United States Government Accountability Office

Report to Congressional Requesters

November 2020

WEAPON SYSTEM SUSTAINMENT

Aircraft Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely

Accessible Version

GAO-21-101SP

Weapon System Sustainment

Aircraft Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely

GAO Highlights

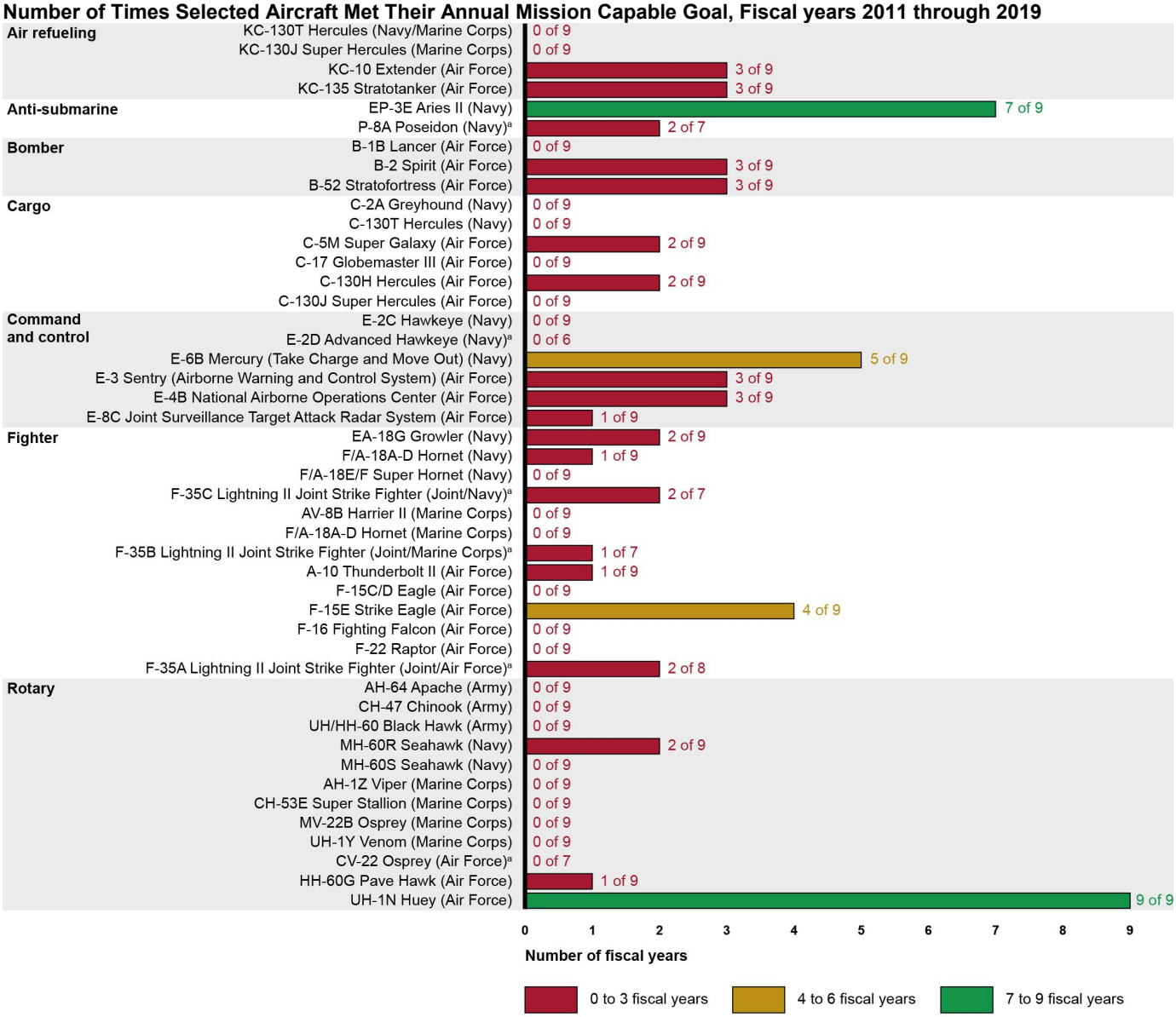
Defense Capabilities and Management Team

Highlights of **GAO-21-101SP**, a report to congressional requesters **November 2020**

Mission Capable Rates for Selected Department of Defense Aircraft

GAO examined 46 types of aircraft and found that only three met their annual mission capable goals in a majority of the years for fiscal years 2011 through 2019 and 24 did not meet their annual mission capable goals in any fiscal year as shown below. The mission capable rate—the percentage of total time when the aircraft can fly and perform at least one mission—is used to assess the health and readiness of an aircraft fleet.

Number of Times Selected Aircraft Met Their Annual Mission Capable Goal, Fiscal years 2011 through 2019



Source: GAO analysis of Army, Navy, and Air Force data. | GAO-21-101SP

[a]The military departments did not provide mission capable goals for all nine years for these aircraft.

Data table for Number of Times Selected Aircraft Met Their Annual Mission Capable Goal, Fiscal years 2011 through 2019

Aircraft	Number of fiscal years
KC-130T Hercules (Navy/Marine Corps)	0
KC-130J Super Hercules (Marine Corps)	0
KC-10 Extender (Air Force)	3
KC-135 Stratotanker (Air Force)	3
EP-3E Aries II (Navy)	7
P-8A Poseidon (Navy)	2
B-1B Lancer (Air Force)	0
B-2 Spirit (Air Force)	3
B-52 Stratofortress (Air Force)	3
C-2A Greyhound (Navy)	0
C-130T Hercules (Navy)	0
C-5M Super Galaxy (Air Force)	2
C-17 Globemaster III (Air Force)	0
C-130H Hercules (Air Force)	2
C-130J Super Hercules (Air Force)	0
E-2C Hawkeye (Navy)	0
E-2D Advanced Hawkeye (Navy)	0
E-6B Mercury (Take Charge and Move Out) (Navy)	5
E-3 Sentry (Airborne Warning and Control System) (Air Force)	3
E-4B National Airborne Operations Center (Air Force)	3
E-8C Joint Surveillance Target Attack Radar System (Air Force)	1
EA-18G Growler (Navy)	2
F/A-18A-D Hornet (Navy)	1
F/A-18E/F Super Hornet (Navy)	0
F-35C Lightning II Joint Strike Fighter (Joint/Navy)	2
AV-8B Harrier II (Marine Corps)	0
F/A-18A-D Hornet (Marine Corps)	0
F-35B Lightning II Joint Strike Fighter (Joint/Marine Corps)	1
A-10 Thunderbolt II (Air Force)	1
F-15C/D Eagle (Air Force)	0
F-15E Strike Eagle (Air Force)	4
F-16 Fighting Falcon (Air Force)	0
F-22 Raptor (Air Force)	0
F-35A Lightning II Joint Strike Fighter (Joint/Air Force)	2
AH-64D/E Apache (Army)	0
CH-47D-F Chinook (Army)	0
HH/UH-60 Black Hawk (Army)	0
MH-60R Seahawk (Navy)	2
MH-60S Seahawk (Navy)	0
AH-1Z Viper (Marine Corps)	0
CH-53E Super Stallion (Marine Corps)	0
MV-22B Osprey (Marine Corps)	0
UH-1Y Venom (Marine Corps)	0
CV-22 Osprey (Air Force)	0
HH-60G Pave Hawk (Air Force)	1
UH-1N Huey (Air Force)	9

Aggregating the trends at the military service level, the average annual mission capable rate for the selected Air Force, Navy, and Marine Corps aircraft decreased since fiscal year 2011, while the average annual mission capable rate for the selected Army aircraft slightly increased. While the average mission capable rate for the

F-35 Lightning II Joint Strike Fighter showed an increase from fiscal year 2012 to 2019, it trended downward from fiscal year 2015 through fiscal year 2018 before improving slightly in fiscal year 2019.

For fiscal year 2019, GAO found only three of the 46 types of aircraft examined met the service-established mission capable goal. Furthermore, for fiscal year 2019:

- six aircraft were 5 percentage points or fewer below the goal;
- 18 were from 15 to 6 percentage points below the goal; and
- 19 were more than 15 percentage points below the goal, including 11 that were 25 or more percentage points below the goal.

Program officials provided various reasons for the overall decline in mission capable rates, including aging aircraft, maintenance challenges, and supply support issues as shown below.

Sustainment Challenges Affecting Some of the Selected Department of Defense Aircraft

	Aging aircraft			Maintenance				Supply support		
	Delays in acquiring replacement aircraft	Service life extension[a]	Unexpected replacement of parts and repairs	Access to technical data	Delays in depot maintenance	Shortage of trained maintenance personnel	Unscheduled maintenance	Diminishing manufacturing source[ab]	Parts obsolescence[ac]	Parts shortage and delay
B-1B Lancer (Air Force)		Yes					Yes			Yes
C-5M Super Galaxy (Air Force)			Yes				Yes			Yes
C-130J Super Hercules (Air Force)			Yes				Yes	Yes	Yes	Yes
F/A-18E/F Super Hornet (Navy)		Yes	Yes		Yes	Yes		Yes	Yes	Yes
F-22 Raptor (Air Force)			Yes				Yes	Yes		Yes
MV-22B Osprey (Marine Corps)			Yes	Yes		Yes				Yes

Source: GAO analysis of Army, Navy, and Air Force information. | GAO-21-101SP
[a]A service life extension refers to a modification to extend the service life of an aircraft beyond what was planned.
[b]Diminishing manufacturing sources refers to a loss or impending loss of manufacturers or suppliers of items.
[c]Obsolescence refers to a lack of availability of a part due to its lack of usefulness or its no longer being current or available for production.

Operating and Support Costs for Selected Department of Defense Aircraft

Operating and support (O&S) costs, such as the costs of maintenance and supply support, totaled over

$49 billion in fiscal year 2018 for the aircraft GAO reviewed and ranged from a low of $118.03 million for the KC-130T Hercules (Navy) to a high of $4.24 billion for the KC-135 Stratotanker (Air Force). The trends in O&S costs varied by aircraft from fiscal year 2011 to 2018. For example, total O&S costs for the F/A-18E/F Super Hornet (Navy) increased $1.13 billion due in part to extensive maintenance needs. In contrast, the

F-15C/D Eagle (Air Force) costs decreased by $490 million due in part to a reduction in the size of the fleet. Maintenance-specific costs for the aircraft types we examined also varied widely.

Why This Matters

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. This report provides observations on mission capable rates and costs to operate and sustain 46 fixed- and rotary-wing aircraft in the Departments of the Army, Navy, and Air Force.

How GAO Did This Study

GAO was asked to report on the condition and costs of sustaining DOD's aircraft. GAO collected and analyzed data on mission capable rates and O&S costs from the Departments of the Army, Navy, and Air Force for fiscal years 2011 through 2019. GAO reviewed documentation and interviewed program office officials to identify reasons for the trends in mission capability rates and O&S costs as well as any challenges in sustaining the aircraft. This is a public version of a sensitive report issued in August 2020. Information on mission capable and aircraft availability rates were deemed to be sensitive and has been omitted from this report.

For more information, contact Director Diana Maurer at (202) 512-9627 or maurerd@gao.gov.

Contents

GAO Highlights i

Mission Capable Rates for Selected Department of Defense Aircraft i
Operating and Support Costs for Selected Department of Defense Aircraft iii
Why This Matters iii
How GAO Did This Study iv

Letter 1

Background 5
DOD Generally Did Not Meet Mission Capable Goals for Selected Aircraft, Mission Capable Rates Have Trended Downward, and Many Sustainment Challenges Exist 9
O&S Costs and the Trends in Those Costs Varied across the Selected Aircraft 18
Sustainment Quick Looks for Selected DOD Aircraft 23
Air refueling aircraft 25
KC-130T Hercules (Navy/Marine Corps) 26
KC-130J Super Hercules (Marine Corps) 31
KC-10 Extender (Air Force) 36
KC-135 Stratotanker (Air Force) 41
Anti-submarine aircraft 46
EP-3E Aries II (Navy) 47
P-8A Poseidon (Navy) 52
Bomber aircraft 56
B-1B Lancer (Air Force) 57
B-2 Spirit (Air Force) 62
B-52 Stratofortress (Air Force) 67
Cargo aircraft 72
C-2A Greyhound (Navy) 73
C-130T Hercules (Navy) 78
C-5M Super Galaxy (Air Force) 83
C-17 Globemaster III (Air Force) 88
C-130H Hercules (Air Force) 93
C-130J Super Hercules (Air Force) 98
Command and control aircraft 103
E-2C Hawkeye (Navy) 104
E-2D Advanced Hawkeye (Navy) 109

E-6B Mercury (Take Charge and Move Out) (Navy) 114
E-3 Sentry (Airborne Warning and Control System) (Air Force) 118
E-4B National Airborne Operations Center (Air Force) 123
E-8C Joint Surveillance Target Attack Radar System (Air Force) 128
Fighter aircraft 135
EA-18G Growler (Navy) 136
F/A-18A-D Hornet (Navy/Marine Corps) 141
F/A-18E/F Super Hornet (Navy) 146
F-35 Lightning II Joint Strike Fighter (Navy/Marine Corps/Air Force) 151
AV-8B Harrier II (Marine Corps) 160
A-10 Thunderbolt II (Air Force) 165
F-15C/D Eagle (Air Force) 169
F-15E Strike Eagle (Air Force) 174
F-16 Fighting Falcon (Air Force) 179
F-22 Raptor (Air Force) 184
Rotary aircraft 189
AH-64 Apache (Army) 190
CH-47 Chinook (Army) 195
UH/HH-60 Black Hawk (Army) 200
MH-60R Seahawk (Navy) 204
MH-60S Seahawk (Navy) 209
AH-1Z Viper (Marine Corps) 214
CH-53E Super Stallion (Marine Corps) 219
MV-22B Osprey (Marine Corps) 223
UH-1Y Venom (Marine Corps) 228
CV-22 Osprey (Air Force) 233
HH-60G Pave Hawk (Air Force) 238
UH-1N Huey (Air Force) 243
Agency Comments 248

Appendix I: Objectives, Scope, and Methodology 250

Appendix II: Additional Information on Navy Aircraft Mission Capable Rates 257

Appendix III: GAO Contact and Staff Acknowledgments 258

Figures

Number of Times Selected Aircraft Met Their Annual Mission Capable Goal, Fiscal years 2011 through 2019 i
Figure 1: Number of Times Selected Aircraft Met Their Annual Mission Capable Goal, Fiscal Years 2011 through 2019 11

Figure 2: Sustainment Challenges Affecting Selected Department of Defense Aircraft 17
Figure 3: Annual Operating and Support Costs per Aircraft for Selected Department of Defense Aircraft, Fiscal Year 2018 21
Figure 4: Aircraft Selected for Review by GAO 251
Data table for Figure 4: Aircraft Selected for Review by GAO 252

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

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

November 19, 2020

Congressional Requesters

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. Aircraft are one type of weapon system sustained by DOD that allow it to conduct its mission.

One of the key metrics used by DOD and the military services to assess the health and readiness of an aircraft fleet is mission capable rate—that is, the percentage of total time when the aircraft can fly and perform at least one mission.[2] For example, the F-22 Raptor (Air Force) has two primary air-to-air focused missions and one secondary air-to-ground

[1]There are two levels of DOD maintenance: field-level and depot-level. Field-level maintenance includes organizational and intermediate maintenance and requires fewer skills, but 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 or 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.

[2]The military services also measure whether systems are full mission capable (that is, can perform all of their assigned missions). We do not discuss full mission capable rates in this report.

mission and would be considered mission capable if it could fulfill only one of these missions.[3]

Each military department determines a mission capable goal for its aircraft, and tracks and reports aircraft mission capable rates.[4] For example, for fiscal year 2018, the Navy's EA-18G Growler had a mission capable goal of 75 percent.[5] In addition, in September 2018 the Secretary of Defense issued a memo directing that the F-22 Raptor (Air Force), F-16 Fighting Falcon (Air Force), F-35 Lighting II Joint Strike Fighter (Joint Program), and F/A-18 aircraft—specifically, the F/A-18A-D Hornet (Navy and Marine Corps), F/A-18E/F Super Hornet (Navy), and EA-18G Growler (Navy)—achieve a minimum 80 percent mission capable rate by the end of fiscal year 2019.[6]

You requested that we report on the condition and O&S costs for additional major weapon systems.[7] This report provides observations on (1) the extent to which the military services met mission capable goals for

[3]The two primary air-to-air missions of the F-22 are Offense Counter-Air—Escort/Sweep and Defensive Counter-Air. The secondary air-to-ground mission of the F-22 is Air Interdiction/Offensive Counter-Air—Attack Operations. For further details on the F-22, see GAO, *Force Structure: F-22 Organization and Utilization Changes Could Improve Aircraft Availability and Pilot Training*, GAO-18-190 (Washington, D.C.: July 19, 2018).

[4]In the Air Force, the lead commands set the aircraft mission capable goals in coordination with the applicable program office and Maintenance Division.

[5]In 2018, in our first weapon-system sustainment assessment, we reported that between fiscal years 2011 and 2016 the Air Force and the Navy generally did not meet aircraft availability goals, and O&S cost trends for 12 fixed-wing aircraft varied. See GAO, *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.: Apr. 25, 2018). In addition, we conduct annual assessments of DOD's major defense acquisition programs and report on the cost, schedule, and performance of those programs. See GAO, *Defense Acquisitions Annual Assessment: Drive to Deliver Capabilities Faster Increases Importance of Program Knowledge and Consistent Data for Oversight,* GAO-20-439 (Washington, D.C.: June 3, 2020), for our most recent annual assessment.

[6]Secretary of Defense Memorandum, *NDS Implementation—Mission Capability of Critical Aviation Platforms* (Sept. 17, 2018).

[7]The Conference Report accompanying a bill for the Department of Defense and Labor, Health and Human Services, and Education Appropriations Act, 2019 and Continuing Appropriations Act, 2019, also included a provision for us to report on the maintenance of the E-8C Joint Surveillance Target Attack Radar System. H.R. Rep. No. 115-952 (2018) (Conf. Rep). This report addresses this provision as it includes detailed information on the E-8C Joint Surveillance Target Attack Radar System, including its depot maintenance program.

46 fixed- and rotary-wing types of aircraft, including trends since fiscal year 2011 in mission capable rates and any sustainment challenges for those aircraft; and (2) the costs to operate and support these aircraft since fiscal year 2011. In addition, we provide 43 individual "Sustainment Quick Looks," some of which cover multiple aircraft that are similar but have separate mission capable goals and are reported separately by DOD and the military services. These Sustainment Quick Looks include detailed information on mission capable rates and other sustainment information, O&S costs, and sustainment challenges and mitigation actions to address these challenges.

This is a public version of a sensitive report that we issued in August 2020.[8] DOD deemed some of the information in our August report to be sensitive (i.e., For Official Use Only), which must be protected from public disclosure. Therefore, this report omits sensitive information about mission capable and aircraft availability rates. Although the information provided in this report is more limited, the report addresses the same objectives as the sensitive report and uses the same methodology.

Our observations are based on 46 manned fixed- and rotary-wing types of aircraft that support combat-related missions in the Departments of the Army, Navy, and Air Force.[9] In selecting these aircraft, we considered a number of factors, such as the mission of the aircraft (e.g., fighters, bombers, or cargo) and the size and age of the inventory for each aircraft. For example, we did not select aircraft that are used solely for training or are used to meet the operational airlift support mission (i.e., the movement of a limited number of high-priority passengers and cargo with time, place, or mission-sensitive requirements).[10]

For objective one, we collected and analyzed data from the Army, Navy, and Air Force on key sustainment metrics for each of the 46 aircraft, including mission capable rates and goals for fiscal years 2011 through 2019, the last fiscal year for which complete data were available at the

[8]GAO, *Weapon System Sustainment: Aircraft Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely*, GAO-20-67SPSU (Washington, D.C.: August 27, 2020).

[9]Aircraft flown by the Marine Corps are included in the data on the Department of the Navy.

[10]We reported on operational support airlift in June 2017. See GAO, *Operational Support Airlift: Fleet Sufficiency Is Assessed Annually*, GAO-17-582 (Washington, D.C.: June 28, 2017).

time of our work. We selected this time frame so that we could identify and obtain insight on mission capable rate trends. We also obtained information from program office officials regarding the reasons for changes in mission capable rates as well as any challenges in sustaining these aircraft.

For objective two, we collected and analyzed O&S data from the Departments of the Army, Navy, and Air Force cost reporting systems.[11] Specifically, we collected O&S cost data for fiscal years 2011 through 2018, the last fiscal year for which complete data were available at the time of our work. We selected this time frame so that we could identify and obtain insight on the historical data trends regarding O&S costs. We also spoke to and obtained information from program office officials about the reasons for changes and trends in O&S costs.

We conducted data-reliability assessments for the data provided by the military departments and the F-35 Joint Program Office. To do this, we reviewed related documentation; held interviews with knowledgeable agency officials; and performed electronic data testing for missing data, outliers, and obvious errors. As a result, we determined these data to be sufficiently reliable for the purposes of summarizing trends in mission capable rates and O&S costs since fiscal year 2011.[12] Appendix I provides further information on our scope and methodology.

We conducted this performance audit from August 2018 to July 2020 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 August 2020 to November 2020 to prepare this unclassified version of the original sensitive report for public release. This public version was also prepared in accordance with these standards.

[11]Specifically, we obtained information from the Army Operating and Support Management Information System (OSMIS), the Navy Visibility and Management of Operating and Support Costs system (VAMOSC), and the Air Force Total Ownership Cost system (AFTOC).

[12]We report on Army O&S costs through fiscal year 2017. We obtained fiscal year 2018 O&S cost data from the Army and discussed these data with the program office officials, who informed us that the data were incorrect. The Army did not provide updated data.

Background

Roles and Responsibilities for the Sustainment of Aircraft

There are a variety of DOD offices that have roles and responsibilities related to sustaining fixed- and rotary-wing aircraft. For example, the Under Secretary of Defense for Acquisition and Sustainment (USD [A&S]) is the principal advisor to the Secretary of Defense for all matters concerning acquisition and sustainment. Specifically, USD (A&S) is responsible for establishing policies for logistics, maintenance, and sustainment support for all elements of DOD, including fixed- and rotary-wing aircraft. The Assistant Secretary of Defense for Sustainment (ASD [Sustainment]) serves as the principal advisor to the USD (A&S) on logistics and materiel readiness within DOD. Specifically, the ASD (Sustainment) (1) establishes DOD policies and procedures for logistics, maintenance, materiel readiness, strategic mobility, and sustainment support; (2) provides related guidance to the Secretaries of the military departments; and (3) monitors and reviews 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- and rotary-wing aircraft. The Program Executive Officer oversees the program office that manages each weapon system. The Air Force Sustainment Center, a subordinate organization of the Air Force Materiel Command, provides

depot maintenance through its Air Logistics Complexes for weapon systems.[13]

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. Naval Air Systems Command is also responsible for the Navy Fleet Readiness Centers, which provide depot-level maintenance for Navy and Marine Corps fixed- and rotary-wing aircraft.[14]

The Army Materiel Command is the Army's primary logistics and sustainment command, responsible for managing the global supply chain and ensuring installation and materiel readiness. The Army's Aviation and Missile Command (AMCOM)—a subordinate command of Army Materiel Command—is a life-cycle management command that works to integrate sustainment, logistics, and contracting in order to support the product life-cycle management efforts. Within AMCOM, the AMCOM Logistics Center provides readiness support for aviation and missile weapon systems, including sustainment logistics, supply chain management, and field and sustainment maintenance. Individual program managers work closely with AMCOM to manage their aircraft sustainment programs. The Army

[13]The Department of the Air Force operates three Air Logistics Complexes that perform depot-level maintenance. These complexes are located in Ogden, Utah; Oklahoma City, Oklahoma; and Warner Robins, Georgia. 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.

[14]The 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.

Materiel Command also provides depot-level maintenance through its depots.[15]

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 accomplishing 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.

Additionally, the Air Force Sustainment Center, the Navy Supply Systems Command, and Army Materiel Command, as well as the Defense Logistics Agency, manage inventories of spare parts. Further, individual weapon systems programs are typically supported by a complex supplier network that includes a prime contractor, subcontractors, and various tiers of parts suppliers. Sustainment responsibilities—either in their entirety, or particular elements—may also be contracted out as part of a public-private partnership or a performance-based logistics agreement, such as is the case with the F-22 Raptor.[16]

[15]The Department of the Army operates two depots that support aircraft: Corpus Christi Army Depot, Texas and Tobyhanna Army Depot, Pennsylvania. Corpus Christi Army Depot is the Army's CITE for the maintenance and repair of structural helicopter airframes and blades; advanced composite technologies; flight controls and control surfaces; and aviation engines, transmissions, and hydraulic systems. Tobyhanna Army Depot is the Army's CITE for the maintenance and repair of systems associated with command, control, communications, and computers; intelligence, surveillance, and reconnaissance; electronics; avionics; and missile control.

[16]According to DOD Instruction 4151.21, *Public-Private Partnerships for Product Support* (Apr. 25, 2007) (incorporating Change 4, effective July 31, 2019), a public-private partnership for depot-level maintenance is a cooperative arrangement between an organic depot-level maintenance activity and one or more private-sector entities to perform DOD or defense-related work and/or to utilize DOD depot facilities and equipment. According to DOD's Performance-Based Logistics Guidebook (2016), performance-based logistics is synonymous with performance-based life-cycle product support, where outcomes are acquired through performance-based arrangements that deliver warfighter requirements and incentivize product support providers to reduce costs through innovation. These arrangements are contracts with industry or intragovernmental agreements.

Key Sustainment Metrics for Aircraft

The services monitor the readiness status of aircraft through multiple performance metrics. This report provides information on, among other things, three metrics that the Air Force, Navy, and Army have in common:

- **Mission capable rate**: The percentage of total time when an aircraft can fly and perform at least one mission.
- **Not mission capable maintenance (NMCM) rate**: The percentage of total time when an aircraft is not capable of performing any of its assigned missions because of maintenance.
- **Not mission capable supply (NMCS) rate**: The percentage of total time when an aircraft is not capable of performing any of its assigned missions because of the lack of a repair part.

In addition to these metrics, the Air Force measures aircraft availability, the number of aircraft that are available for flight operations, and not mission capable for both supply and maintenance (NMCB), 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. Lastly, the Navy tracks not mission capable depot (NMCD)—aircraft that are not capable of performing any assigned missions because of standard or special rework that is required, such as depot maintenance, special inspections, or modifications.

Operating and Support Costs for Major Weapon Systems

O&S costs historically account for approximately 70 percent of a weapon system's total life-cycle cost and include costs for repair parts, depot and field maintenance, contract services, engineering support, and personnel, among other things. 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.[17] 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

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

historical data on the O&S costs for major fielded weapon systems.[18] 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:[19]

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

DOD Generally Did Not Meet Mission Capable Goals for Selected Aircraft, Mission Capable

[18]The Air Force uses the Air Force Total Ownership Cost system, the Army uses the Operating and Support Cost Management Information 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.

[19]These six elements are further classified into additional subcategories. The maintenance cost elements for the Army and the Navy are further classified into five subcategories, including consumable materials and repair parts, depot-level reparables, depot maintenance, intermediate maintenance, and other maintenance. The Air Force's maintenance cost element is further classified into six subcategories, including consumable materials and repair parts, contractor logistics support, depot-level reparables, depot maintenance, interim contractor support, and other maintenance.

Rates Have Trended Downward, and Many Sustainment Challenges Exist

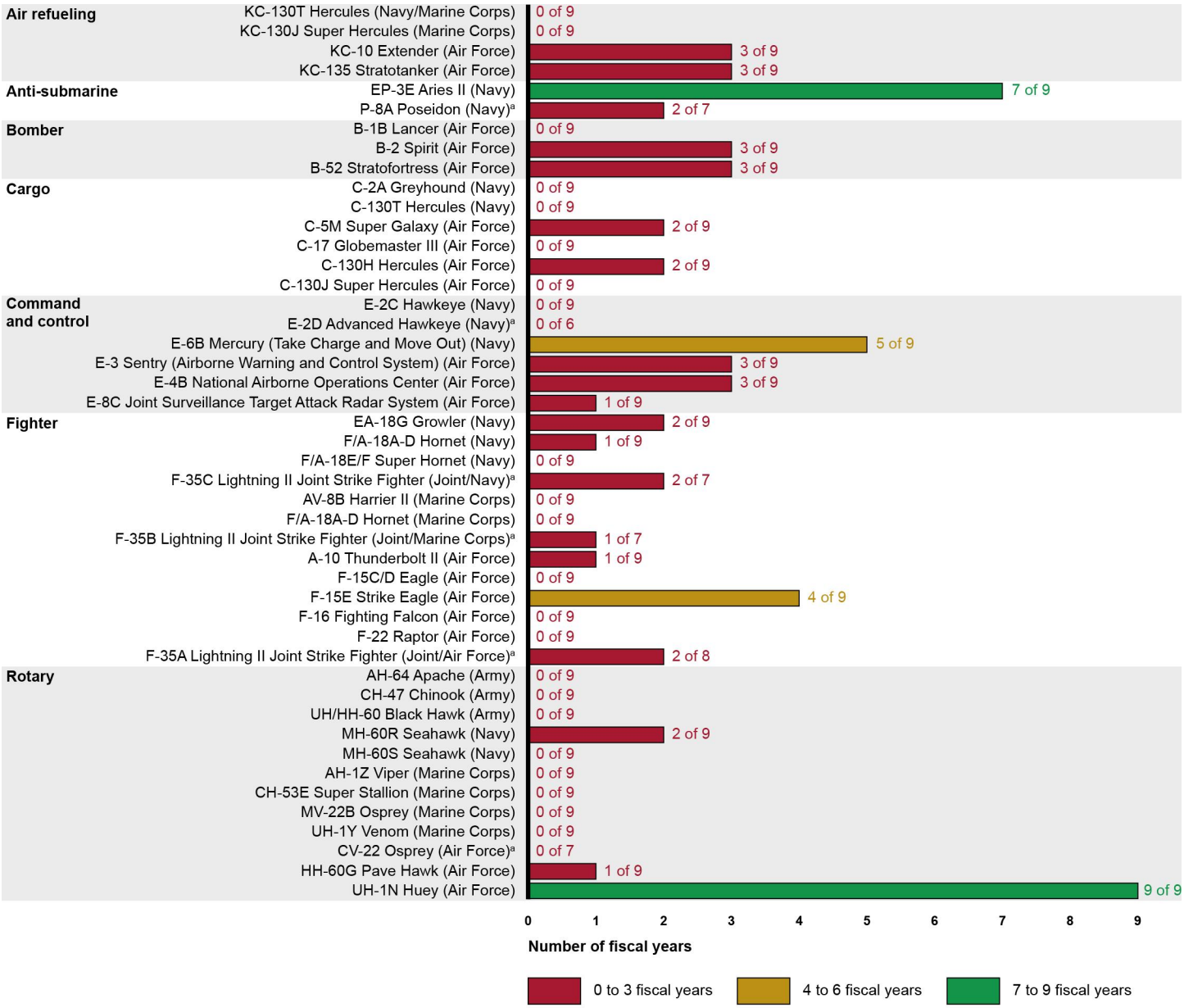
DOD Has Generally Not Met Established Mission Capable Goals for Selected Aircraft

We found that of the 46 individual fixed- and rotary-wing types of aircraft we examined, only three met the service-established mission capable goal for fiscal year 2019. Furthermore, for fiscal year 2019:

- six aircraft were 5 percentage points or fewer below the goal;
- 18 were from 15 to 6 percentage points below the goal; and
- 19 were more than 15 percentage points below the goal, including 11 that were 25 or more percentage points below the goal.

In addition, we found that 24 aircraft in our review did not meet their annual mission capable goals for any year from fiscal year 2011 through fiscal year 2019 and only three met their annual mission capable goals in a majority of those years, as shown in figure 1 below. Specific details on the rates for each type of aircraft were omitted because the information was deemed by DOD to be sensitive.

Figure 1: Number of Times Selected Aircraft Met Their Annual Mission Capable Goal, Fiscal Years 2011 through 2019



Source: GAO analysis of Army, Navy, and Air Force data. | GAO-21-101SP

Data table for Figure 1: Number of Times Selected Aircraft Met Their Annual Mission Capable Goal, Fiscal Years 2011 through 2019

Aircraft	Number of fiscal years
KC-130T Hercules (Navy/Marine Corps)	0
KC-130J Super Hercules (Marine Corps)	0
KC-10 Extender (Air Force)	3
KC-135 Stratotanker (Air Force)	3
EP-3E Aries II (Navy)	7
P-8A Poseidon (Navy)	2
B-1B Lancer (Air Force)	0
B-2 Spirit (Air Force)	3
B-52 Stratofortress (Air Force)	3
C-2A Greyhound (Navy)	0
C-130T Hercules (Navy)	0
C-5M Super Galaxy (Air Force)	2
C-17 Globemaster III (Air Force)	0
C-130H Hercules (Air Force)	2
C-130J Super Hercules (Air Force)	0
E-2C Hawkeye (Navy)	0
E-2D Advanced Hawkeye (Navy)	0
E-6B Mercury (Take Charge and Move Out) (Navy)	5
E-3 Sentry (Airborne Warning and Control System) (Air Force)	3
E-4B National Airborne Operations Center (Air Force)	3
E-8C Joint Surveillance Target Attack Radar System (Air Force)	1
EA-18G Growler (Navy)	2
F/A-18A-D Hornet (Navy)	1
F/A-18E/F Super Hornet (Navy)	0
F-35C Lightning II Joint Strike Fighter (Joint/Navy)	2
AV-8B Harrier II (Marine Corps)	0
F/A-18A-D Hornet (Marine Corps)	0
F-35B Lightning II Joint Strike Fighter (Joint/Marine Corps)	1
A-10 Thunderbolt II (Air Force)	1
F-15C/D Eagle (Air Force)	0
F-15E Strike Eagle (Air Force)	4
F-16 Fighting Falcon (Air Force)	0
F-22 Raptor (Air Force)	0
F-35A Lightning II Joint Strike Fighter (Joint/Air Force)	2

Aircraft	Number of fiscal years
AH-64D/E Apache (Army)	0
CH-47D-F Chinook (Army)	0
HH/UH-60 Black Hawk (Army)	0
MH-60R Seahawk (Navy)	2
MH-60S Seahawk (Navy)	0
AH-1Z Viper (Marine Corps)	0
CH-53E Super Stallion (Marine Corps)	0
MV-22B Osprey (Marine Corps)	0
UH-1Y Venom (Marine Corps)	0
CV-22 Osprey (Air Force)	0
HH-60G Pave Hawk (Air Force)	1
UH-1N Huey (Air Force)	9

[a]DOD did not provide mission capable goals for all nine years for these aircraft.

Aircraft Did Not Meet the Secretary of Defense's 80 Percent Mission Capable Goal

As previously discussed, in September 2018 the Secretary of Defense issued a memorandum emphasizing that a key component of implementing the 2018 National Defense Strategy is ensuring the mission capability of critical aviation platforms.[20] In addition to the mission capable goals established by the military departments for each aircraft, the memorandum established an 80 percent mission capable goal for the F-22 Raptor (Air Force), F-16 Fighting Falcon (Air Force), F-35 Lighting II Joint Strike Fighter (Joint Program), and F/A-18 inventories (Navy)—including the F/A-18A-D Hornet, F/A-18E/F Super Hornet, and EA-18G Growler—by the end of fiscal year 2019.[21] We reported in December

[20]Secretary of Defense Memorandum, *NDS Implementation—Mission Capability of Critical Aviation Platforms* (Sept. 17, 2018).

[21]Implementing guidance for this goal specifies that it applies only to F-35 aircraft acquired in low-rate initial production lot 6 or later. Low-rate initial production establishes the initial production base for the system or capability increment, provides an efficient ramp-up to full-rate production, and maintains continuity in production pending operational test and evaluation completion. The mission capable rate of these aircraft is slightly higher than the mission capable rate of the entire F-35 fleet. See Office of the Under Secretary of Defense, Personnel and Readiness, Memorandum, *NDS Implementation—Mission Capability of Critical Aviation Platform Metrics* (Nov. 27, 2018).

2018 that program officials within DOD and the Navy told us this goal would be challenging to achieve by the end of fiscal year 2019.[22]

We found that none of these aircraft had achieved the 80 percent mission capable goal, when mission capable rate data are averaged for each day in fiscal year 2019. Secretary of Defense Mark Esper, in responding to advance policy questions for his July 2019 Senate Armed Services Committee nomination hearing, stated that the F-35 Lighting II Joint Strike Fighter fleet (i.e., the F-35A [Air Force], F-35B [Marine Corps], and F-35C [Navy]) was not expected to reach an 80 percent mission capable rate by the end of fiscal year 2019. Additionally, Secretary Esper noted that the F-22 Raptor (Air Force) fleet was not expected to achieve the 80 percent goal due to challenges associated with low-observable maintenance capacity that were exacerbated by the extreme damage at Tyndall Air Force Base from the effects of Hurricane Michael. In February 2020, F-16 Fighting Falcon (Air Force) program office officials also acknowledged that, despite some improvement, the F-16 had not achieved the Secretary's 80 percent goal.

The Navy publicly reported in late September 2019 that it had met the Secretary's 80 percent mission capable goal for the F/A-18E/F Super Hornet and EA-18G Growler. Our analysis showed that mission capable rates generally did improve for these Navy systems over the course of fiscal year 2019, including meeting the 80 percent mission capable rate at particular points of time in fiscal year 2019. However, we found that none of these aircraft achieved the mission capable goal when mission capable rate data were averaged for each day in fiscal year 2019. Navy officials noted that the Navy continues to work at sustaining the progress made during fiscal year 2019. The details of our analysis of these rates were omitted because the information was deemed by DOD to be sensitive.

Air Force Chief of Staff General Charles Q. Brown, Jr., in responding to advance policy questions from the Senate Armed Services Committee for his nomination hearing in May 2020, stated that the Office of the Secretary of Defense had determined that the fiscal year 2019 80 percent mission capable goal is not a fiscal year 2020 requirement. An Office of the Secretary of Defense official stated that the department had decided

[22]GAO, *Navy and Marine Corps: Rebuilding Ship, Submarine, and Aviation Readiness Will Require Time and Sustained Management Attention,* GAO-19-225T (Washington, D.C.: Dec.12, 2018).

to move away from a goal that narrowly focused on selected aircraft and had expanded to a more holistic view of readiness.

The Navy Uses Two Approaches to Measure Mission Capable Rates, Resulting in Different Outcomes

During the process of conducting our analysis, we determined that the Navy has two information technology systems that track mission capable rates. These systems use separate approaches, resulting in different outcomes. According to Navy officials, the Navy uses mission capable rate data from its Aviation Maintenance Supply Readiness Reporting (AMSRR) information technology system to evaluate its progress against the Secretary's 80 percent mission capable goal.[23] These officials further stated that the AMSRR data they are using to track progress against the Secretary's 80 percent mission capable goal allows for a better assessment of the Navy's ability to "fight tonight" as it measures mission capability at a point in time on each day.

The Navy also maintains mission capable rate data as well as other sustainment data in its Decision Knowledge Programming for Logistics Analysis and Technical Evaluation (DECKPLATE) information technology system. Navy officials acknowledge that DECKPLATE data provide a more comprehensive measure of the health of aircraft, systems, and components as they measure mission capability based on a percentage of the total time the aircraft is available. As a result, in this report we used sustainment data from DECKPLATE in our Sustainment Quick Looks for the Navy and Marine Corps aircraft, as well as in any summary information on mission capable rates that are not related to the Secretary's 80 percent goal.

The Navy's AMSRR mission capable rates for fiscal year 2019 are higher for the 19 Navy and Marine Corps aircraft than the DECKPLATE mission capable rates for those aircraft for the same fiscal year. While three aircraft—EP-3E Aries II, E-6B Mercury, and F/A-18A-D Hornet—met the service's goals using AMSRR mission capable rate data, one aircraft met the service's mission capable goal for fiscal year 2019 using the

[23]Secretary of Defense Memorandum, *NDS Implementation—Mission Capability of Critical Aviation Platforms* (Sept. 17, 2018).

DECKPLATE mission capable rates.[24] As there are trade-offs to the different approaches, we did not evaluate the efficacy of the Navy's tracking and reporting of mission capable rates and are not making any related recommendations.

Mission Capable Rates Generally Trended Downward from Fiscal Year 2011 through Fiscal Year 2019 for the Selected Aircraft

Average mission capable rates for the selected Air Force, Navy, and Marine Corps aircraft have fallen since fiscal year 2011, while average mission capable rates for the selected Army aircraft have slightly risen. While the average mission capable rate for the F-35 Lightning II Joint Strike Fighter showed an increase from fiscal year 2012 through fiscal year 2019, it trended downward from fiscal year 2015 through fiscal year 2018, before improving slightly in fiscal year 2019. Specific details of these rates were omitted because the information was deemed by DOD to be sensitive.

Wide Variety of Sustainment Challenges for the Selected DOD Aircraft

Program officials provided various reasons for the overall decline in mission capable rates, including aging aircraft, maintenance challenges, and supply support issues. These challenges are summarized and presented in figure 2 below.

[24]In appendix II we present AMSRR mission capable rates for each of the aircraft against the Navy's or Marine Corps' goals and a comparison of the AMSRR and DECKPLATE mission capable rate data for each aircraft. We also provide additional technical details on the differences between the AMSRR and DECKPLATE systems and implications for reported mission capable rates.

Figure 2: Sustainment Challenges Affecting Selected Department of Defense Aircraft

	Aging aircraft			Maintenance				Supply support		
	Delays in acquiring replacement aircraft	Service life extension[a]	Unexpected replacement of parts and repairs	Access to technical data	Delays in depot maintenance	Shortage of trained maintenance personnel	Unscheduled maintenance	Diminishing manufacturing source[ab]	Parts obsolescence[ac]	Parts shortage and delay
Air refueling										
KC-130T Hercules (Navy/Marine Corps)		●	●		●				●	●
KC-130J Super Hercules (Marine Corps)		●	●	●	●					●
KC-10 Extender (Air Force)							●			●
KC-135 Stratotanker (Air Force)			●				●		●	
Anti-submarine										
EP-3E Aries II (Navy)						●		●		●
P-8A Poseidon (Navy)				●						●
Bomber										
B-1B Lancer (Air Force)		●					●			●
B-2 Spirit (Air Force)									●	●
B-52 Stratofortress (Air Force)		●	●				●	●	●	●
Cargo										
C-2A Greyhound (Navy)		●	●		●	●	●	●	●	
C-130T Hercules (Navy)		●	●		●				●	
C-5M Super Galaxy (Air Force)			●				●			●
C-17 Globemaster III (Air Force)							●	●		
C-130H Hercules (Air Force)			●				●	●	●	●
C-130J Super Hercules (Air Force)			●				●	●	●	●
Command and control										
E-2C Hawkeye (Navy)			●		●	●	●	●	●	●
E-2D Advanced Hawkeye (Navy)					●	●	●	●	●	
E-6B Mercury (Take Charge and Move Out) (Navy)		●	●			●		●	●	
E-3 Sentry (Airborne Warning and Control System) (Air Force)			●					●		●
E-4B National Airborne Operations Center (Air Force)			●		●					●
E-8C Joint Surveillance Target Attack Radar System (Air Force)			●		●		●			
Fighter										
EA-18G Growler (Navy)					●	●		●	●	●
F/A-18A-D Hornet (Navy/Marine Corps)	●	●	●		●	●	●	●	●	
F/A-18E/F Super Hornet (Navy)		●	●		●	●		●	●	●
F-35ABC Lightning II Joint Strike Fighter (Air Force/Marine Corps/Navy)					●		●			●
AV-8B Harrier II (Marine Corps)	●		●		●	●		●	●	
A-10 Thunderbolt II (Air Force)			●					●		●
F-15C/D Eagle (Air Force)			●				●	●		●
F-15E Strike Eagle (Air Force)			●		●			●		●
F-16 Fighting Falcon (Air Force)		●	●		●		●	●		●
F-22 Raptor (Air Force)			●				●	●		●
Rotary										
AH-64 Apache (Army)					●					●
CH-47 Chinook (Army)			●		●		●	●	●	●
UH/HH-60 Black Hawk (Army)										●
MH-60R Seahawk (Navy)				●		●	●			●
MH-60S Seahawk (Navy)				●		●	●			●
AH-1Z Viper (Marine Corps)							●			●
CH-53E Super Stallion (Marine Corps)		●	●	●	●	●		●	●	●
MV-22B Osprey (Marine Corps)			●	●		●				●
UH-1Y Venom (Marine Corps)						●	●			●
CV-22 Osprey (Air Force)				●	●			●		●
HH-60G Pave Hawk (Air Force)			●		●		●	●	●	●
UH-1N Huey (Air Force)			●				●			●

Source: GAO analysis of Army, Navy, and Air Force information. | GAO-21-101SP

[a]A service life extension refers to a modification to extend the service life of an aircraft beyond what was planned.

[b]Diminishing manufacturing sources refers to a loss or impending loss of manufacturers or suppliers of items.

[c]Obsolescence refers to a lack of availability of a part due to its lack of usefulness or its no longer being current or available for production.

O&S Costs and the Trends in Those Costs Varied across the Selected Aircraft

While mission capable rates have primarily declined since fiscal year 2011, O&S costs and the trends in these costs have varied across aircraft, for a variety of reasons. In fiscal year 2018, O&S costs for the aircraft in our review that provided us with O&S cost data totaled $49.33 billion.[25] Specifically, the total fiscal year 2018 O&S costs for the aircraft we reviewed ranged from a low of $118.03 million for the Navy's fleet of KC-130T Hercules to a high of $4.24 billion for the Air Force's fleet of KC-135T Stratotankers, with a key factor being the size of the fleet. Maintenance costs for the aircraft in our review that provided us with O&S cost data totaled $21.52 billion (or 44 percent of the total O&S costs) in fiscal year 2018.[26] Maintenance costs also varied widely across the aircraft, due to the size of the aircraft fleet and the particular challenges associated with the aircraft. For example, maintenance costs ranged from $43.91 million for the Navy's fleet of KC-130T Hercules to $2.02 billion for the Air Force's fleet of C-130H Hercules in fiscal year 2018.

The trends in total O&S costs from fiscal year 2011 through fiscal year 2018 varied by aircraft, either increasing, remaining consistent, or decreasing, as detailed below:

- **Increased**: Twenty aircraft in our review experienced increasing total O&S costs, including the MH-60R Seahawk (Navy), the E-2D Advanced Hawkeye (Navy), and the F/A18-E/F (Navy). For example, both the MH-60R Seahawk and the E-2D Advanced Hawkeye experienced increasing O&S costs, largely due to an increase in fleet

[25]The total O&S costs do not include the Army aircraft—AH-64 Apache, CH-47 Chinook, and HH/UH-60 Black Hawk. We obtained fiscal year 2018 O&S cost data from the Army, but we learned from the Army that the data were inaccurate. In fiscal year 2017, O&S costs for these three aircraft totaled about $2.79 billion.

[26]These total fiscal year 2018 maintenance costs do not include the Army aircraft, as previously discussed. In fiscal year 2017, maintenance costs for the three Army aircraft totaled about $1.03 billion.

size, according to program officials. Specifically, total costs for the MH-60R Seahawk fleet increased from about $398.50 million in fiscal year 2011 to $1.19 billion in fiscal year 2018, while total O&S costs for the E-2D fleet increased from $1.54 million in fiscal year 2012 (the first year during which the aircraft incurred significant O&S costs) to $228.75 million in fiscal year 2018.The total O&S costs for the F/A-18E/F Super Hornet (Navy) increased by $1.13 billion—from $2.16 billion to $3.29 billion—from continuing systems improvements, the results of sustained high flight hours, and to address extensive maintenance needs associated with extending the service life of the aircraft, among other reasons, according to program officials.

- **Consistent**: Three aircraft—the F-22 Raptor (Air Force), the UH-1N Huey (Air Force), and the B-2 Spirit (Air Force)—had generally consistent O&S costs from fiscal year 2011 through fiscal year 2018, with O&S costs in fiscal year 2018 that were within 5 percent or less of the O&S costs in fiscal year 2011.[27] For example, O&S costs for the B-2 fleet increased from $859.31 million in fiscal year 2011 to $885.49 million in fiscal year 2018, an increase of 3 percent.
- **Decreased**: Twenty-two aircraft had decreasing fleet-wide O&S costs, including the E-2C Hawkeye (Navy), A-10 Thunderbolt II (Air Force), AV-8B Harrier II (Marine Corps), KC-10 Extender (Air Force), and C-17 Globemaster III (Air Force). There were various reasons for these decreases. For example, the Air Force decreased the flight hours of the C-17 Globemaster III, resulting in lower O&S costs for the fleet, according to program officials. An AV-8B program office official stated that the fleet-wide O&S costs decreased because of the transition to the F-35B Lightning II Joint Strike Fighter, as well as less utilization of the AV-8B after Operation Iraqi Freedom and Operation Enduring Freedom, among other reasons. Further, as the Air Force transitions from the C-130H Hercules to the C-130J Super Hercules, O&S costs on the C-130H Hercules have decreased, mainly due to a reduced fleet size as a result of aircraft retirements, according to program officials.

The trends in maintenance costs also varied by aircraft, either increasing, remaining consistent, or decreasing, as detailed below:

- **Increased**: Twenty-five aircraft in our review experienced increasing maintenance costs since fiscal year 2011, including the MV-22B Osprey (Marine Corps), the E-8C Joint Surveillance Target Attack

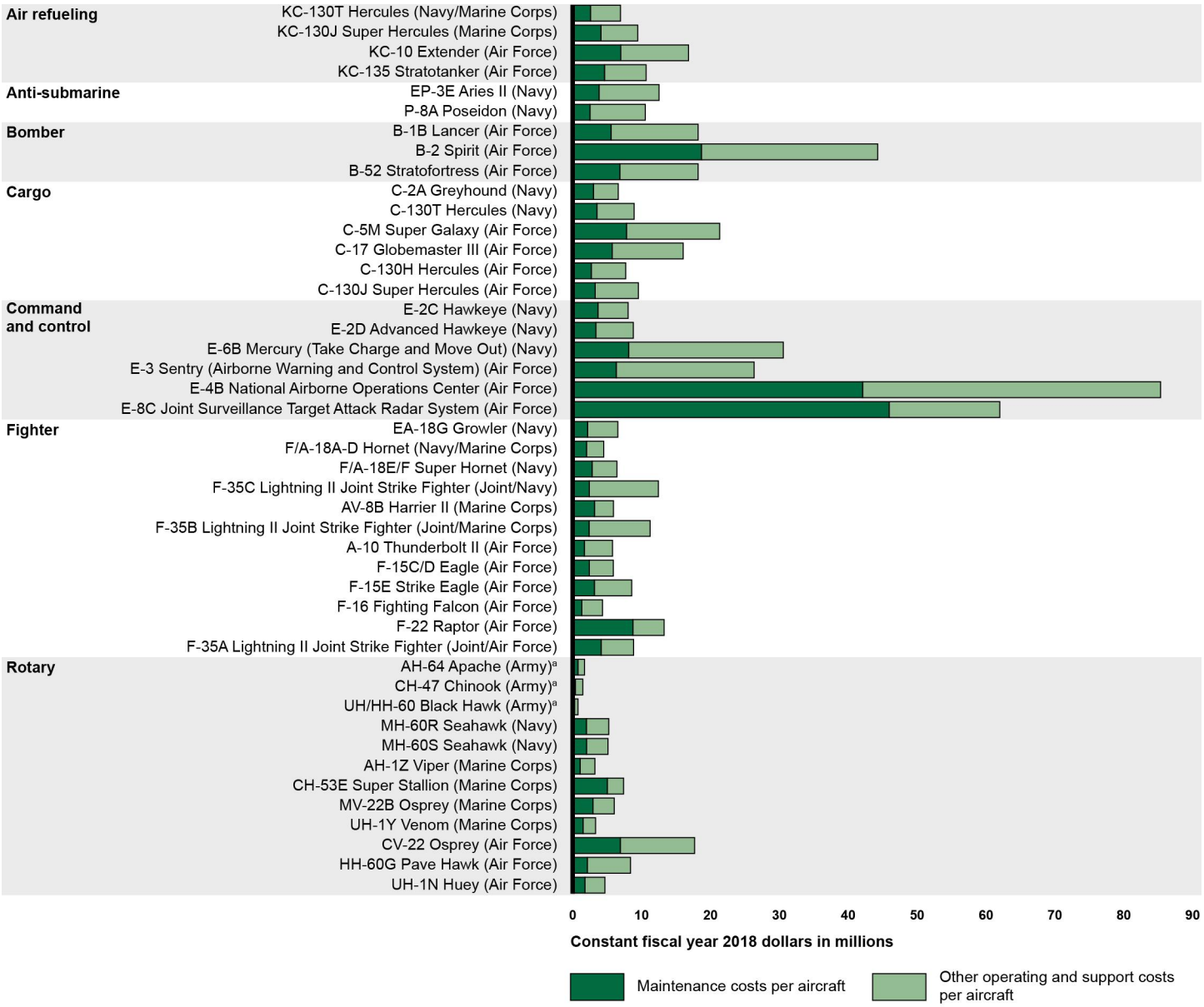
[27]For this report, we are defining “consistent” as being within 5 percent or less of the original costs.

Radar System (Air Force), and the F-22 Raptor (Air Force). For example, maintenance costs on the MV-22B Osprey (Marine Corps) increased from $412.1 million in fiscal year 2011 to $835.6 million in fiscal year 2018, largely due to the increase in the number of aircraft. In addition, maintenance costs for the E-8C Joint Surveillance Target Attack Radar System (Air Force) increased from $274.94 million in fiscal year 2011 to $734.96 million in fiscal year 2018, due to increases in the cost of depot maintenance as a result of the age of the aircraft and the current depot maintenance plan, among other reasons, according to officials. Maintenance costs for the F-22 Raptor (Air Force) also increased, primarily due to increased contractor support costs and repairs to the low-observable coating, from $1.04 billion in fiscal year 2011 to $1.59 billion in fiscal year 2018.

- **Consistent**: Four aircraft that we reviewed had consistent maintenance costs, with maintenance costs in fiscal year 2018 that were within 5 percent or less of the maintenance costs in fiscal year 2011. For example, the maintenance costs for the EP-3E Aries II were $44.51 million in fiscal year 2011 and $45.87 million in fiscal year 2018.
- **Decreased**: Sixteen aircraft in our review experienced decreases in maintenance costs. For example, the A-10 Thunderbolt II (Air Force) maintenance costs decreased from $604.45 million in fiscal year 2011 to $478.52 million in fiscal year 2018 as the number of active A-10 aircraft have decreased, as part of the Air Force's efforts to retire the A-10. In addition, the maintenance costs for the E-2C Hawkeye (Navy) decreased from $241.97 million in fiscal year 2011 to $135.91 million in fiscal year 2018 as the Navy transitions to using the E-2D Advanced Hawkeye.

We also analyzed the O&S costs on a per aircraft basis to account for differences in the fleet size of various aircraft types. We found that fiscal year 2018 per aircraft O&S costs also varied across platforms, as shown in figure 5.

Figure 3: Annual Operating and Support Costs per Aircraft for Selected Department of Defense Aircraft, Fiscal Year 2018



Source: GAO analysis of Army, Navy, and Air Force data. | GAO-21-101SP

Data table for Figure 3: Annual Operating and Support Costs per Aircraft for Selected Department of Defense Aircraft, Fiscal Year 2018

Aircraft	Maintenance costs per aircraft	Other operating and support costs
KC-130T Hercules (Navy/Marine Corps)	2.58	4.36
KC-130J Super Hercules (Marine Corps)	4.09	5.35
KC-10 Extender (Air Force)	6.99	9.82
KC-135 Stratotanker (Air Force)	4.61	6.04
EP-3E Aries II (Navy)	3.82	8.71
P-8A Poseidon (Navy)	2.51	8.04
B-1B Lancer (Air Force)	5.56	12.64
B-2 Spirit (Air Force)	18.69	25.58
B-52 Stratofortress (Air Force)	6.84	11.37
C-2A Greyhound (Navy)	3.01	3.6
C-130T Hercules (Navy)	3.51	5.41
C-5M Super Galaxy (Air Force)	7.81	13.53
C-17 Globemaster III (Air Force)	5.75	10.29
C-130H Hercules (Air Force)	2.71	4.98
C-130J Super Hercules (Air Force)	3.26	6.27
E-2C Hawkeye (Navy)	3.67	4.37
E-2D Advanced Hawkeye (Navy)	3.36	5.44
E-6B Mercury (Take Charge and Move Out) (Navy)	8.12	22.46
E-3 Sentry (Airborne Warning and Control System) (Air Force)	6.32	20.01
E-4B National Airborne Operations Center (Air Force)	42.09	43.25
E-8C Joint Surveillance Target Attack Radar System (Air Force)	45.94	16.06
EA-18G Growler (Navy)	2.17	4.38
F/A-18A-D Hornet (Navy)	2	2.5
F/A-18E/F Super Hornet (Navy)	2.82	3.59
F-35C Lightning II Joint Strike Fighter (Joint/Navy)	2.41	10.02
AV-8B Harrier II (Marine Corps)	3.16	2.75
F/A-18A-D Hornet (Marine Corps)	2.37	8.86
F-35B Lightning II Joint Strike Fighter (Joint/Marine Corps)	1.7	4.08
A-10 Thunderbolt II (Air Force)	2.41	3.49
F-15C/D Eagle (Air Force)	3.15	5.41
F-15E Strike Eagle (Air Force)	1.32	3.01
F-16 Fighting Falcon (Air Force)	8.75	4.52
F-22 Raptor (Air Force)	4.13	4.71

Aircraft	Maintenance costs per aircraft	Other operating and support costs
F-35A Lightning II Joint Strike Fighter (Joint/Air Force)	0.77	0.94
AH-64D/E Apache (Army)	0.4	1.07
CH-47D-F Chinook (Army)	0.27	0.49
HH/UH-60 Black Hawk (Army)	1.99	3.25
MH-60R Seahawk (Navy)	2	3.12
MH-60S Seahawk (Navy)	1.07	2.15
AH-1Z Viper (Marine Corps)	5.03	2.36
CH-53E Super Stallion (Marine Corps)	2.94	3.1
MV-22B Osprey (Marine Corps)	1.51	1.81
UH-1Y Venom (Marine Corps)	6.93	10.77
CV-22 Osprey (Air Force)	2.12	6.27
HH-60G Pave Hawk (Air Force)	1.77	2.9
UH-1N Huey (Air Force)	2.58	4.36

[a]We obtained fiscal year 2018 operating and support (O&S) cost data from the Army, but we learned from the Army that the data were inaccurate. Thus, the costs presented here for the Army aircraft are based on fiscal year 2017 O&S data.

Sustainment Quick Looks for Selected DOD Aircraft

This section contains 43 Sustainment Quick Looks that provide information on 46 types of DOD aircraft. Some of the Quick Looks cover multiple aircraft that are similar but have separate goals and are reported separately by DOD and the military services. These Quick Looks are broken out into the following mission areas of aircraft: air refueling, anti-submarine, bomber, cargo, command and control, fighter, and rotary.

Each Sustainment Quick Look presents information and data on the life cycle, sustainment strategy, availability and condition, O&S costs, and sustainment challenges for the aircraft. To develop these Quick Looks, we collected information and data on each aircraft from the program offices and the military departments, obtained and reviewed agency documents, and interviewed program and military department officials. See the next page for an illustration of the layout of each Sustainment Quick Look.

See Quicklook attachment for pages 25 through 247.

Agency Comments

We provided a draft of the sensitive report to DOD for review and comment. DOD provided technical comments which we incorporated where appropriate.

We are sending copes of this report to the appropriate congressional committees, the Secretary of Defense, the Under Secretary of Defense for Acquisition and Sustainment, the Assistant Secretary of Defense for Sustainment, and the Secretaries of the Army, the Navy, and the Air Force. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-9627 or maurerd@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Diana Maurer
Director, Defense Capabilities and Management

List of Requesters

The Honorable James M. Inhofe
Chairman
Committee on Armed Services
United States Senate

The Honorable Dan Sullivan
Chairman
The Honorable Tim Kaine
Ranking Member
Subcommittee on Readiness and Management Support
Committee on Armed Services
United States Senate

The Honorable John Garamendi
Chairman
The Honorable Doug Lamborn
Ranking Member
Subcommittee on Readiness
Committee on Armed Services
House of Representatives

Appendix I: Objectives, Scope, and Methodology

This report provides observations on (1) the extent to which the military departments met mission capable goals for 46 fixed- and rotary-wing types of aircraft, including trends since fiscal year 2011 in mission capable rates and any sustainment challenges for those aircraft; and (2) the costs to operate and support these aircraft since fiscal year 2011.

This is a public version of a sensitive report that we issued in August 2020.[1] DOD deemed some of the information in our August report to be sensitive (i.e., For Official Use Only), which must be protected from public disclosure. Therefore, this report omits sensitive information about mission capable and aircraft availability rates. Although the information provided in this report is more limited, the report addresses the same objectives as the sensitive report and uses the same methodology.

Our observations are based on 46 manned fixed- and rotary-wing types of aircraft that support combat-related missions in the Departments of the Army, Navy, and Air Force.[2] In selecting these aircraft, we considered a number of factors, such as the mission of the aircraft (e.g., fighters, bombers, or cargo) and the size and age of the inventory for each aircraft. For example, we did not select aircraft that are used solely for training or are used to meet the operational airlift support mission (i.e., the movement of a limited number of high-priority passengers and cargo with time, place, or mission-sensitive requirements).[3]

Figure 4 below lists the aircraft reviewed, by type and military department.

[1]GAO, *Weapon System Sustainment: Aircraft Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely*, GAO-20-67SPSU (Washington, D.C.: August 27, 2020).

[2]Aircraft flown by the Marine Corps are included in the data on the Department of the Navy.

[3]We reported on operational support airlift in June 2017. See GAO, *Operational Support Airlift: Fleet Sufficiency Is Assessed Annually*, GAO-17-582 (Washington, D.C.: June 28, 2017).

Figure 4: Aircraft Selected for Review by GAO

Air refueling		
KC-130T	Hercules	Navy/Marine Corps
KC-130J	Super Hercules	Marine Corps
KC-10	Extender	Air Force
KC-135	Stratotanker	Air Force
Anti-submarine		
EP-3E	Aries II	Navy
P-8A	Poseidon	Navy
Bomber		
B-1B	Lancer	Air Force
B-2	Spirit	Air Force
B-52	Stratofortress	Air Force
Cargo		
C-2A	Greyhound	Navy
C-130T	Hercules	Navy
C-5M	Super Galaxy	Air Force
C-17	Globemaster III	Air Force
C-130H	Hercules	Air Force
C-130J	Super Hercules	Air Force
Command and control		
E-2C	Hawkeye	Navy
E-2D	Advanced Hawkeye	Navy
E-6B	Mercury (Take Charge and Move Out)	Navy
E-3	Sentry (Airborne Warning and Control System)	Air Force
E-4B	National Airborne Operations Center	Air Force
E-8C	Joint Surveillance Target Attack Radar System	Air Force
Fighter		
EA-18G	Growler	Navy
F/A-18A-D	Hornet	Navy/Marine Corps
F/A-18E/F	Super Hornet	Navy
F-35ABC	Lightning II Joint Strike Fighter	Air Force/Marine Corps/Navy
AV-8B	Harrier II	Marine Corps
A-10	Thunderbolt II	Air Force
F-15C/D	Eagle	Air Force
F-15E	Strike Eagle	Air Force
F-16	Fighting Falcon	Air Force
F-22	Raptor	Air Force
Rotary		
AH-64	Apache	Army
CH-47	Chinook	Army
UH/HH-60	Black Hawk	Army
MH-60R	Seahawk	Navy
MH-60S	Seahawk	Navy
AH-1Z	Viper	Marine Corps
CH-53E	Super Stallion	Marine Corps
MV-22B	Osprey	Marine Corps
UH-1Y	Venom	Marine Corps
CV-22	Osprey	Air Force
HH-60G	Pave Hawk	Air Force
UH-1N	Huey	Air Force

Source: GAO. | GAO-21-101SP

Data table for Figure 4: Aircraft Selected for Review by GAO

Air Refueling

Designation	Name	Service
KC-130T	Hercules	Navy/Marine Corps
KC-130J	Super Hercules	Marine Corps
KC-10	Extender	Air Force
KC-135	Stratotanker	Air Force

Anti-submarine

Designation	Name	Service
EP-3E	Aries II	Navy
P-8A	Poseidon	Navy
Bomber		
B-1B	Lancer	Air Force
B-2	Spirit	Air Force
B-52	Stratofortress	Air Force

Cargo

Designation	Name	Service
C-2A	Greyhound	Navy
C-130T	Hercules	Navy
C-5M	Super Galaxy	Air Force
C-17	Globemaster III	Air Force
C-130H	Hercules	Air Force
C-130J	Super Hercules	Air Force

Command and control

Designation	Name	Service
E-2C	Hawkeye	Navy
E-2D	Advanced Hawkeye	Navy
E-6B	Mercury (Take Charge and Move Out)	Navy
E-3	Sentry (Airborne Warning and Control System)	Air Force
E-4B	National Airborne Operations Center	Air Force
E-8C	Joint Surveillance Target Attack Radar System	Air Force

Fighter

Designation	Name	Service
EA-18G	Growler	Navy
F/A-18A-D	Hornet	Navy/Marine Corps
F/A-18E/F	Super Hornet	Navy
F-35ABC	Lightning II Joint Strike Fighter	Air Force/Marine Corps/Navy
AV-8B	Harrier II	Marine Corps
A-10	Thunderbolt II	Air Force
F-15C/D	Eagle	Air Force
F-15E	Strike Eagle	Air Force
F-16	Fighting Falcon	Air Force
F-22	Raptor	Air Force

Rotary

Designation	Name	Service
AH-64	Apache	Army
CH-47	Chinook	Army
UH/HH-60	Black Hawk	Army
MH-60R	Seahawk	Navy
MH-60S	Seahawk	Navy
AH-1Z	Viper	Marine Corps
CH-53E	Super Stallion	Marine Corps
MV-22B	Osprey	Marine Corps
UH-1Y	Venom	Marine Corps
CV-22	Osprey	Air Force
HH-60G	Pave Hawk	Air Force
UH-1N	Huey	Air Force

For objective one, we collected and analyzed data from the Army, Navy, and Air Force as well as the F-35 Joint Program Office on key sustainment metrics for each of the 46 aircraft.[4] These metrics included mission capable rates and goals and not mission capable rates for maintenance, supply, and both for fiscal years 2011 through 2019, the last fiscal year for which complete data were available at the time of our work. For Air Force aircraft and the F-35, we also collected and analyzed data on aircraft availability rates and goals for fiscal years 2011 through 2019.[5] We selected this time frame so that we could identify and obtain insight on mission capable rate trends. In addition, we obtained information from program office officials regarding the reasons for changes in mission capable rates and aircraft availability rates as well as any challenges in sustaining these aircraft. We also discussed with

[4]Mission capability data were pulled from the Logistics Information Warehouse Readiness Integrated Data Base for the Army; the Decision Knowledge Programming for Logistics and Technical Evaluation (DECKPLATE) and the Aviation Maintenance Supply Readiness Reporting (AMSRR) information systems for the Navy; Logistics, the Installations and Mission Support – Enterprise View system for the Air Force; and the Sustainment Performance Management System via the Autonomic Logistics Information System for the F-35.

[5]The Air Force refers to the aircraft availability goals as the aircraft availability standard.

program office officials any ongoing and planned actions to address those challenges. We reviewed those challenges and summarized them in three broad categories: aging aircraft, maintenance, and supply support. We further summarized these challenges with several sub-categories and presented these challenges in a summary figure. Further, we obtained and reviewed documents, including life-cycle sustainment plans and aircraft availability improvement plans.

For objective two, we collected and analyzed operating and support (O&S) cost data from the Departments of the Army, Navy, and Air Force cost reporting systems.[6] Specifically, we collected O&S cost data for fiscal years 2011 through 2018, the last fiscal year for which complete data were available at the time of our work.[7] We selected this time frame so that we could identify and obtain insight on the historical data trends regarding O&S costs.[8] We also obtained information from program office officials about the reasons for changes and trends in O&S costs.

We conducted data reliability assessments for the data provided by the military departments and the F-35 Joint Program Office. To do this, we reviewed related documentation; held interviews with knowledgeable agency officials; and performed electronic data testing for missing data, outliers, and obvious errors. Additionally, we shared the mission capable rate and O&S cost data with the program offices that manage each individual type of aircraft for review and comment, to ensure the accuracy of the data presented. Lastly, the Army, Navy, and Air Force, as well as the F-35 Joint Program Office, use these data to manage the sustainment of aircraft. As a result, we determined these data to be sufficiently reliable for the purposes of summarizing trends in mission capable rates and O&S costs since fiscal year 2011.[9]

[6]Specifically, we obtained information from the Army's Operating and Support Management Information System (OSMIS), the Navy Visibility and Management of Operating and Support Costs system (VAMOSC), and the Air Force Total Ownership Cost system (AFTOC).

[7]We report on Army O&S trends through fiscal year 2017. We obtained fiscal year 2018 O&S cost data from the Army, but we learned from the Army that the data were inaccurate. Thus, the costs presented for the Army are based on fiscal year 2017 O&S data.

[8]O&S costs are adjusted for inflation and presented in fiscal year 2018 constant dollars.

[9]As previously noted, we did not report fiscal year 2018 O&S cost data from the Army because we learned from the Army that the data provided to us were inaccurate.

To develop the Sustainment Quick Looks on each aircraft, we obtained historical and current information, including background on aircraft capabilities, manufacturers, sustainment strategies, depot maintenance and squadron locations, and key dates in the life cycle of each aircraft (e.g., first manufactured, initial and full operational capability, last production, and planned sunset year). We used this information, as well as the information collected for objectives one and two on readiness and O&S costs, in each Sustainment Quick Look. In the Quick Looks, we compared mission capable and aircraft availability rates to goals set by the military departments. We analyzed O&S costs, including maintenance sub-categories, and compared the costs to readiness trends. We also obtained and reviewed sustainment documentation on each aircraft, such as life-cycle sustainment plans and aircraft availability plans, and we discussed sustainment plans and activities with knowledgeable program officials. Through interviews with knowledgeable officials and reviewing documentation, we identified sustainment challenges and mitigation actions to address these challenges.

We conducted this performance audit from August 2018 to July 2020 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 August 2020 to November 2020 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 II: Additional Information on Navy Aircraft Mission Capable Rates

The Navy uses mission capable rate data from its Aviation Maintenance Supply Readiness Reporting (AMSRR) information technology system to evaluate its progress against the Secretary of Defense's 80 percent mission capable rate goal as it measures mission capability at a point in time on each day.[1] The Navy also maintains mission capable rate data as well as other sustainment data in its Decision Knowledge Programming for Logistics Analysis and Technical Evaluation (DECKPLATE) information technology system, which Navy officials acknowledge provides a more comprehensive measure of the health of aircraft, systems, and components. DECKPLATE measures mission capability based on a percentage of the total time the aircraft is available and provides additional insight into the reasons for an aircraft not being mission capable, such as not mission capable maintenance and supply rates.

For each of the 19 Navy and Marine Corps aircraft, AMSRR mission capable rates are higher than DECKPLATE mission capable rates. Additionally, while only one aircraft met the mission capable goal during fiscal year 2019 using DECKPLATE mission capable rates, three aircraft—EP-3E Aries II, E-6B Mercury, and F/A-18A-D Hornet—met the goals using AMSRR mission capable rate data.

Comparing AMSRR mission capable rates from fiscal year 2018 to fiscal year 2019 for the selected aircraft shows that twelve of the 19 aircraft showed an improvement, one aircraft was constant, and six showed a decline in mission capable rates.

[1]Secretary of Defense Memorandum, *NDS Implementation—Mission Capability of Critical Aviation Platforms* (Sept. 17, 2018).

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Diana Maurer, (202) 512-9627 or maurerd@gao.gov.

Staff Acknowledgments

In addition to the contact named above, John Bumgarner (Assistant Director), Clarine Allen, Leslie Bharadwaja, Vincent Buquicchio, Amy Bush, Christopher Gezon, Chad Hinsch, James Lackey, Amie Lesser, Edward Malone, Jacqueline McColl, Richard Powelson, Janine Prybyla, Cheryl Weissman, Melissa Wohlgemuth, and Lillian Yob made key contributions to this report.

GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through our website. Each weekday afternoon, GAO posts on its website newly released reports, testimony, and correspondence. You can also subscribe to GAO's email updates to receive notification of newly posted products.

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, https://www.gao.gov/ordering.htm.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

Connect with GAO

Connect with GAO on Facebook, Flickr, Twitter, and YouTube.
Subscribe to our RSS Feeds or Email Updates. Listen to our Podcasts.
Visit GAO on the web at https://www.gao.gov.

To Report Fraud, Waste, and Abuse in Federal Programs

Contact FraudNet:

Website: https://www.gao.gov/fraudnet/fraudnet.htm

Automated answering system: (800) 424-5454 or (202) 512-7700

Congressional Relations

Orice Williams Brown, Managing Director, WilliamsO@gao.gov, (202) 512-4400,
U.S. Government Accountability Office, 441 G Street NW, Room 7125,
Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548

Strategic Planning and External Liaison

Stephen J. Sanford, Acting Managing Director, spel@gao.gov, (202) 512-4707
U.S. Government Accountability Office, 441 G Street NW, Room 7814,
Washington, DC 20548

Please Print on Recycled Paper.