studies to identify maintenance tasks to mitigate potential failures, identifying all parts and components that need to be repaired and replaced during the inspection phase, training depot and field maintainers and other personnel to transition to vacated positions and to be proficient in repairing all parts of the aircraft, and allowing depot and field maintainers to work overtime to keep up with maintenance schedules.

Supply Support: The E-2C is experiencing shortages of parts because vendors are no longer producing these parts. The Navy's ongoing and planned actions, according to officials, include locating another vendor source, hardware and software upgrades, reverse engineering, cannibalizing parts (i.e., removing serviceable parts from one aircraft and installing them in another aircraft), or waiting until the part is available.

Program Office Comments

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



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

Appendix X

E-2D Advanced Hawkeye Early Warning and Control Aircraft Sustainment Quick Look

Common Name: E-2D

Lead Service: Navy

Program Essentials

Manufacturer: Northrup Grumman Aerospace Corporation

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers, and field maintenance conducted by Navy maintainers

Program Office: Program Manager–Air (PMA) 231, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

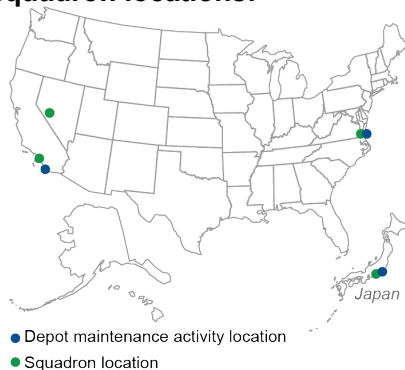
Average age: 3 years

Average number of flying hours: 988 hours per aircraft

Inventory: 20 aircraft

Operating and support cost: \$125 million

Depot maintenance activity and squadron locations:



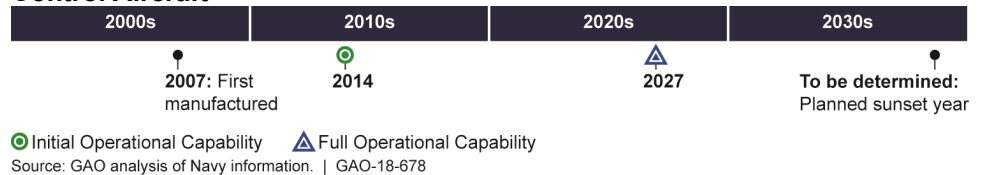
Sustainment Challenges and Mitigation Actions

As a new aircraft, the E-2D is experiencing maintenance and supply issues. The Navy’s actions to mitigate these challenges include troubleshooting component failures, and cannibalizing parts—moving parts from one aircraft to another.

Background

The E-2 Advanced Hawkeye (E-2D) is the newest variant of the E-2 aircraft platform, expecting to reach full operational capability by 2027 (see fig. 24). Using the same configuration as the E-2C, the E-2D aircraft is used for surface-surveillance coordination and airborne early warning, and command control. Its mission is to provide advanced warning of approaching enemy surface units, and cruise missiles and aircraft, among other things. Total operating and support (O&S) costs for the E-2D have increased consistently since fiscal year 2011 to about \$125 million in fiscal year 2016. This increase is driven by the addition of aircraft to the inventory as the Navy continues to produce E-2D aircraft through 2026.

Figure 24: Life Cycle of the E-2 Advanced Hawkeye Early Warning and Control Aircraft



Sustainment Strategy

- Life-Cycle Sustainment Plan (2013) provides a systematic approach to ensure that a comprehensive support package is in place for the sustainment of the aircraft. Also, it describes the overall plan for the management and execution of the product support package by communicating the sustainment strategy to stakeholders in the acquisition, engineering, and logistics communities. The Navy is revising the E-2D sustainment strategy for its 5-year update.
- Similar to the E-2C, the E-2D will be maintained organically by field maintainers and at Navy Fleet Readiness Centers under a planned maintenance interval cycle. According to officials, the intervals will be approved in fiscal year 2018. Supply support is provided organically by Naval Supply Systems Command and Defense Logistics Agency; contractor support services are provided by Northrup Grumman Systems Corporation-Aerospace Systems.

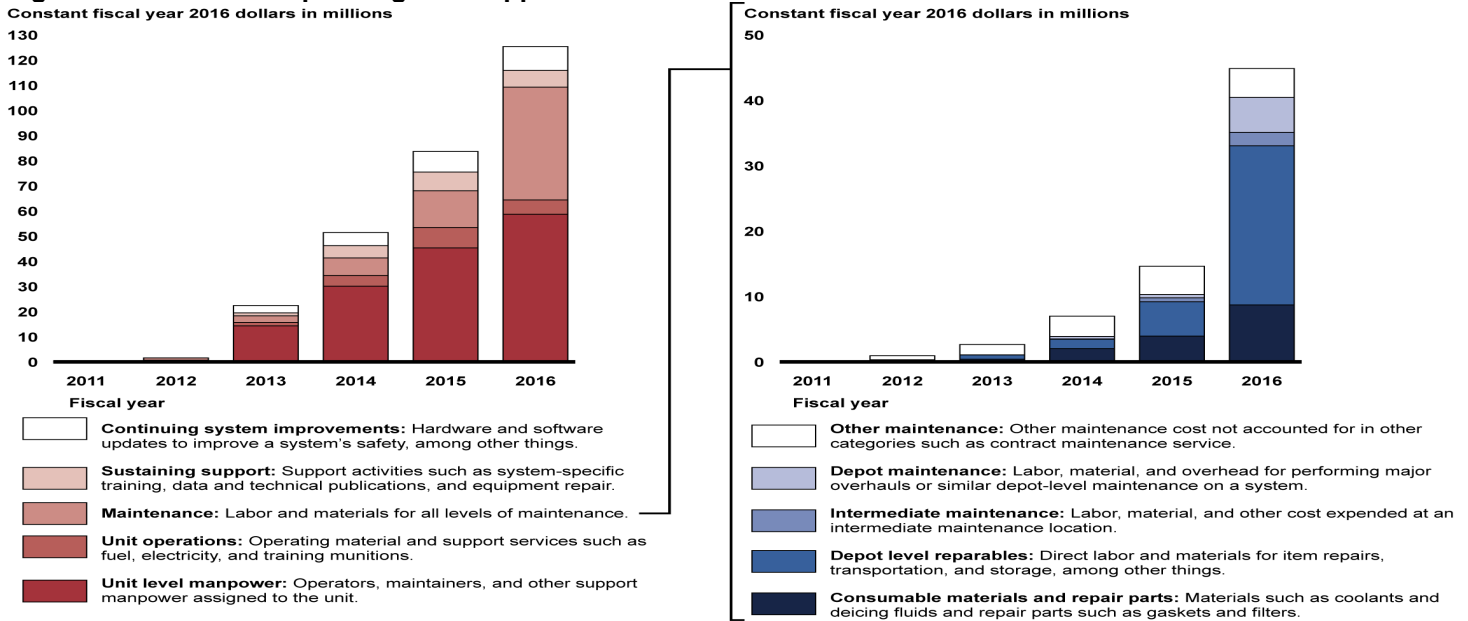
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the E-2D's total O&S costs increased (as shown in fig. 25). Unit-level manpower accounted for the largest share of O&S costs over the period, averaging about \$24 million per year because the aircraft is still in production. During this same period, maintenance costs have increased. According to officials, this increase in maintenance costs can be attributed to the increase in inventory. Specifically, in fiscal year 2016, component costs for the E-2D transitioned from the Navy's aircraft procurement account to the O&S account. Also, the cost of depot-level reparable is the most significant contributor to maintenance costs, averaging about \$5 million a year, while intermediate maintenance cost accounted for the smallest share of maintenance costs, averaging about \$457,000 a year.

Figure 25: E-2D Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Navy data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Maintenance: According to officials, some components of the E-2D are experiencing faster failure rates than originally planned, resulting in increased maintenance requirements of the aircraft. Officials told us that the avionics system on the E-2D is much heavier than the airframe can support, resulting in additional weight and balance checks as well as airframe maintenance issues. Also, there is high demand for these low-inventory aircraft because of the unique mission capabilities of these aircraft to support the Navy's mission, which has resulted in increased maintenance repairs. Additionally, there is a shortage of depot and field maintenance personnel due to attrition, inability to find skilled workers, and a hiring freeze. The Navy's ongoing and planned actions, according to officials, include weight and balance check during maintenance repairs, original equipment manufacturers troubleshooting component failures, identifying all parts and components that need to be repaired and replaced during the inspection phase, moving maintainers around to squadrons as their skill set is needed, and allowing maintainers to work overtime to keep up with maintenance schedules.

Supply Support: Even though the E-2D is still in production, the aircraft is experiencing shortages of parts because vendors are no longer producing these parts and there is not enough demand for manufacturers to keep production lines open or propose redesigns of parts. The Navy's ongoing and planned actions, according to officials, include locating another vendor source, hardware and software upgrades, performing maintenance practices to determine whether a part is reusable before ordering a new part, cannibalizing parts (i.e., removing serviceable parts from one aircraft and installing them in another aircraft), or waiting until the part is available.

Program Office Comments

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



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

EA-18G Growler Sustainment Quick Look

Common Name: Growler

Lead Service: Navy

Program Essentials

Manufacturer: Boeing

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers and Boeing, and field maintenance conducted by Navy maintainers

Program Office: Program Manager–Air (PMA) 265, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

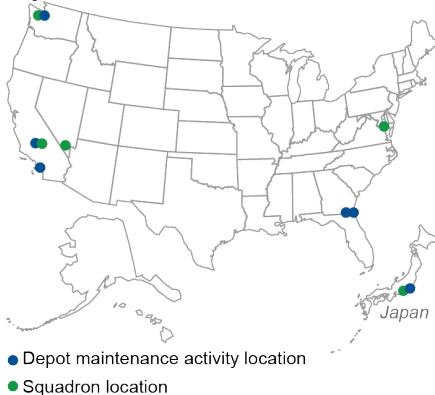
Average age: 5 years

Average number of flying hours: 1,489 hours per aircraft

Inventory: 115 aircraft

Operating and support cost: \$868 million

Depot maintenance activity and squadron locations:



Sustainment Challenges and Mitigation Actions

A new aircraft, the EA-18G is experiencing maintenance and supply issues. The Navy's actions to mitigate these challenges include waiting for available space at depots and cannibalizing parts—moving parts from one aircraft to another.

Background

The EA-18G Growler is the fourth major variant of the F/A-18 family of aircraft manufactured in 2007 to replace the EA-6B Prowler (see fig. 26). The EA-18G is the first newly designed electronic warfare aircraft produced in more than 35 years and combines the proven F/A-18 Super Hornet platform with a sophisticated electronic warfare suite. Total O&S costs for the EA-18G have consistently increased from about \$334 million in fiscal year 2011 to about \$868 million in fiscal year 2016. Specifically, unit manpower and maintenance costs have increased partly because the inventory is increasing, as EA-18Gs are still in production.

Figure 26: Life Cycle of the EA-18G Growler



Sustainment Strategy

- Acquisition Logistics Support (2006) documents the Navy's plan for design, development, and fielding of the aircraft. Some of the key support program elements include developing support equipment and technical data, testing requirements for avionics, and facilities requirements, among others. The Navy is updating this plan and expects to finalize it in 2018.
- The aircraft are maintained organically at Navy Fleet Readiness Centers under planned maintenance intervals, which typically occur every 72 months. Also, the Navy partners with Boeing to provide wholesale supply and depot repair support for major components, such as the engine.

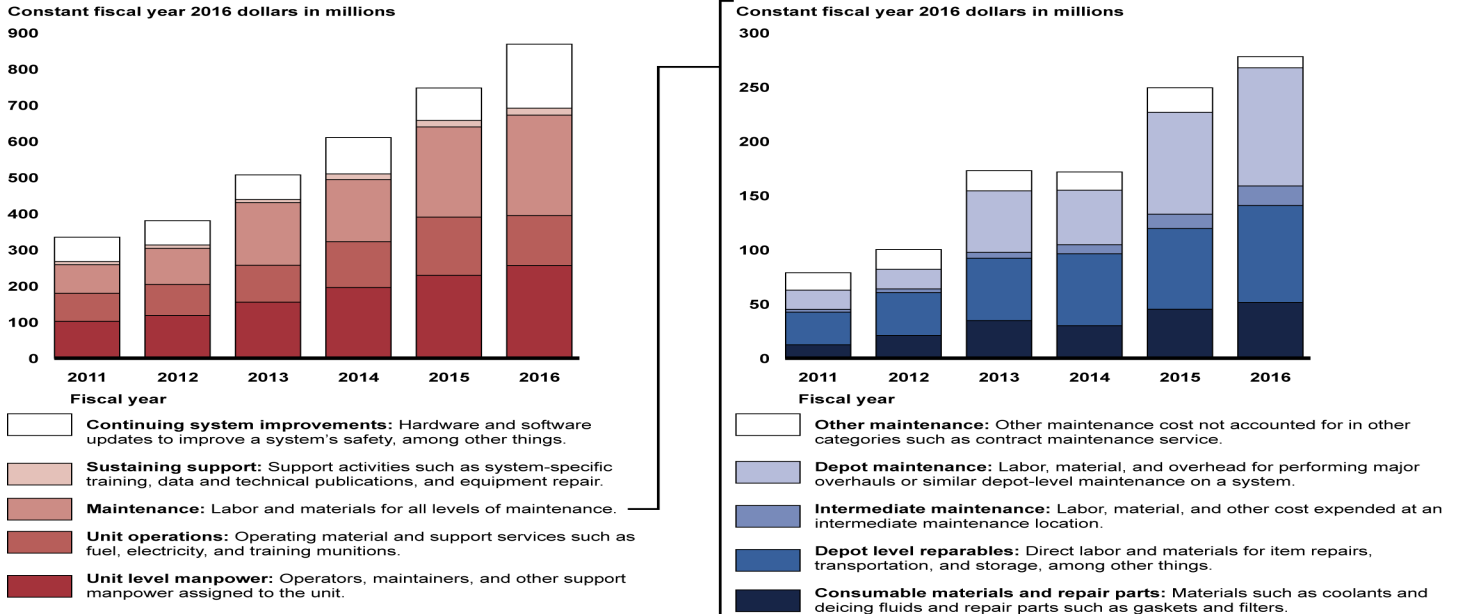
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the EA-18G's total O&S costs increased (as shown as fig. 27). Maintenance and unit-level manpower accounted for the largest share of O&S cost over the period, averaging about \$175 million and \$176 million per year, respectively, and these costs have increased. According to officials, these increases can be attributed to the increase in the inventory of the EA-18G. Also, the cost of depot-level reparable and depot maintenance cost are the most significant contributors to maintenance costs, averaging about \$60 million and \$58 million a year, respectively, while the "other" maintenance cost accounted for the smallest share to maintenance costs, averaging about \$17 million a year.

Figure 27: EA-18G Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Navy data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Maintenance: The EA-18G is experiencing several maintenance challenges, including whether the maintenance occurs in close proximity to the squadron, capacity of depots, and personnel. For example, while the majority of the squadrons are located at Whidbey Island, Washington, most of the component repairs are performed at Fleet Readiness Center–West in Lemoore, California. However, according to officials, Lemoore's depots have limited capacity to repair these aircraft, creating a maintenance backlog. Also, while all depot maintenance for the EA-18G is performed at Fleet Readiness Center–Northwest in Whidbey Island, Washington, there is a shortage of depot and field maintenance personnel due to attrition, inability to find skilled workers, and a hiring freeze. The Navy's ongoing and planned actions include establishing additional maintenance support for a number of systems on the EA-18G, such as the electronic warfare system and the generator control unit, at Whidbey Island and increasing the available depot maintenance spaces at Fleet Readiness Center–Northwest; training depot and field maintainers to be proficient in repairing parts of the aircraft outside their assigned position; and allowing depot and field maintainers to work overtime to keep up with maintenance schedules.

Supply Support: The EA-18G is experiencing shortages of parts because, according to officials, it takes a long time to repair parts. Also, contractors are no longer producing some of these parts. The Navy's ongoing and planned actions include locating another vendor source, reverse engineering, cannibalizing parts (i.e., removing serviceable parts from one aircraft and installing them in another aircraft), or waiting until the part is available.

Program Office Comments

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



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

Appendix XII

F/A-18A-D Hornet Strike Fighter Sustainment Quick Look

Common Name: Legacy Hornet

Lead Services: Navy and Marine Corps

Program Essentials

Manufacturer: McDonnell Douglas and Boeing

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers and Boeing, and field maintenance conducted by Navy maintainers

Program Office: Program Manager–Air (PMA) 265, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

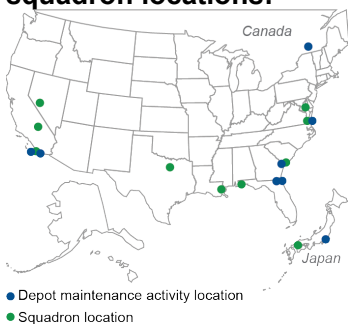
Average age: 26 years

Average number of flying hours: 7,499 hours per aircraft

Inventory: 537 aircraft

Operating and support cost: \$2.4 billion

Depot maintenance activity and squadron locations:



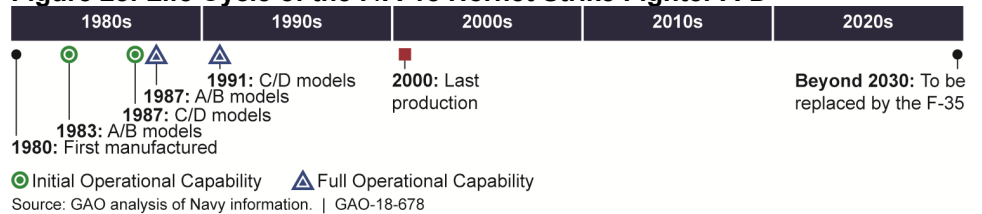
Sustainment Challenges and Mitigation Actions

The F/A-18A-D is operating beyond its planned service life with maintenance and supply issues. The Navy's actions to mitigate these challenges include extending the service life of the aircraft, allowing maintainers to work overtime to reduce backlog, and cannibalizing parts—moving parts from one aircraft to another.

Background

The F/A-18A-D Hornet Strike Fighter is a twin-engine, mid-wing, multimission tactical aircraft initially fielded in the 1980s (see fig. 28). In its fighter mode, it is used primarily as a fighter escort and for air defense; in its attack mode, it is used for force projection, interdiction, and air support. Total operating and support (O&S) costs for the F/A-18A-D have decreased consistently from about \$3.1 billion in fiscal year 2011 to about \$2.4 billion in fiscal year 2016. Specifically, unit manpower, operations, and maintenance costs have decreased, partly because the F/A-18A-Ds are being permanently transitioned out of service to be replaced by the F-35 Joint Strike Fighter..

Figure 28: Life Cycle of the F/A-18 Hornet Strike Fighter A-D



Sustainment Strategy

- The In-Service Support Plan (2001) documents the engineering, logistics, and financial resources necessary to ensure continued readiness and supportability for the remainder of the aircraft's service life. The Navy is currently updating this plan and expects to finalize it in 2018.
- The aircraft are maintained organically at Navy Fleet Readiness Centers under planned maintenance intervals, which typically occur every 48 months for carrier-deploying aircraft, and every 72 months for land-based aircraft.
- The Navy implemented the High-Flight-Hour program in 2006 to extend the service life from 8,000 to 10,000 flight hours by inspecting and repairing airframes, and replacing major components and parts. The High-Flight-Hour program, along with other factors, has led to maintenance carryover (i.e., into the next fiscal year) due to maintenance events taking longer than planned.
- In 1999, the Navy entered into a contract with Boeing for engineering support to leverage resources within the technology and industrial base to improve efficiency of the maintenance process and address the maintenance backlog.

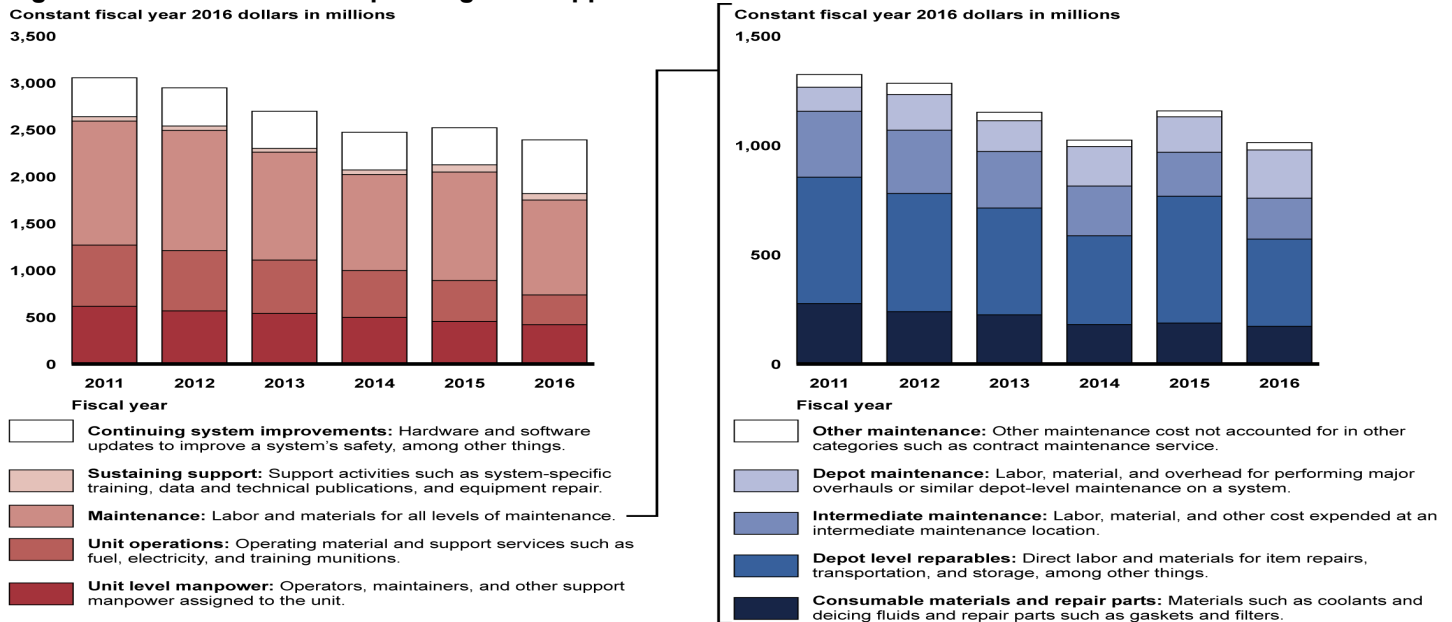
Availability and Condition

This report is a public version of a sensitive report that we issued on April 25, 2018. DOD deemed some of the information, such as aircraft availability, not mission capable rates, number of aircraft in depots, and budgeted and executed flight hours to be sensitive (i.e., For Official Use Only). This public report omits the information that DOD deemed to be sensitive.

Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the F/A-18A-D's total O&S costs decreased (as shown in fig. 29). Maintenance accounted for the largest share of O&S costs over the period, averaging about \$1.2 billion per year, but these costs have decreased. According to officials, this decrease is a result of reduction in the inventory of the F/A-18A-D from 581 aircraft in fiscal year 2011 to 537 aircraft in fiscal year 2016. Also, the cost of depot-level reparables is the most significant contributor to maintenance costs, averaging about \$499 million a year, while the "other" maintenance accounted for the smallest share of maintenance costs, averaging about \$40 million a year.

Figure 29: F/A-18A-D Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Navy data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: The F/A-18A-D's service life has been extended 4,000 flight hours beyond its planned service life of 6,000 flight hours. As the fleet ages, some F/A-18A-Ds have been permanently removed from service, decreasing the number of aircraft available for missions. The Navy's ongoing and planned actions include extending the service life of the F/A-18A-D to 10,000 flight hours through its High-Flight-Hour program—such as replacing major components including the landing gear—to increase the service life of the aircraft, and moving aircraft between squadrons to meet the requirements of deploying missions.

Maintenance: As the F/A-18A-D ages, it is requiring additional maintenance for repairs that were not originally planned, such as repairs for corrosion, and maintenance activities are taking longer to perform. Also, there is a shortage of depot and field maintenance personnel because of attrition, inability to find skilled workers, and a hiring freeze. The Navy's ongoing and planned actions include: training personnel on prevention and mitigation efforts for unplanned maintenance, such as corrosion; identifying all parts and components that need to be repaired and replaced during the inspection phase; and training depot and field maintainers to be proficient in repairing parts of the aircraft outside their assigned position, as well as allowing depot and field maintainers to work overtime to keep up with maintenance schedules.

Supply Support: The F/A-18A-D is experiencing shortages of parts because vendors are no longer producing these items. The Navy's ongoing and planned actions include identifying alternate vendors, performing hardware and software upgrades, reverse engineering parts, cannibalizing parts (i.e., removing serviceable parts from one aircraft and installing them in another aircraft), and waiting until parts become available.

Program Office Comments

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



Source: Defense Video and Imagery Distribution System. | GAO-18-146SU

Appendix XIII

F/A-18E-F Super Hornet Sustainment Quick Look

Common Name: Super Hornet

Lead Service: Navy

Program Essentials

Manufacturer: Boeing

Sustainment: Depot maintenance conducted at Navy Fleet Readiness Centers and field maintenance conducted by Navy maintainers

Program Office: Program Manager – Air (PMA) 265, Naval Air Systems Command, Patuxent River, Maryland

Fiscal Year 2016 Data

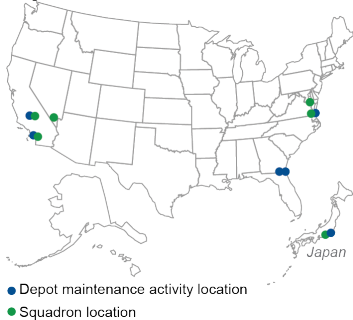
Average age: 10 years

Average number of flying hours: 2,970 hours per aircraft

Inventory: 505 aircraft

Operating and support cost: \$3.1 billion

Depot maintenance activity and squadron locations:



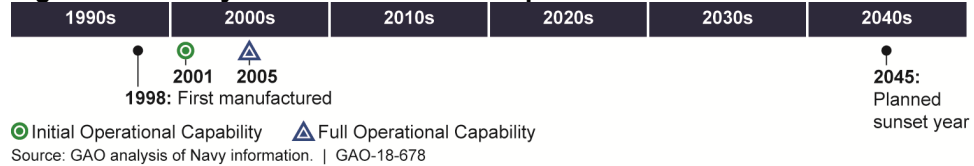
Sustainment Challenges and Mitigation Actions

The F/A-18E-F is a high operational tempo aircraft supporting contingency operations with maintenance and supply issues. The Navy's actions to mitigate these challenges include plans to extend the service life of the aircraft, training maintainers to transition to vacated positions, and cannibalizing parts—removing parts from one aircraft to another.

Background

The F/A-18E-F Super Hornet was first manufactured in 1998 (see fig. 30). The F/A-18E-F is highly capable across the full mission spectrum: air superiority, fighter escort, reconnaissance, aerial refueling, close air support, air defense suppression, and day/night precision strike. The F/A-18E-F provides aircrew the capability and performance necessary to face 21st century threats. Total operating and support (O&S) costs for the F/A-18E-4 have increased from about \$2.2 billion in fiscal year 2011 to about \$3.1 billion in fiscal year 2016. Specifically, unit manpower, maintenance, and continuing system support have increased, partly because the inventory is increasing, as the F/A-18E-F is still in production.

Figure 30: Life Cycle of the F/A-18E-F Super Hornet



Sustainment Strategy

- Sustainment planning is focused on major components, such as the Infrared Search and Track System (2013) to include the policies, processes, and responsibilities for the planning and maintenance support of the program, including the original equipment manufacturer, among other things.
- The aircraft are maintained organically at Navy Fleet Readiness Centers under planned maintenance intervals, which typically occur every 72 months. The Navy also partners with Boeing to provide depot repair support for hardware and software components for the Infrared Search and Track System.
- The Navy is planning to extend the service life of the aircraft. Currently, the Navy is conducting an assessment to determine the number of flight hours the aircraft can safely continue to fly, and then extend the service life of the program through inspections, repairs, and modifications, among other things. The Navy contracted with Boeing to potentially begin these efforts by fiscal year 2018.

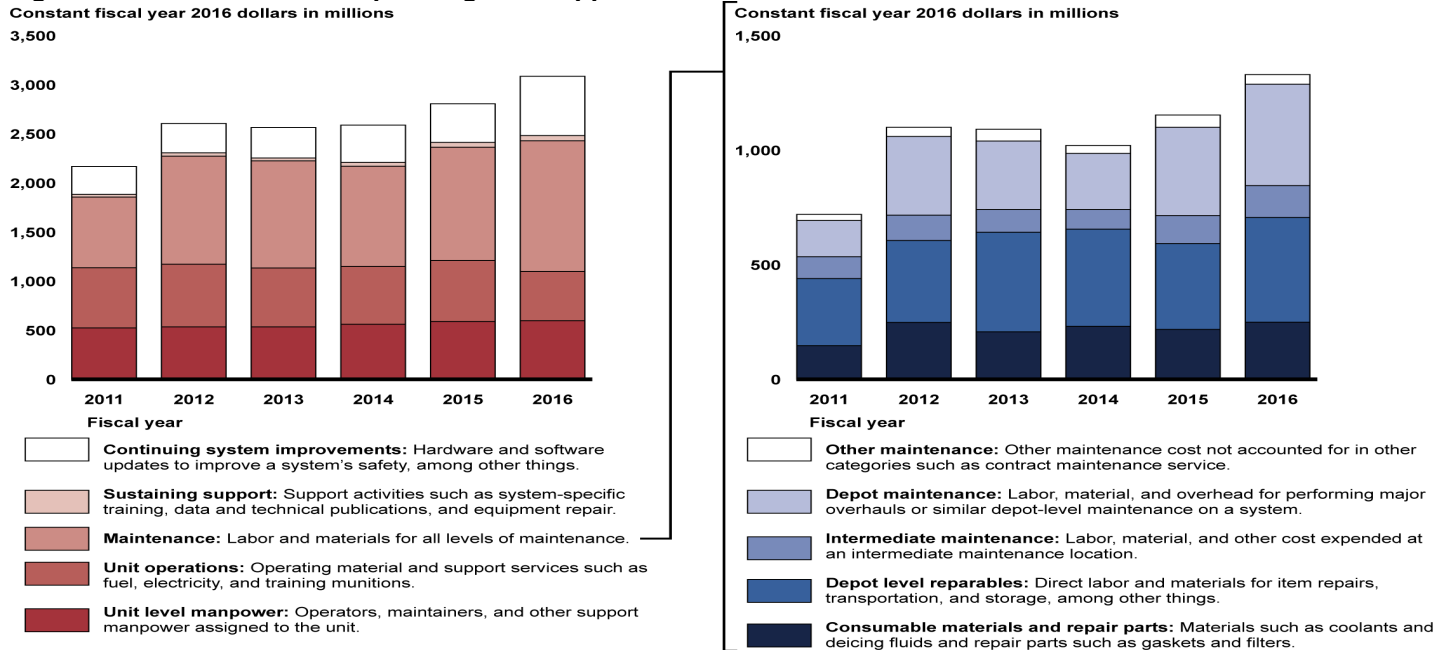
Availability and Condition

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Operating and Support Costs

From fiscal year 2011 through fiscal year 2016, the F/A-18E-F's total O&S costs have generally increased (as shown in fig. 31). Maintenance accounted for the largest share of O&S costs over the period, averaging about \$1.1 billion per year and these costs have increased. According to officials, these increases can be attributed to the high operational tempo of the aircraft requiring additional maintenance repairs, which is taking longer to perform. Also, the cost of depot-level reparableables is the most significant contributor to maintenance costs, averaging about \$390 million per year, while the "other" maintenance accounted for the smallest share of maintenance costs, averaging about \$41 million per year.

Figure 31: F/A-18 E-F Total Operating and Support Costs and Maintenance Cost Elements



Source: GAO analysis of Navy data. | GAO-18-678

Sustainment Challenges and Mitigation Actions

Aging: Due to the high operational tempo of the F/A-18E-F, aircraft are being flown much longer to support contingency operations and require additional maintenance. The Navy's ongoing and planned actions include plans—potentially to begin in fiscal year 2018—to extend the service life to increase its flight hours through modifications, repairs, and inspections, among other things. The Navy plans to implement lessons learned from other service life extension programs (e.g., F/A-18A-D Hornet Strike Fighter), such as monitoring depot induction flows, and obtaining contractor support from Boeing to assist with initial program challenges, including knowledge, skills, and facilities.

Maintenance: Corrosion has been a challenge for the F/A-18E-F and has caused some aircraft to be out of service for an extended period. Also, shortage of depot and field maintenance personnel due to attrition, inability to find skilled workers, and hiring freezes has caused maintenance backlogs. The Navy's ongoing and planned actions include corrosion prevention efforts, such as a corrosion-resistance initiative and corrosion action teams to identify corrosion early in the inspection phase and address it before it becomes a problem. Also, to reduce maintenance backlogs, the Navy is training depot and field maintainers to be proficient in repairing parts of the aircraft outside their assigned position, as well as allowing depot and field maintainers to work overtime to keep up with maintenance schedules.

Supply Support: Even though the F/A-18E-F is still in production, the aircraft is experiencing shortages of parts that suppliers are no longer producing. Also, according to officials, suppliers are slow, which increases maintenance wait times. The Navy's ongoing and planned actions include locating another vendor source, hardware and software upgrades, reverse engineering, cannibalizing parts (i.e., removing serviceable parts from one aircraft and installing them in another aircraft), or waiting until the part is available.

Program Office Comments

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

Appendix XIV: Scope and Methodology

To examine the trends in aircraft availability and operating and support (O&S) costs for selected Air Force and Navy fixed-wing aircraft, including whether the aircraft met availability goals, we selected a nongeneralizable sample of 12 fixed-wing aircraft managed by the Departments of the Air Force and the Navy. These included two Marine Corps aircraft that are managed by the Department of the Navy. This nongeneralizable sample was selected to ensure a mix of aircraft, including type of aircraft (fighter, bomber, cargo, etc.), age of the aircraft, and size of inventory, and whether the aircraft were sustained organically by the Department of Defense (DOD) or through contract arrangements, such as public-private partnerships or performance-based logistics, among other factors.¹

For the Air Force, we selected five fixed-wing aircraft—the B-52 Stratofortress, C-17 Globemaster III, E-8C Joint Surveillance and Target Attack Radar System (JSTARS), F-16 Fighting Falcon, and F-22 Raptor. For the Navy, including the Marine Corps, we selected seven fixed-wing aircraft—the AV-8B Harrier, C-2A Greyhound Logistics Aircraft, E-2 Hawkeye Early Warning and Control Aircraft, E-2 Advanced Hawkeye Early Warning and Control Aircraft, EA-18G Growler, F/A-18 Hornet Strike Fighter A-D, and F/A-18 Super Hornet E-F. The Marine Corps uses the AV-8B Harrier and also uses a variant of the F/A-18A-D. For the selected aircraft, we obtained and reviewed the aircraft availability, sustainment, and O&S data for accuracy and completeness, interviewed officials regarding their data-collection processes, and reviewed available related policies and procedures associated with the collection of the data. As a result, we found the information to be sufficiently reliable for the purposes of presenting sustainment metrics, such as aircraft availability and O&S costs.

We collected and analyzed data on aircraft condition metrics calculated based on the number of aircraft and period of time from fiscal years 2011 through fiscal year 2016 to compare goals and actuals for aircraft availability. We selected this period so we could identify and obtain insight on historical data trends and provide annual averages across these fiscal years. We also collected and analyzed data on not mission capable

¹DOD defines a public-private partnership as a cooperative arrangement between an organic product support provider and one or more private-sector entities to perform DOD or defense-related work or to utilize DOD depot facilities and equipment, or both. A performance-based logistics contract is outcome-based product support, where outcomes are acquired through performance-based arrangements that deliver the requirements contracted for and that incentivize product support providers to reduce costs through innovation.

status due to maintenance, supply, and both. With respect to O&S costs, we collected and analyzed data from fiscal years 2011 through 2016.²

We conducted data-reliability assessments for the data provided by the Air Force and the Navy. To do this, we sent data-reliability questionnaires to both departments requesting information on the sources that generated the data. For the Air Force, we conducted data-reliability assessments on the Air Force Total Ownership Cost system and the Logistics Installation and Mission Support system. For the Navy, we conducted data-reliability assessments on the Aviation Management Supply and Readiness Reporting—Type Model Series Integrated Database, the Decision Knowledge Programming for Logistics Analysis and Technical Evaluation system, the Flying Hour Projection System / Cost Adjustment and Visibility Tracking System, and the Visibility and Management of Operating and Support Costs system. We reviewed responses from both departments on these sources as well as documentation—such as guidance, user manuals, and data dictionaries—provided to corroborate questionnaire responses, and interviewed knowledgeable officials to discuss the data. We concluded that the data provided by the Air Force and the Navy were sufficiently reliable for the purposes of reporting condition metrics such as aircraft availability; not mission capable status due to maintenance, supply, and both; depot inductions; budgeted and executed flight hours; and O&S costs for the selected fixed-wing aircraft in our review.

To identify the sustainment challenges and mitigation actions for the selected aircraft, we reviewed sustainment metrics data, performance briefings, and other relevant documentation to identify specific challenges for each of the 12 aircraft in our review. We also reviewed ongoing and planned actions to address those challenges. Additionally, we interviewed program officials, depot officials, field maintainers, and squadron personnel to obtain their views on the challenges they face in sustaining the aircraft and the actions they take to mitigate those challenges. In some instances, we visited depots and squadrons to observe aircraft undergoing maintenance, discuss the respective maintenance processes, and discuss challenges and mitigation actions with officials. We then grouped the identified challenges into categories and represented them in a table to demonstrate which aircraft are experiencing specific challenges.

²O&S costs are adjusted for inflation and presented in fiscal year 2016 constant dollars.

To assess the extent to which the Air Force and the Navy have sustainment strategies, regularly review sustainment metrics, and have plans to improve aircraft availability for the selected fixed-wing aircraft, we obtained and analyzed sustainment strategies, performance management frameworks (i.e., sustainment metrics collected and monitored as well as the levels of management review), and improvement plans for each of the selected 12 fixed-wing aircraft.

We also identified and reviewed DOD, Air Force, and Navy guidance to analyze the departments' efforts in sustaining these aircraft and to determine whether these were consistent with federal standards for internal control that deal with management defining objectives in specific terms. Specifically, we reviewed DOD Instruction 5000.02, *Operation of the Defense Acquisition System*, which provides management principles and mandatory policies for defense acquisition systems such as fixed-wing aircraft. These policies incorporate decision processes and assessing of readiness, which includes the creation of and requirements for a Life-cycle Sustainment Plan. We also reviewed Air Force Instruction 63-101/20-101, *Integrated Life Cycle Management*, which implements various Air Force and DOD policy directives, including DOD Instruction 5000.02. It establishes the integrated life-cycle management guidelines and procedures for Air Force personnel who develop, review, approve, or manage the systems, subsystems, end-items, services, and activities procured by the Air Force. For the Navy, we reviewed Secretary of the Navy M-5000.2, *Department of the Navy Acquisition and Capabilities Guidebook*, which provides guidance for the operation of the defense acquisition system and the joint capabilities integration and development system. It also implements DOD Instruction 5000.02 for the Navy and Marine Corps, including guidance on the management and execution of a sustainment strategy.

We analyzed additional service guidance and documentation, such as sustainment strategies and life-cycle sustainment plans, postproduction support plans, or an in-service support plans, among other types of documented strategies, for the selected fixed-wing aircraft in our review to determine whether each selected aircraft had a sustainment strategy and to assess whether these strategies were current based on DOD policy

and service guidance.³ We also reviewed the Air Force's and the Navy's performance metric briefings and improvement plans to determine whether the departments regularly reviewed sustainment metrics and had plans aimed at improving aircraft availability. We interviewed DOD, Air Force, and Navy officials knowledgeable about sustainment of these selected fixed-wing aircraft to discuss DOD's and the departments' efforts in sustaining these aircraft, including historical information on each aircraft, applicability of policy and guidance for legacy aircraft, and overviews of performance management frameworks identified by the departments to monitor and improve aircraft availability.

To develop the fixed-wing aircraft sustainment summary documents (i.e., "Sustainment Quick Looks") in appendixes II–XIII we obtained historical and current information including background on aircraft capabilities, manufacturer, sustainment strategy, depot maintenance and squadron locations, and key dates in the life cycle of each aircraft (i.e., first manufactured, initial and full operational capability, last production, and planned sunset year). We collected and analyzed the following metrics:

- aircraft availability, not mission capable maintenance, not mission capable supply, and not mission capable aircraft from fiscal year 2011 through March 2017;⁴
- the number of aircraft in depots for fiscal years 2011 through 2016;
- budgeted and executed flight hours from fiscal years 2011 through 2016; and
- overall O&S and maintenance costs for fiscal years 2011 through 2016.

³Secretary of the Navy Instruction (SECNAVINST) 5000.2E, *Department of the Navy Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System* (Sept. 1, 2011); and Secretary of the Navy Instruction (SECNAVINST) 5400.15C Change Transmittal 1, *Department of the Navy Research and Development, Acquisition, Associated Life-Cycle Management, and Logistics Responsibilities and Accountability* (Sept. 13, 2007) (Change Transmittal 1, Dec. 2, 2011).

⁴In the "Sustainment Quick Looks" we present monthly data for the first half of fiscal year 2017 to provide the most up-to-date data possible. However, within the report we did not include these monthly data for fiscal year 2017 in our trend analysis because we used averages across the fiscal year. This method was not possible for fiscal year 2017 since, at the time of our analysis, data for all of fiscal year 2017 were not available. With respect to the number of aircraft in depot, flight hours, and O&S costs, the data for fiscal year 2017 were not available at the time of our analysis.

We compared availability actuals to goals, aircraft in depots to availability trends, and budgeted and executed flight hours to availability trends. We analyzed O&S cost by reviewing its six elements and compared them to availability trends. We also analyzed the subcategories of the maintenance costs element. Through interviews with knowledgeable officials and reviewing documentation, we identified sustainment challenges (i.e., aging, maintenance and supply support) and mitigation actions to address these challenges for each selected fixed-wing aircraft. DOD deemed some of the information, such as aircraft availability, not mission capable status, number of aircraft in depots, and budgeted and executed flight hours, to be sensitive (i.e., For Official Use Only), which must be protected from public disclosure. This public report omits the information that DOD deemed to be sensitive.

Additionally, to support our work for each objective we conducted site visits and interviewed officials to discuss data trends and identify specific sustainment challenges such as aging, maintenance, and supply support, among other challenges affecting aircraft availability, and mitigation actions to address these challenges. For the Air Force, we met with the following entities:

- **Headquarters**—Secretary of the Air Force, Logistics and Product Support and Deputy Assistant Secretary for Cost and Economics, Air Force Cost Analysis Agency;
- **Materiel Commands**—Air Force Materiel Command and Air Force Life Cycle Management Center;
- **Program Offices**—B-52 Program Office, C-17 Program Office, E-8C Program Office, F-16 Program Office, and F-22 Program Office;
- **Depots**—Tinker Air Force Base at Oklahoma City, Oklahoma (B-52); Robins Air Force Base at Warner Robins, Georgia (C-17); Northrop Grumman facility at Lake Charles, Louisiana (E-8C); Ogden Air Logistics Center / Hill Air Force Base at Ogden, Utah (F-16 and F-22); and
- **Squadrons**—437th Maintenance Group, Joint Base Charleston, South Carolina (C-17); 461st Air Control Wing, Robins Air Force Base Georgia (E-8C); 20th Fighter Wing, Shaw Air Force Base, South Carolina (F-16); and 325th Maintenance Group, Tyndall Air Force Base, Florida (F-22).

For the Navy, we met with the following entities:

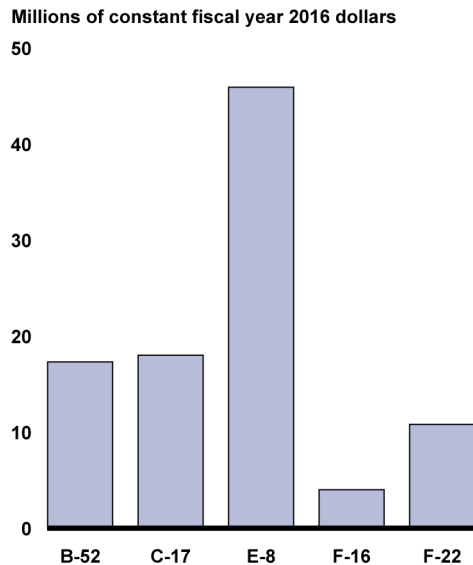
- **Headquarters**—Deputy Assistant Secretary of the Navy— Expeditionary Programs and Logistics Management, Marine Corps Aviation Plans and Policy Branch, and Air Warfare Division;
- **Materiel Commands**—Commander, Fleet Readiness Center; Naval Air Systems Command; and Naval Supply Systems Command;
- **Program Offices**—Program Manager–Air (PMA)-231 (C-2A, E-2C, and E-2D); PMA- 257 (AV-8B); and PMA-265 (F/A-18A-F, and EA-18G);
- **Depots**—Fleet Readiness Center–East at Cherry Point, North Carolina; Fleet Readiness Center–Mid Atlantic at Naval Air Station Norfolk, Virginia, and Naval Air Station Oceana, Virginia;
- **Squadrons**—Marine Corps Air Station Cherry Point, North Carolina; Marine Corps Air Station Miramar, California; Naval Air Station Norfolk, Virginia; and Naval Air Station Oceana, Virginia; and
- **Other**—Naval Center for Cost Analysis.

The performance audit upon which this report is based was conducted from September 2016 to April 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate, evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. We subsequently worked with DOD from April 2018 to September 2018 to prepare this unclassified version of the original sensitive report for public release. This public version was also prepared in accordance with these standards.

Appendix XV: Air Force and Navy Average Operating and Support Cost per Aircraft for Selected Fixed-Wing Aircraft

For fiscal year 2016, total operating and support (O&S) costs for the five Air Force fixed-wing aircraft selected in our review were about \$12 billion, and the average O&S cost per aircraft across all five fleets was about \$96 million, as shown in figure 32. Each of the C-17 and F-16 fleets accounted for about 33 percent of the total O&S cost, and the E-8C's average cost per aircraft accounted for about 48 percent of the total average cost per aircraft.

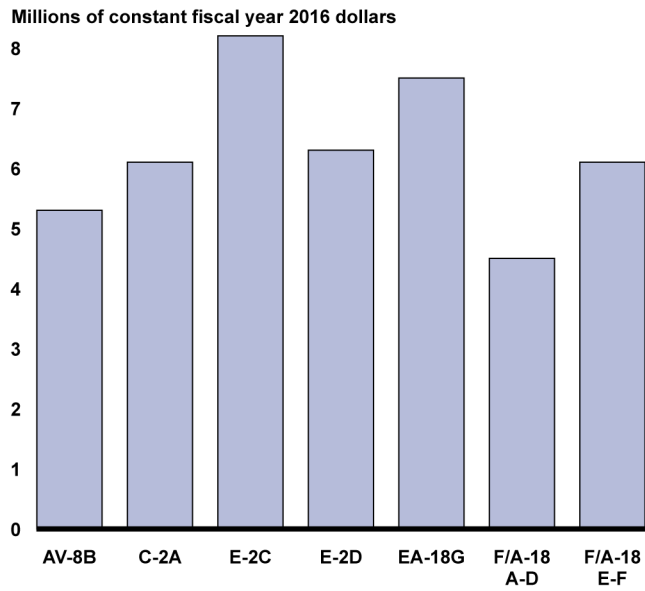
Figure 32: Average Cost per Aircraft for Selected Air Force Fixed-Wing Aircraft, Fiscal Year 2016



Source: GAO analysis of Air Force data. | GAO-18-678

For fiscal year 2016, total O&S costs for the seven Navy fixed-wing aircraft selected in our review were about \$7.7 billion, and the average O&S cost per aircraft across all seven fleets was about \$44 million, as shown in figure 33. The F/A-18E-F fleet accounted for about 40 percent of the total O&S cost, and the E-2C's average cost per aircraft accounted for about 19 percent of the total average cost per aircraft.

Figure 33: Average Cost per Aircraft for Selected Navy Fixed-Wing Aircraft, Fiscal Year 2016



Source: GAO analysis of Navy data. | GAO-18-678

Appendix XVI: Comments from the Department of Defense



LOGISTICS AND
MATERIEL READINESS

ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

Ms. Zina D. Merritt
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Merritt:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GAO-18-146, "WEAPON SYSTEM SUSTAINMENT: Selected Air Force and Navy Aircraft Generally Have Not Met Availability Goals, and DOD and Navy Guidance Needs Clarification" dated December 15, 2017 (GAO Code 101131). Detailed comments on the report recommendations are enclosed.

Sincerely,

A handwritten signature in black ink, appearing to read "R. McMahon", is written over a light blue horizontal line.

Robert H. McMahon

Enclosure:
As stated

**GAO Draft Report Dated December 15, 2017
GAO-18-146 (GAO CODE 101131)**

**“WEAPON SYSTEM SUSTAINMENT: SELECTED AIR FORCE AND NAVY
AIRCRAFT GENERALLY HAVE NOT MET AVAILABILITY GOALS, AND DOD AND
NAVY GUIDANCE NEEDS CLARIFICATION”**

**DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION**

RECOMMENDATION 1: The Government Accountability Office (GAO) recommends that the Under Secretary of Defense for Acquisition, Technology and Logistics should update or issue new policy clarifying the requirements for documenting sustainment strategies for legacy weapon systems, including fixed-wing aircraft.

DoD RESPONSE: Concur. While the Department policy specifies that all programs will have a Life Cycle Sustainment Plan (LCSP) that is updated every five years following Initial Operating Capability, additional language will be added to DoDI 5000.02 to clarify this applies to all legacy weapon systems.

RECOMMENDATION 2: The Government Accountability Office (GAO) recommends that the Secretary of the Navy should update or issue new guidance clarifying the requirements for documenting sustainment strategies for legacy weapon systems, including fixed-wing aircraft.

DoD RESPONSE: Concur. While the Navy does direct this in policy, reflecting direction from DoDI 5000.02, additional clarifying language will be added to Navy Policy 5400.15 to clarify this applies to all legacy weapon systems.

Appendix XVII: GAO Contact and Staff Acknowledgments

GAO Contact

Zina D. Merritt, (202) 512-5257, or merrittz@gao.gov

Staff Acknowledgements

In addition to the contact named above, John Bumgarner (Assistant Director), Clarine Allen, Ron Aribio, Vincent Buquicchio, Amie Lesser, Richard Powelson, Steven Putansu, Matt Spiers, and Natasha Wilder made key contributions to this report.

Related GAO Products

Defense Supply Chain: DOD Needs Complete Information on Single Sources of Supply to Proactively Manage the Risks. [GAO-17-768](#). Washington, D.C.: September 27, 2017.

Weapon Systems Management: Product Support Managers' Perspectives on Factors Critical to Influencing Sustainment-Related Decisions. [GAO-17-744R](#). Washington, D.C.: September 12, 2017.

Defense Acquisitions: Assessments of Selected Weapon Programs. [GAO-17-333SP](#). Washington, D.C.: March 30, 2017.

Depot Maintenance: Executed Workload and Maintenance Operations at DOD Depots. [GAO-17-82R](#). Washington, D.C.: February 3, 2017.

Defense Inventory: Further Analysis and Enhanced Metrics Could Improve Service Supply and Depot Operations. [GAO-16-450](#). Washington, D.C.: June 9, 2016.

Weapon Systems Management: DOD Has Taken Steps to Implement Product Support Managers but Needs to Evaluate Their Effects. [GAO-14-326](#). Washington, D.C.: April 29, 2014.

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