



Testimony

Before the Subcommittees on
Readiness and Tactical Air and Land
Forces, Committee on Armed Services,
House of Representatives

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F-35 SUSTAINMENT

Enhanced Attention to and Oversight of F-35 Affordability Are Needed

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Accessible Version

GAO Highlights

Highlights of [GAO-21-505T](#), a testimony before the Subcommittees on Readiness and Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

Why GAO Did This Study

The F-35 aircraft with its advanced capabilities represents a growing portion of DOD's tactical aviation fleet—with the Air Force, Marine Corps, and Navy currently flying about 400 of the aircraft. It is also DOD's most ambitious and costly weapon system in history, with estimated life-of-program costs exceeding \$1.7 trillion. DOD plans to procure nearly 2,500 F-35s at an estimated total acquisition cost of just under \$400 billion. The remaining \$1.3 trillion in life cycle costs is associated with operating and sustaining the aircraft.

This statement, among other things, assesses the extent to which (1) the F-35 has met warfighter-required mission capable rates; and (2) DOD has reduced the F-35's estimated life cycle sustainment costs and made progress in meeting its affordability constraints. This statement is largely based on GAO's draft report, which was provided to DOD in March for review and comment. For that report and this statement, GAO reviewed program documentation, analyzed performance and cost data, collected data from F-35 locations, and interviewed officials.

What GAO Recommends

GAO's draft report suggested that Congress should consider (1) requiring DOD to report annually on progress in achieving the affordability constraints, and (2) making F-35 aircraft procurement decisions contingent on DOD's progress in achieving these constraints. GAO also made four recommendations to DOD, including that it assess its cost reduction efforts and F-35 program requirements, and develop a plan to ensure it can afford to sustain the future F-35 fleet.

View [GAO-21-505T](#). For more information, contact Diana Maurer at (202) 512-9627 or maurerd@gao.gov.

April 22, 2021

F-35 SUSTAINMENT

Enhanced Attention to and Oversight of F-35 Affordability Are Needed

What GAO Found

F-35 mission capable rates—a measure of the readiness of an aircraft fleet—have recently improved, but still fall short of warfighter requirements, as discussed in our draft report. Specifically, from fiscal year 2019 to fiscal year 2020, the U.S. F-35 fleet's average annual (1) mission capable rate—the percentage of time during which the aircraft can fly and perform one of its tasked missions—improved from 59 to 69 percent; and (2) full mission capable rate—the percentage of time during which the aircraft can perform all of its tasked missions—improved from 32 to 39 percent. Both metrics fall below the services' objectives. For example, in fiscal year 2020 the Air Force F-35A full mission capable rate was 54 percent, versus a 72 percent objective.

Since 2012, F-35 estimated sustainment costs over its 66-year life cycle have increased steadily, from \$1.11 trillion to \$1.27 trillion, despite efforts to reduce costs. The services face a substantial and growing gap between estimated sustainment costs and affordability constraints—i.e., costs per tail (aircraft) per year that the services project they can afford—totaling about \$6 billion in 2036 alone (see fig.). The services will collectively be confronted with tens of billions of dollars in sustainment costs that they project as unaffordable during the program.

Gap between F-35 Affordability Constraints and Estimated Sustainment Costs in 2036

Service and aircraft	2020 JPO CPTPY estimate in steady state ^a	Affordability constraint	Gap between projected cost and affordability constraint	Planned aircraft total in steady state ^a year 2036	Total cost overrun in steady state ^a year 2036
Air Force F-35A	(\$7.8)	- \$4.1)	= \$3.7	x 1,192	= \$4.4 billion
Marine Corps F-35B	(\$9.1)	- \$6.8)	= \$2.3	x 353	= \$812 million
Marine Corps F-35C	(\$7.9)	- \$6.8)	= \$1.1	x 67	= \$74 million
Navy F-35C	(\$9.9)	- \$7.5)	= \$2.4	x 273	= \$655 million
CPTPY cost per tail (aircraft) per year					Almost \$6 billion

Source: GAO analysis of Joint Program Office (JPO) data. | GAO-21-505T

Note: Costs are in constant year 2012 dollars as that was the year when the F-35 program was most recently re-baselined.

^aSteady state years for the F-35 program are defined in each respective service's affordability analysis as: US Air Force/F-35A – 2036-2041; US Marine Corps/F-35B – 2033-2037; US Navy/F-35C – 2036-2043. Steady state refers to the program's peak operating point.

The Air Force needs to reduce estimated costs per tail per year by \$3.7 million (or 47 percent) by 2036 or it will incur \$4.4 billion in costs beyond what it currently projects it could afford in that year alone. Cost reductions become increasingly difficult as the program grows and matures. However, GAO found there is no agreed upon approach to achieve the constraints. Without an assessment of cost-reduction efforts and program requirements (such as number of planned aircraft), along with a plan, the Department of Defense (DOD) may continue to invest resources in a program it ultimately cannot afford. Congress requiring DOD to report on its progress in achieving affordability constraints and making F-35 procurements contingent on DOD's demonstrated progress would enhance DOD's accountability for taking the necessary and appropriate actions to afford sustaining the F-35 fleet.

Chairmen Garamendi and Norcross, Ranking Members Lamborn and Hartzler, and Members of the Subcommittees:

Thank you for the opportunity to be here today to discuss the Department of Defense's (DOD) sustainment of the F-35 aircraft and its associated costs. As you know, the F-35 Lightning II aircraft and its advanced capabilities represent a growing portion of the tactical aviation fleet for DOD. The F-35 is also DOD's most ambitious and costly weapon system in history, with overall costs for the program estimated by DOD at more than \$1.7 trillion over its 66-year life cycle.¹ Current DOD plans call for procuring 2,456 F-35s at an estimated total acquisition cost of just under \$400 billion. This leaves the majority of estimated F-35 program costs, approximately \$1.3 trillion, associated with the sustainment of the aircraft.² For the past decade, DOD has been working to deliver a sustainment strategy that will be both affordable and able to meet the needs of the Air Force, Navy, and Marine Corps (hereinafter referred to as "the services"). This remains an ongoing challenge, as DOD continues to support a rapidly expanding F-35 fleet.

My testimony today is largely based on our draft report, which we provided to DOD last month for review and comment.³ However, it is also informed by our body of work issued from 2014 through 2020 addressing F-35 sustainment, affordability, the Autonomic Logistics Information System (ALIS), operations, and the global supply chain. This testimony (1) assesses the extent to which the F-35 has met warfighter-required mission capable rates, (2) provides an update on the status of significant sustainment-related challenges facing the F-35 program, and (3) assesses the extent to which DOD has reduced the F-35's estimated life cycle sustainment costs and made progress in meeting its affordability constraints—that is, the amount of financial resources a military service can afford in order to operate and support a system, given future force budgets and portfolio prioritizations.

¹The \$1.7 trillion reflects then-year dollars. Then-year dollars include the effects of inflation or escalation.

²Historically, the official sustainment cost estimate for the F-35 program is produced by the Office of the Secretary of Defense Cost Assessment & Program Evaluation (CAPE). This estimate was most recently updated in June 2020.

³House Report 116-120, accompanying a proposed bill for the National Defense Authorization Act for Fiscal Year 2020, included a provision for us to review DOD's sustainment efforts related to the F-35.

For our draft report, we collected and analyzed performance metrics, such as mission capable and full mission capable rates, from fiscal years 2015 through 2020 for the U.S. F-35 fleet. We surveyed 12 U.S. F-35 locations to collect sustainment-related inputs, data, and flight-line experiences, receiving responses from 11 of the 12 locations. We collected and reviewed each of DOD's three sustainment cost estimates—the Secretary of Defense Cost Assessment and Program Evaluation's (CAPE) Independent Cost Estimate, the F-35 Joint Program Office's Annual Cost Estimate, and the Joint Service Cost Position—completed in 2020. We reviewed the cost estimates to determine current sustainment-related cost projections, identify deviations from previous cost estimates, and assess any progress made toward achieving the services' affordability constraints.⁴ Finally, we conducted interviews with officials from the F-35 Joint Program Office, the services, the Office of the Under Secretary of Defense for Acquisition and Sustainment, CAPE, Lockheed Martin (the prime contractor for the F-35 aircraft system), and Pratt and Whitney (the prime contractor for the F-35 engine) to discuss sustainment-related challenges impacting the fleet as well as current and projected sustainment-related costs for the F-35.

We performed the work on which this statement is based from March 2020 through April 2021 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.

Background

The program has developed and is delivering three variants of the F-35 aircraft:

- **F-35A** – A conventional take-off and landing variant that is intended to replace Air Force F-16 fighters and A-10 attack aircraft (and possibly

⁴We did not independently evaluate or assess the cost estimates' reliability.

F-15 fighters).⁵ The Air Force plans to procure 1,763 F-35As, making that service the largest customer in the F-35 program.

- **F-35B** – A short take-off and vertical landing variant that is intended to replace Marine Corps AV-8B Harrier vertical/short take-off and landing attack aircraft and Marine Corps F/A-18A/B/C/D strike fighters, which are conventional take-off and landing aircraft. The Marine Corps plans to procure 353 F-35Bs.
- **F-35C** – A carrier-suitable variant that is intended to complement the Navy F/A-18E/F, an aircraft the Navy has been procuring since 1997. The Navy plans to procure 273 F-35Cs. Furthermore, to supplement its own aircraft fleet, the Marine Corps plans to procure 67 F-35Cs.

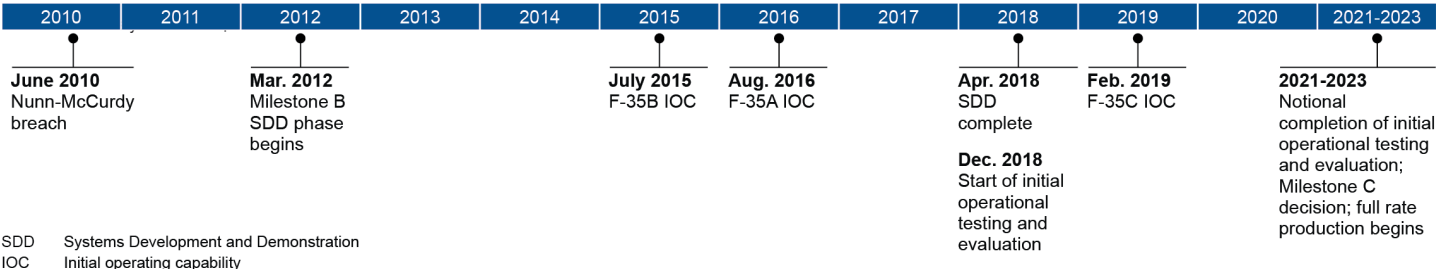
As of November 2020, more than 525 U.S. and international aircraft had been fielded and were operating from various sites worldwide. This represented an increase of more than 270 aircraft relative to August 2017, and 175 more aircraft than were fielded and operating in February 2019. By 2023 the global F-35 fleet is expected to expand, with more than 1,100 aircraft planned across 43 operational sites. In total, the program participants plan to purchase more than 3,300 F-35 aircraft, with the U.S. services planning to purchase nearly 2,500 of those aircraft.

DOD Instruction 5000.85, *Major Capability Acquisition*, states that the purpose of key milestone decisions is to carefully assess a program's readiness to proceed to the next phase of the acquisition process and make a sound investment decision committing the department's financial resources. The next such milestone for the F-35 program is Milestone C, which gives the program the approval to move into full-rate production of the aircraft. Milestone C cannot be declared until DOD has completed several efforts, including Initial Operational Test and Evaluation, which began back in December 2018. According to DOD officials, Initial Operational Test and Evaluation will likely not be completed until sometime in the late 2021-or-2022 time frame. Once all of the requisite factors have been completed and reviewed, the program can declare

⁵For information on the aircraft that the F-35 is replacing, including their ability to meet mission capable rate goals and associated operating and support (O&S) costs, see GAO, *Weapon System Sustainment: Aircraft Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely*, [GAO-21-101SP](#) (Washington, D.C.: Nov. 19, 2020). This is a public version of a more detailed August 2020 sensitive report: 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.: Aug. 27, 2020).

Milestone C and enter into full-rate production. However, as we reported in March 2021, the F-35 program has not identified an official date for a full-rate production decision.⁶ According to DOD officials, it could be late 2022 or 2023. See figure 1 for completed and planned milestones for the F-35 program.

Figure 1: F-35 Key Dates and Milestones



Source: GAO analysis of Department of Defense information. | GAO-21-505T

Figure 1: F-35 Key Dates and Milestones

- June 2010, Nun-Mccurdy breach
- March 2012, Milestone B SDD phase begins
- July 2015, F-35B IOC
- August 2016, F-35A IOC
- April 2018, SDD complete
- December 2018, Start of initial operational testing and evaluation
- Feb. 2019, F-35C IOC
- 2021-2023, Notational completion of initial operational testing and evaluation; Milestone C decision; full rate production begins

We have published a series of reports examining sustainment of the F-35. In particular, since 2014, we have reported significant challenges DOD faced in sustaining a growing F-35 fleet, such as the availability of spare parts.⁷ As a result of those challenges, F-35 performance has not met warfighter-required mission capable rates—that is, the percentage of total

⁶GAO, *F-35 Joint Strike Fighter: DOD Needs to Update Modernization Schedule and Improve Data on Software Development*, [GAO-21-226](#) (Washington, D.C.: Mar. 18, 2021).

⁷See, Related GAO Products page at the end of this statement for a full list of F-35-related reports.

time during which the aircraft can fly and perform at least one of its missions.

Furthermore, we have reported on the program's affordability challenges tied to its uniquely high and growing sustainment-related cost estimates. For example, in 2014 we reported that annual F-35 sustainment costs were estimated to be considerably higher than the combined annual costs of several legacy aircraft, and that DOD had not established sustainment affordability constraints using the services' budgets.⁸ Affordability constraints are the amount of financial resources a military service can afford to operate and support a system, like the F-35, given future force budgets and portfolio prioritizations.⁹ These constraints then provide a threshold, or cap, for sustainment that cannot be exceeded. We recommended in 2014 that DOD develop affordability constraints linked to the services' budgets. DOD concurred with the recommendation. Subsequently, in October 2018, DOD released sustainment-related affordability constraints based on service budgets and identified the need to substantially reduce the estimated sustainment costs for the program.

Sustainment for the F-35 aircraft is a large and complex undertaking. Key stakeholders include the following:

- **Office of the Undersecretary of Defense (Acquisition and Sustainment) (OUSD (A&S)):** OUSD (A&S) is the Defense Acquisition Executive and oversees the entire acquisition of the F-35, including sustainment and overall costs. OUSD (A&S) also serves as the Milestone Decision Authority for the program.
- **F-35 Joint Program Office:** The F-35 Joint Program Office manages and oversees the support functions required to field and maintain the readiness and operational capability of the F-35 aircraft across the enterprise.
- **Prime Contractor Support:** The F-35 program currently relies heavily on contractors to provide support for its F-35 aircraft. DOD has two primary contractors for the program: Lockheed Martin, for the overall air system, and Pratt & Whitney, for the engine.

⁸GAO, *F-35 Sustainment: Need for Affordable Strategy, Greater Attention to Risks, and Improved Cost Estimates*, [GAO-14-778](#) (Washington, D.C.: Sept. 23, 2014).

⁹Office of the Secretary of Defense, *Report to Congress on F-35 Joint Strike Fighter Sustainment Affordability and Transparency* (December 2018).

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- **Military Services:** The Air Force, Navy, and Marine Corps have each established an F-35 integration office or similar construct focused on how the services will operate and afford the F-35, among other things.

F-35 Mission Capable Rates Have Improved since 2019 but Still Fall Short of Program Goals

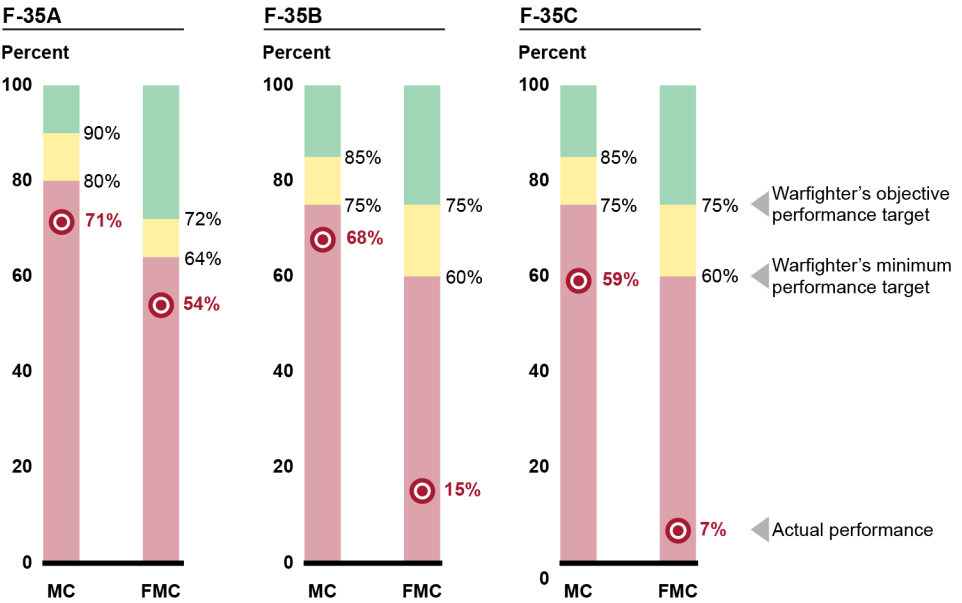
We found that the F-35 program has improved the F-35's mission capable rate—the percentage of time during which the aircraft can fly and perform at least one of its tasked missions and full mission capable rate—the percentage of time during which the aircraft can perform all of its tasked missions. Specifically, the U.S. F-35 fleet's average annual:

- mission capable rate increased by 10 percent—from 59 percent in fiscal year 2019 to 69 percent in fiscal year 2020; and
- full mission capable rate improved by 7 percent—from 32 percent in fiscal year 2019 to 39 percent in fiscal year 2020.

Although there have been improvements in both rates, both still fall below the warfighter's minimum and objective performance targets, as shown in figure 2.¹⁰

¹⁰The warfighter's minimum and objective performance targets are those requirements established by the U.S. Air Force for the F-35A; by the U.S. Marine Corps for the F-35B; and by the U.S. Navy for the F-35C, in their respective Performance Based Arrangements.

Figure 2: U.S. F-35 Fleet Mission Capable and Full Mission Capable Rates, Fiscal Year 2020



Mission Capable (MC): This metric assesses only aircraft that are in the possession of F-35 units. It measures the percentage of time during which these aircraft are safe to fly and able to perform at least one tasked mission.

Full Mission Capable (FMC): This metric assesses only aircraft that are in the possession of F-35 units. It measures the percentage of time during which these aircraft are fully capable of accomplishing all tasked missions.

Source: GAO analysis of Department of Defense and Lockheed Martin information. | GAO-21-505T

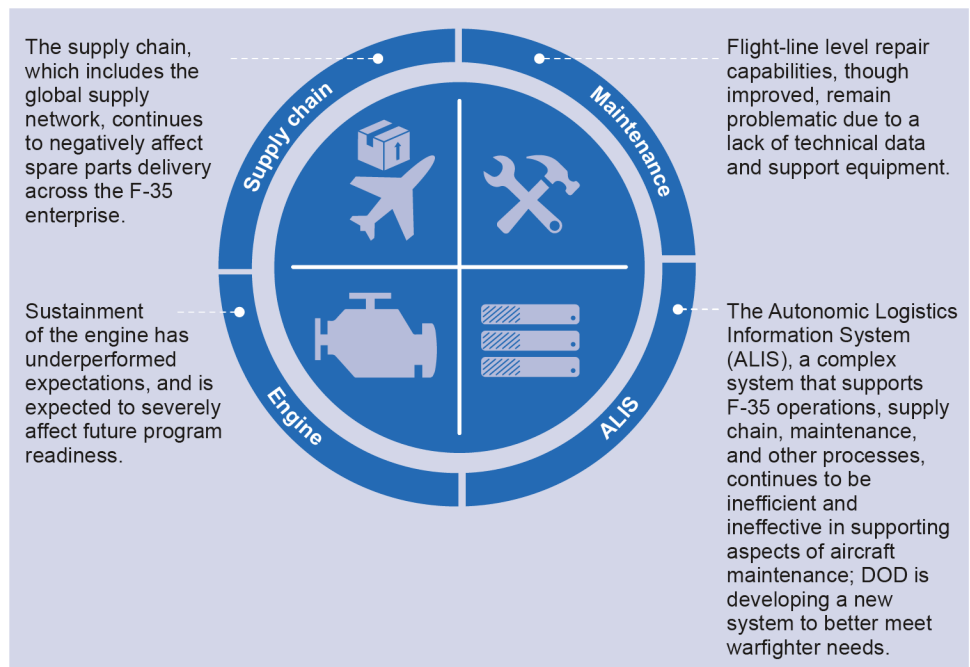
Data table for Figure 2: U.S. F-35 Fleet Mission Capable and Full Mission Capable Rates, Fiscal Year 2020

	F-35A		F-35B		F-35C	
	MC	FMC	MC	FMC	MC	FMC
Actual performance	71%	54%	68%	15%	59%	7%
Warfighter's minimum performance target	80%	64%	75%	60%	75%	60%
Warfighter's objective performance target	90%	72%	85%	75%	85%	75%

F-35 Has Made Progress in Addressing Some Sustainment Challenges, but Significant Issues Continue to Affect Aircraft Readiness

The F-35 program and the services have made progress in addressing sustainment challenges we reported in our prior work, leading to improvements in performance.¹¹ However, we found that these challenges continue to affect F-35 sustainment operations and aircraft readiness. As described in figure 3, the significant challenges are as follows: (1) the supply chain; (2) maintenance; (3) Autonomic Logistics Information System (ALIS)—a complex system that supports F-35 operations, mission planning, supply-chain management, maintenance, and other processes; and (4) the F-35 engine.

¹¹GAO, *Weapon System Sustainment: DOD Needs a Strategy for Re-Designing the F-35's Central Logistics System*, [GAO-20-316](#) (Washington, D.C.: Mar. 6, 2020); GAO, *F-35 Aircraft Sustainment: DOD Needs to Address Substantial Supply Chain Challenges*, [GAO-19-321](#) (Washington, D.C.: Apr. 25, 2019); GAO, *F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency*, [GAO-18-75](#) (Washington D.C.: Oct. 26, 2017); and [GAO-14-778](#).

Figure 3: Significant Sustainment Challenges for the F-35 Program

Source: GAO analysis of Department of Defense (DOD) information. | GAO-21-505T

Text of Figure 3: Significant Sustainment Challenges for the F-35 Program

- **Supply Chain:** The supply chain, which includes the global supply network, continues to negatively affect spare parts delivery across the F-35 enterprise.
- **Maintenance:** Flight-line level repair capabilities, though improved, remain problematic due to a lack of technical data and support equipment.
- **ALIS:** The Autonomic Logistics Information System (ALIS), a complex system that supports F-35 operations, supply chain, maintenance, and other processes, continues to be inefficient and ineffective in supporting aspects of aircraft maintenance; DOD is developing a new system to better meet warfighter needs.
- **Engine:** Sustainment of the engine has underperformed expectations, and is expected to severely affect future program readiness.

The F-35 Supply Chain Has Become More Responsive, but Challenges Remain

Since we reported on the F-35 supply chain in 2019, we have found that the F-35 program has made improvements in three areas: spare parts availability, customer wait time, and depot-level repair.¹² However, while the program has made improvements, it continues to not meet its objectives in each of those areas.

First, spare parts availability improved over the course of fiscal years 2019 and 2020. Specifically, non-mission capable due to supply rates—the percentage of time during which the aircraft in F-35 units' possession are unable to fly or conduct any of their tasked missions due to a lack of spare parts—improved from an average of 24 percent in fiscal year 2019 to an average of 16 percent in fiscal year 2020. The program office stated that the program plans to fund only enough spare parts to achieve an approximately 15 percent non-mission capable due to supply rate. Given that the Air Force's objective performance target for the mission capable rate in fiscal year 2020 was 90 percent for the F-35A, and that mission capable rate is determined by subtracting the percentage of time during which the aircraft is not available due to issues pertaining to supply and maintenance, having a non-mission capable due to a supply rate of 15 percent categorically makes it impossible to achieve the F-35A's target.

Second, DOD decreased customer wait times for parts and achieved five of its eight customer wait time metrics in fiscal year 2020. This was an improvement from calendar year 2018, when DOD achieved just three of eight customer wait time metrics. However, customer wait times for parts outside of the United States remain problematic. In April 2019 we reported that fewer than 20 percent of critical parts outside of the continental United States were received within 6 days of request—well below the fleet-wide minimum target of 60 percent.¹³ This metric still remained well below the 60 percent target in 2020; however, it did improve to 41 percent.

Finally, the inability of the F-35 program to keep up with repair demands has been a recurring issue. As we reported in April 2019, average depot-

¹²[GAO-19-321](#).

¹³[GAO-19-321](#).

level repair times were double the program's objective, leading to a significant impact on aircraft readiness.¹⁴ As of August 2020, average repair times improved to 131 days, from 188 days in November 2018; however, this figure remains well above the program's 60-90 day program objective. According to program officials, part repair times continue to lag because the depots do not yet have the capacity to meet program repair time goals, and they are years away from having sufficient capacity to achieve these goals.

As a result of supply chain challenges, all 11 F-35 locations that responded to our survey reported negative effects on the readiness or capabilities of their aircraft. Specifically, six of the 11 locations reported that parts failed to arrive on time, or that fewer spare parts arrived than were required. As a result, locations were unable to plan for both daily flying operations and aircraft maintenance.

Maintenance Challenges Continue to Affect Aircraft Readiness

We found that the non-mission capable due to maintenance rate—the percentage of time during which aircraft in F-35 units' possession are unable to fly or conduct any of their tasked missions due to a maintenance requirement—decreased from 17 percent in fiscal year 2019 to 16 percent in fiscal year 2020. However, the warfighter's objective performance targets for the mission capable rate in fiscal year 2020 were 90 percent for the F-35A and 85 percent for the F-35B and F-35C. Given that the mission capable rate is determined by subtracting the percentage of time during which the aircraft is not available due to maintenance and supply issues, a non-mission capable due to maintenance rate of 16 percent makes it impossible to achieve any of the F-35 variants' targets.

DOD officials and all 11 F-35 locations that responded to our survey told us that maintenance challenges are still affecting aircraft performance. In particular, they identified two specific challenges, described in detail below: (1) flight line maintainers lack access to technical data to conduct certain maintenance activities; and (2) locations lack support equipment to conduct maintenance efficiently.

¹⁴[GAO-19-321](#).

Technical data. Technical data, which include the details about how the aircraft should perform and how to maintain its continued performance, constitute an important part of F-35 maintenance.¹⁵ In September 2014 we reported that DOD lacked access to proprietary technical data that could help promote contractor competition or support organic (i.e., government-operated) sustainment operations, such as maintenance activities.¹⁶ We recommended that DOD develop an Intellectual Property strategy to identify the current levels of the federal government's technical data rights ownership, as well as all critical technical data needs and their associated costs. As of February 2021, DOD was developing but had not yet completed an Intellectual Property strategy for the program. Seven of the 11 locations reported that having accessible technical data remains a challenge directly affecting aircraft availability and operations.

Support equipment. Service officials and F-35 locations also pointed to a lack of support equipment—equipment items that are required to support the operation and maintenance of the aircraft—as a primary driver of maintenance challenges. According to officials who represented five of 11 locations, maintainers lack sufficient support equipment, such as defueling kits or power tools, thus delaying aircraft maintenance. The maintainers attributed the lack of support equipment both to the program not knowing how much support equipment is needed at individual locations, and to the contractors not producing enough support equipment to fully support ongoing operations. The lack of support equipment leads to delays in the required maintenance and to a decrease in the readiness of the aircraft.

ALIS Challenges Persist as the Program Begins Transition to a New System

ALIS is intended to provide the necessary logistics tools for F-35 program participants to operate and sustain the aircraft.¹⁷ However, we have

¹⁵“Technical data” refers to recorded information (regardless of the form or method of the recording) of a scientific or technical nature (including computer databases and computer software documentation) (see 41 U.S.C. 116). Federal Acquisition Regulation (FAR), 48 C.F.R. § 27.403.

¹⁶[GAO-14-778](#).

¹⁷ALIS consists of multiple software applications designed to support different squadron activities, such as supply chain management, maintenance, training management, and mission planning.

previously identified numerous long-standing issues with ALIS, including that the system is not user-friendly and does not provide the sustainment-related capabilities that were promised.¹⁸ In March 2020 we reported, among other things, that inaccurate and/or missing data in ALIS have at times resulted in the system's signaling that an F-35 aircraft should not be flown—even though the aircraft had no issues that required it to be grounded, and was ready for flight.¹⁹

In our draft report, we found that 10 of the 11 F-35 locations we surveyed reported ongoing issues with several of the ALIS-related challenges we have raised in the past, including data related to aircraft parts. Certain F-35 parts have an associated electronic record that is used to track the remaining time before the part must be replaced, among other things.²⁰ These electronic records reside within ALIS and are supposed to alert maintainers when parts need to be replaced; however, incorrect, missing, or corrupt electronic records within ALIS continue to affect day-to-day operations on the flight lines. This situation has resulted in the unnecessary grounding of “healthy” F-35 aircraft, as well as a culture of otherwise unnecessary manual workarounds to circumvent the electronic records problem at the squadron level.²¹

Recognizing the ongoing challenges with ALIS, in January 2020 DOD began taking steps to replace it with a future system—the F-35 Operational Data Integrated Network (ODIN). In our March 2020 report we recommended that DOD develop and implement a strategy for the re-design of ALIS to address a myriad of technical and programmatic uncertainties surrounding the development of ODIN.²² DOD concurred with our recommendation. However, DOD has not yet finalized its strategy for ODIN, including how and when it will address several of the technical and programmatic uncertainties we raised in March 2020. DOD

¹⁸[GAO-14-778](#); and GAO, *F-35 Sustainment: DOD Needs a Plan to Address Risks Related to Its Central Logistics System*, [GAO-16-439](#) (Washington, D.C.: Apr. 14, 2016).

¹⁹[GAO-20-316](#).

²⁰Electronic Equipment Logbooks are electronic files assigned to certain parts that include information such as part history and remaining life (hours). For the purposes of this statement, Electronic Equipment Logbooks are referred to as “electronic records.”

²¹GAO testified before the House Oversight and Reform Committee on the Autonomic Logistics Information System and the ongoing issue of Electronic Equipment Logbooks in July 2020. *F-35 Sustainment: DOD Needs to Address Key Uncertainties as It Re-Designs the Aircraft's Logistics System*, [GAO-20-665T](#) (Washington, D.C.: July 22, 2020).

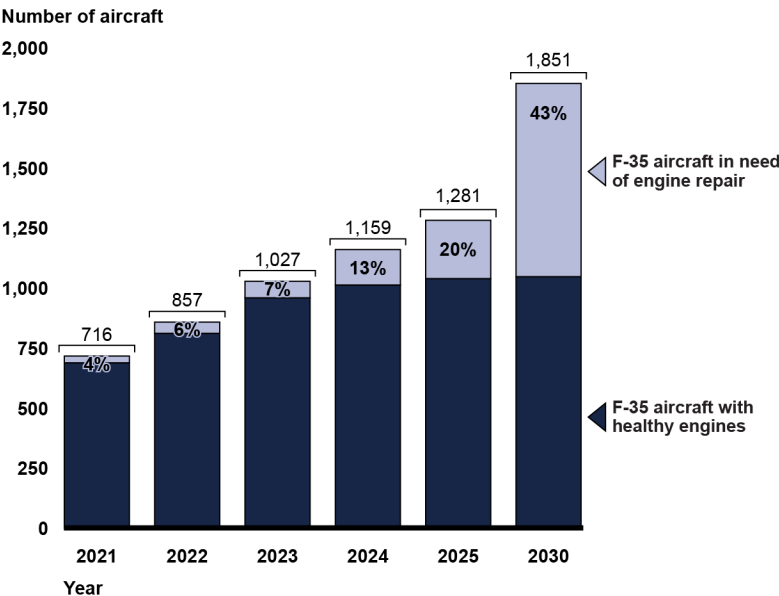
²²[GAO-20-316](#).

will continue to rely on ALIS to serve as its primary logistics system while the F-35 Joint Program Office continues to focus on completing the strategy for the development and eventual rollout of ODIN.

Problems with Engine Sustainment Are Affecting the Program and Could Significantly Affect Future F-35 Mission Capable Rates

According to multiple service and program officials, challenges related to F-35 engine sustainment are currently affecting the program and may pose its greatest sustainment risk over the next 10 years. At the end of 2020, the program had 20 aircraft unable to fly because they needed engine repairs, according to program officials. In January 2021 the F-35 Joint Program Office projected that the program would have a deficit of approximately 800 engines by 2030 without the implementation of considerable mitigation actions, as shown in figure 4. A deficit of this size could lead to 43 percent of the total F-35 fleet being grounded in 2030.

Figure 4: Projected F-35 Aircraft Needing Engine Repairs



Source: GAO analysis of Joint Program Office data. | GAO-21-505T

Data table for Figure 4: Projected F-35 Aircraft Needing Engine Repairs

Year	MC engines	Engine holes
2021	687	29
2022	810	47
2023	958	69
2024	1011	148
2025	1038	243
2030	1046	805

We found that two main factors contributed to 20 F-35 aircraft needing engine repairs. First, F-35 squadrons removed engines for unscheduled maintenance more often than expected, primarily to repair the power module—a key component of the engine that generates thrust for the aircraft to fly.²³ Specifically, in 2020 the F-35 Joint Program Office projected 52 power module removals, but it experienced 67. Second, the F-35 program was able to repair only 43 percent of removed power modules in 2020, thereby resulting in a backlog of power modules needing repair.²⁴ The program planned for Oklahoma City Air Logistics Complex—a key source of engine repairs—to repair 90 percent of the program’s total of removed power modules in 2020. However, according to program officials, Oklahoma City Air Logistics Complex was able to repair only 23 percent of what the program had originally forecasted for the site in 2020.²⁵ The F-35 Joint Program Office attributed this shortfall to numerous challenges, such as:

- more extensive maintenance being required on the engine module than expected;
- the fact that available technical data did not support the more extensive maintenance being required;

²³The engine in the F-35A and F-35C has four modules: fan, power, augmentor, and nozzle. The engine in the F-35B has an additional module—the lift fan. The power module includes a compressor, combustor, and two turbines, and it is considered the hottest part of the engine with the smallest rotational parts and some of the tightest tolerances, according to a DOD official.

²⁴The 43 percent represents the total number of repaired power modules in 2020 divided by the total number of removed power modules (in need of repair) in 2020.

²⁵According to program officials, engines are repaired at a heavy maintenance center located at Oklahoma City Air Logistics Complex and other contractor facilities in the repair network. Those other contractor facilities repaired 15 power modules in 2020. The heavy maintenance center at Oklahoma City Air Logistics Complex is a public-private partnership between Pratt & Whitney and the U.S. government.

-
- inefficient maintenance processes and a lack of available support equipment to conduct the more extensive maintenance; and
 - a lack of proficiency in the depot workforce.

These challenges resulted in the program's not meeting its goals for engine module repair turnaround time. As of October 2020, the depot had an average repair time of 207 days for a power module—far greater than its turnaround time goal of 122 days. The officials reported that, consequently, the program ended 2020 with a backlog of 65 power modules awaiting repair—a number that had decreased by one, to 64, as of mid-February 2021.

In addition, we found that scheduled engine removals are projected to increase the number of power modules needing repair beginning in late fiscal year 2021. Scheduled engine removals are planned periodic maintenance, based on the number of flying hours, requiring an overhaul of the engine power module as well as other maintenance. An increasing number of scheduled engine removals will further strain the capacity of depots, which are currently struggling to handle the workload associated with repairing the engine power module from the unscheduled engine removals. This capacity issue will lead to an increasing number of aircraft being non-mission capable due to the lack of power modules, as shown previously in figure 4.

DOD recognizes that it lacks the capacity to make both unscheduled and scheduled engine power module repairs at the levels needed to support the F-35 program. As a result, DOD is taking steps to increase its depot repair capacity for the power module. However, in the near term, capacity challenges at depots will continue to contribute to the number and percentage of non-mission capable aircraft. The program's current goal is for propulsion-related challenges to account for no more than 4 percent of the program's overall non-mission capable due to supply rate. However, projections have the program exceeding that percentage by the end of fiscal year 2021. Achieving the program's 4 percent goal will depend upon the program's ability to address the various challenges in sustaining the engine. We have an ongoing review focused on DOD's plans to address F-35 engine sustainment challenges, and we plan to report on these issues later in 2021. Therefore, in our draft report, we did not make recommendations concerning F-35 engine sustainment.

F-35 Life Cycle Sustainment Cost Estimates Continue to Rise, and DOD Has Not Made Progress in Meeting Its Affordability Constraints

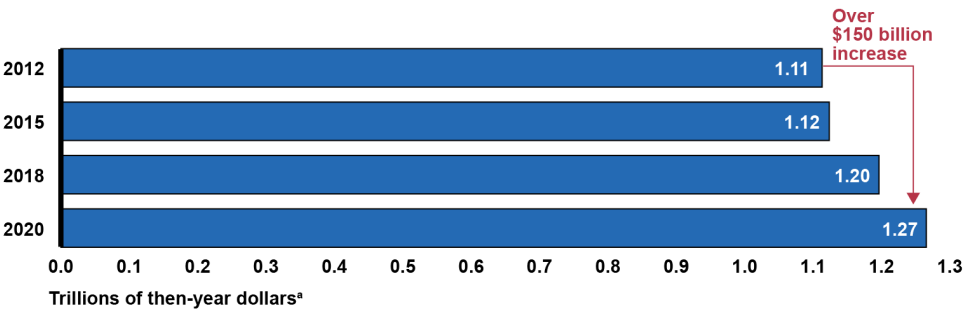
F-35 life cycle sustainment cost estimates continue to increase. We found that a substantial gap exists between estimated operating and support costs for the F-35 and service-established affordability constraints—i.e., operating and support costs the services can afford based on their projected budgets and other priorities. Within DOD there are differing perspectives as to the best course of action, and the program lacks a strategic approach for ensuring that the services can afford to operate and support the F-35. We found that it will become more difficult to reduce sustainment costs as the fleet of F-35 aircraft grows, thus necessitating urgency in addressing significant concerns about the services' ability to afford the long-term sustainment costs of the F-35 program.

Estimated F-35 Life Cycle Sustainment Costs Have Increased by \$150 Billion since 2012

Since 2012, sustainment-related cost estimates for the life cycle of the F-35 program have steadily increased, as depicted in figure 5. The F-35 program's latest cost estimate, issued by the Secretary of Defense's CAPE, projects overall sustainment (i.e., operating and support) costs for the program to be about \$1.3 trillion through the program's life cycle.²⁶

²⁶CAPE's 2020 ICE issuance was submitted in accordance with statutory requirements in the National Defense Authorization Act for Fiscal Year 2020. The F-35 program has two additional cost estimates: the F-35 Joint Program Office's Annual Cost Estimate, and the Joint Service Cost Position. These figures, both released in June 2020, estimated total O&S costs for the program. Both produced total O&S costs and cost elements that were very similar to the CAPE O&S estimate.

Figure 5: Growth in F-35 Life Cycle Sustainment Cost Estimates



Source: GAO analysis of Department of Defense data. | GAO-21-505T

Data table for Figure 5: Growth in F-35 Life Cycle Sustainment Cost Estimates

Year	Cost Estimates (trillions of then year dollars)
2012"	1.1133
2015"	1.1238
2018"	1.1964
2020"	1.2656

^aThen-year dollars include the effects of inflation.

DOD Has Set Affordability Constraints for F-35 Sustainment Costs, but Its Cost Estimates Project Sustainment Cost Overruns

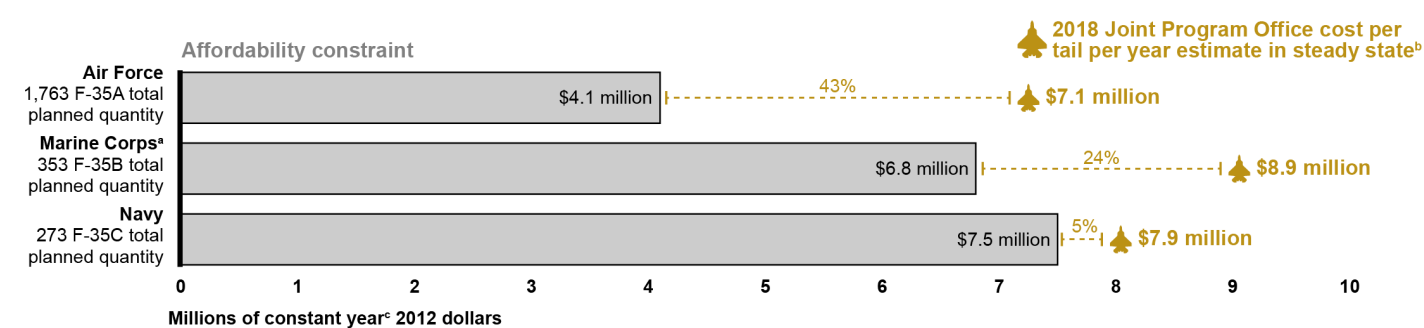
For Major Defense Acquisition Programs like the F-35, affordability constraints are developed by the military services based on the assumptions about the total funding available to them over the life cycle of the given program and projected costs to operate and support other systems in their respective portfolios. In October 2018, in response to a recommendation we made in 2014, the Undersecretary of Defense for Acquisition and Sustainment issued affordability constraints for each of the services.²⁷ The constraints were established in a cost per tail per year metric, as shown in figure 6.²⁸ To achieve the constraints, the Air Force, Marine Corps, and Navy determined that, based on F-35 Joint Program

²⁷[GAO-14-778](#).

²⁸Cost per tail per year is defined as the average annual operating and support cost per aircraft (tail) in a given fleet. It is generally estimated by dividing total operating and support costs of an aircraft fleet by the total number of aircraft.

Office cost per tail per year estimates, they would need to reduce projected F-35 sustainment costs by 43 percent (or \$3.0 million per tail per year), 24 percent (or \$2.1 million per tail per year), and 5 percent (or \$0.4 million per tail per year), respectively, by the steady state time frame for each variant.²⁹

Figure 6: Differences between Service F-35 Affordability Constraints and 2018 Cost Estimates for Annual Sustainment Costs, per Aircraft, at Program Steady State



Source: GAO analysis of Joint Program Office data. | GAO-21-505T

Data table for Figure 6: Differences between Service F-35 Affordability Constraints and 2018 Cost Estimates for Annual Sustainment Costs, per Aircraft, at Program Steady State

Service	Per Aircraft cost estimates (millions)	2018 Joint Program Office cost per tail per year estimate insteady state (millions)	Total planned quantity
Air Force	\$4.1	\$7.1	1,763
Marine Corps	\$6.8	\$8.9	353
Navy	\$7.5	\$7.9	273

^aThe Marine Corps plans to procure 67 F-35C aircraft in addition to the 353 F-35B aircraft. These 67 F-35C aircraft have the same \$6.8 million affordability constraint associated with them; however, since these aircraft were not specifically referenced in the October 2018 F-35 Lighting II Joint Strike Fighter Acquisition Decision Memorandum, we did not include them in the graphic.

^bSteady state years for the F-35 program are defined in each respective service's affordability analysis as follows: U.S. Air Force/F-35A – 2036-2041; U.S. Marine Corps/F-35B – 2033-2037; U.S. Navy/F-35C – 2036-2043.

^cConstant-year dollars are expressed as the value of a specific year and do not include escalation or inflation.






In 2020 the F-35 Joint Program Office updated its cost per tail per year estimates. The estimated annual costs for all three F-35 variants

²⁹According to program officials, the steady state period for each service is the period in which it intends to be operating the F-35 at its maximum capabilities. Steady state years for the F-35 program are defined in each respective service's affordability analysis as follows: U.S. Air Force/F-35A – 2036-2041; U.S. Marine Corps/F-35B – 2033-2037; U.S. Navy/F-35C – 2036-2043.

increased, thereby furthering the gap between the affordability constraints established in 2018 and the projected sustainment costs at steady state. Specifically, the Air Force, Marine Corps, and Navy, based on the updated F-35 Joint Program Office estimates, will need to reduce projected F-35A sustainment costs by 47 percent (or \$3.7 million per tail per year), 26 percent (or \$2.3 million per tail per year for the F-35B), and 24 percent (or \$2.4 million per tail per year), respectively, by the steady state time frame for each variant.

Furthermore, as shown in figure 7, based on these updated estimates, we found that the Air Force, Marine Corps, and Navy collectively face annual multi-billion dollar gaps between the projected costs to sustain their respective F-35 fleets at steady state and their stated affordability goals. For example, we found that in steady state year 2036 alone, the Air Force, which projects that it will own 1,192 F-35A aircraft at that time, will need to pay \$4.4 billion more than it projects it can afford to sustain those aircraft.

Figure 7: Differences between Service F-35 Affordability Constraints and 2020 Cost Estimates for Annual Sustainment Costs, per Aircraft, at Program Steady State

Service and aircraft	 2020 JPO cost per tail per year estimate in steady state ^a (in millions)	 Affordability constraint (in millions)	 Gap between projected cost and affordability constraint (in millions)	 Planned aircraft total in steady state ^a year 2036	 Total cost overrun in steady state ^a year 2036
Air Force F-35A	(\$7.8)	\$4.1)	\$3.7	1,192	\$4.4 billion
Marine Corps F-35B	(\$9.1)	\$6.8)	\$2.3	353	\$812 million
Marine Corps F-35C	(\$7.9)	\$6.8)	\$1.1	67	\$74 million
Navy F-35C	(\$9.9)	\$7.5)	\$2.4	273	\$655 million
					Almost \$6 billion

Source: GAO analysis of Joint Program Office (JPO) data. | GAO-21-505T

Note: Costs are in constant-year 2012 dollars as that was the year when the F-35 program was most recently re-baselined. Constant-year dollars are expressed as the value of a specific year and do not include escalation or inflation. We used Total Aircraft Inventory, which does not account for aircraft attrition, to calculate the planned aircraft totals in steady state year 2036.

^aSteady state years for the F-35 program are defined in each respective service's affordability analysis as follows: U.S. Air Force/F-35A – 2036-2041; U.S. Marine Corps/F-35B – 2033-2037; U.S. Navy/F-35C – 2036-2043. We used 2036 for our calculations, as that year fell within each service's steady state time frame.

DOD recognizes the critical need to reduce sustainment costs for the program, and the department has undertaken efforts to do so. However,

these efforts have produced limited results. In September 2014 we reported that in 2013 DOD had established a Cost War Room—a collaborative group comprising the services, the F-35 Joint Program Office, and contractor personnel—for the purpose of reducing program sustainment costs. Recently renamed the Affordability War Room, the group helps assess and manage cost reduction initiatives from across the F-35 program, including government and industry. The Affordability War Room has reported identifying \$68 billion in life cycle cost avoidance through various initiatives since 2013.³⁰ However, according to several DOD officials, even if all of the \$68 billion in cost avoidance was achieved, that would represent only a fraction of the reductions needed to lower the F-35 program's sustainment costs (and achieve the services' affordability constraints).

F-35 Stakeholders Hold Differing Perspectives, and DOD Lacks a Strategic Approach to Achieving Its Affordability Constraints

According to DOD officials, all stakeholders—the services, the F-35 Joint Program Office, and the contractors—share responsibility for achieving the services' sustainment affordability constraints. OUSD (A&S), which serves as the F-35 program's oversight authority, is also responsible for ensuring that the overall program is affordable from both a production and a sustainment perspective.³¹ According to program officials, although the services receive appropriations from Congress to fund the F-35 program and ultimately set the requirements that drive sustainment-related costs for their respective variants, it is imperative for all stakeholders to work together to achieve affordability for the program. However, we found that the stakeholders held unique and differing perspectives on affordability, as described below.

Air Force: Air Force officials told us that the Air Force will not be able to afford the cost of sustaining the 1,763 aircraft it plans to purchase without dramatic cuts to sustainment costs of the F-35A. Since the aircraft has already passed Milestone B, Air Force officials stated that there is little room left for the program to make significant sustainment-related cost

³⁰Cost avoidance does not result in a tangible benefit that lowers current spending, investment, or debt levels; rather, it is an action that avoids incurring costs in the future.

³¹Oversight is a review activity conducted by the Office of the Secretary of Defense, among others, to determine current status, ascertain whether the law or other intentions of Congress are being followed, or serve as a basis for possible future legislation.

reductions, as the program has already made definitive design decisions and established a maintenance strategy. Air Force officials told us that, as a result, the only remaining options for their meeting the affordability constraints are to reduce the total number of F-35A aircraft they plan to purchase, or to reduce the aircraft's planned flying hours, which would have implications on the force structure and capabilities of the Air Force.

Marine Corps: Marine Corps officials stated that while they do not currently face affordability challenges, they anticipate that affordability will negatively affect F-35B sustainment in the future. According to these officials, they will likely need to re-examine the service-related requirements for the aircraft going forward but are not focused on doing so now. Until the F-35B's cost per tail per year becomes an immediate issue, the Marine Corps will continue to fund reliability and maintainability projects and work with the F-35 Joint Program Office's Affordability War Room to focus on reducing F-35B-related sustainment costs.

Navy: Navy officials stated that while they are aware of the affordability challenges faced by the overall program, they believe that the F-35 Joint Program Office's current efforts on reducing program sustainment costs should be sufficient to meet the Navy's affordability goal of \$7.5 million cost per tail per year. Navy officials stated that future cost per tail per year overruns should be resolved through various cost savings initiatives being explored and implemented by the F-35 Joint Program Office's Affordability War Room.

F-35 Joint Program Office: Program office officials told us that for the services to achieve their respective affordability constraints, the F-35 program needs to significantly reduce overall F-35 costs. However, the program office's ability to achieve cost savings is constrained by its obligation to fulfill the services' program requirements. According to program officials, if current requirements remain the same, it may be difficult to realize the cost reductions needed to achieve the services' affordability constraints in the steady state time frame.

OUSD (A&S): OUSD (A&S) officials told us that they do not believe the current cost-savings approach will be sufficient to make the program affordable for the services. OUSD (A&S) officials stated that transitioning the sustainment of the F-35 from a predominantly contractor-managed framework to one managed and conducted by the government (i.e., organic sustainment) could be a primary method for sufficiently reducing sustainment costs to achieve the services' affordability constraints. The current mix of service and contractor personnel, according to these

officials, is too expensive, and the government could reduce sustainment costs by utilizing an organic approach to F-35 sustainment.

While F-35 program stakeholders agree that sustainment costs are of concern, we found that there is no clear consensus on what should be done to address those concerns. Given the significant affordability challenge facing the department and the uncertainty on how to address this growing issue, in our draft report we recommended that DOD assess and document its ability to meet the services' affordability constraints with existing or planned cost-reduction efforts, and also assess and document changes in service-related program requirements (e.g., the number of aircraft purchases and flying hours) to achieve cost reductions. Additionally, in our draft report we recommended that DOD develop and document a program-wide plan for achieving the services' affordability constraints, and also develop and document a risk management approach for addressing potential challenges to achieving affordability.

Furthermore, DOD is not required to report periodically to Congress on the progress the department has made in reducing the F-35's sustainment costs and closing the gap between these costs and the services' affordability constraints. As the program grows and matures, sustainment cost reductions will become more difficult. Therefore, in our draft report we suggest that Congress should consider (1) requiring DOD to report annually on progress made in achieving the services' affordability constraints, including the actions taken and planned to reduce sustainment costs; and (2) making future F-35 aircraft procurement decisions contingent on DOD's progress in achieving its F-35 sustainment affordability constraints.

In summary, since 2012 the F-35 program's sustainment cost estimates have increased by more than \$150 billion, and these costs are already preventing the services from reaching their respective readiness objectives. Looking ahead, the gap between projected sustainment costs and what the services say they can afford is on track to widen substantially. Achieving cost reductions of this magnitude—billions of dollars a year, every year—presents a formidable challenge for the program. Without a cohesive, strategic approach on the part of DOD, in tandem with ongoing congressional oversight, DOD may continue to invest resources in a program that the department and the services ultimately cannot afford to sustain.

Chairmen Garamendi and Norcross, Ranking Members Lamborn and Hartzler, and Members of the Subcommittees, this completes my

prepared statement. I would be pleased to respond to any questions you may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff have questions about this testimony, please contact Diana Maurer, Director, Defense Capabilities and Management, 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 statement. GAO staff who made key contributions to this testimony are John Bumgarner and Alissa Czyz (Assistant Directors), Jeff Hubbard (Analyst-in-Charge), Vincent Buquicchio, Juaná Collymore, Ethan Kennedy, William Lamping, Jennifer Leotta, Amie Lesser, Elizabeth Morris, Terry Richardson, and Cheryl Weissman.

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