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F-35 SUSTAINMENT

DOD Faces Several Uncertainties and Has Not Met Key Objectives

Statement of Diana Maurer, Director,
Defense Capabilities and Management

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GAO-22-105995

GAO Highlights

Highlights of GAO-22-105995, a testimony before the Subcommittee on Readiness, Committee on Armed Services, House of Representatives

April 28, 2022

F-35 SUSTAINMENT

DOD Faces Several Uncertainties and Has Not Met Key Objectives

Why GAO Did This Study

The F-35 aircraft with its advanced capabilities, represents a growing portion of DOD's tactical aviation fleet. DOD plans to procure nearly 2,500 F-35s with an estimated $1.3 trillion in life-cycle costs associated with operating and sustaining the aircraft.

This statement provides (1) the status of the F-35 program's ability to meet key sustainment metrics, (2) DOD's current engine sustainment strategy, and (3) uncertainties facing F-35 sustainment. This statement is based on GAO's body of work issued from 2014 through 2022, draft report on F-35 engine sustainment that was provided to DOD this month for review and comment, and ongoing review of F-35 maintenance.

GAO analyzed key metrics for fiscal years 2019-2022, reviewed F-35 strategy and program documents, and interviewed officials. As a part of ongoing work, from December 2021 through March 2022, GAO staff visited two depot maintenance facilities and three installations that are the home stations for F-35 squadrons.

What GAO Recommends

In its draft report, GAO is recommending, among other things, that DOD assess and update the F-35 engine sustainment strategy, including its goals and actions to achieve its goals. GAO's prior reports since 2014 have made several recommendations to enhance F-35 sustainment, some of which remain unimplemented as discussed in the testimony.

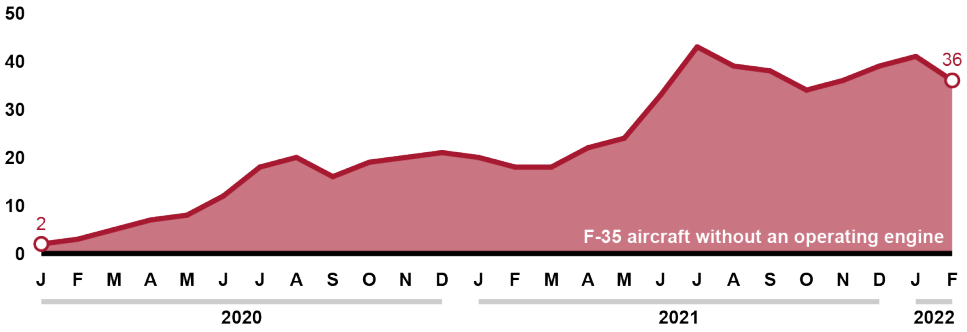
View GAO-22-105995. For more information, contact Diana Maurer at (202) 512-9627 or maurerd@gao.gov.

What GAO Found

The F-35 continues to not meet its targets for mission capable rates—a measure of the readiness of an aircraft fleet—or its reliability and maintainability metrics. For example, the Department of Defense's (DOD) full mission-capable rates—the percentage of time during which the aircraft can perform all of its missions—for the F-35B were below the target by 41 percentage points in fiscal year 2021.

A leading driver of the F-35 not being mission capable has been engine issues, as discussed in GAO's draft report.

F-35 Aircraft without an Operating Engine, January 2020 – February 2022



Source: GAO analysis of Pratt & Whitney data. | GAO-22-105995

DOD has begun implementing multiyear plans leading to some improved engine outcomes. The engine sustainment strategy's goal is that no more than 6 percent of F-35 aircraft are unable to operate due to engine issues, which DOD has exceeded since April 2021. However, the military services desire outcomes similar to other fighter aircraft, which since 2016 have generally experienced less than 1 percent being unable to operate due to engine issues. Until the strategy is assessed and updated, the services may be limited in achieving their missions.

GAO's prior and ongoing work show that DOD also faces many uncertainties as it decides the future of F-35 sustainment.

Uncertainties Shaping the Future of F-35 Sustainment

Source: GAO analysis of Department of Defense information; U.S. Air Force/R. Nial Bradshaw (photo). | GAO-22-105995

Chairman Garamendi, Ranking Member Waltz, and Members of the Subcommittee:

Thank you for the opportunity to be here today to discuss the Department of Defense's (DOD) sustainment of the F-35 aircraft. 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. Current DOD plans call for procuring 2,470 F-35s at an estimated total acquisition cost of just under $400 billion, leaving the majority of the estimated program costs, approximately $1.3 trillion, associated with sustainment of the aircraft. 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).[1] This remains an ongoing challenge, as DOD continues to assess the future sustainment concept while continuing to support a rapidly expanding F-35 fleet.

This testimony (1) provides the status of the F-35 program's ability to meet key sustainment metrics, (2) assesses DOD's current engine sustainment strategy, and (3) discusses uncertainties facing the future of F-35 sustainment.

This statement is based on several efforts: our draft report on F-35 engine sustainment, which we provided to DOD this month for review and comment; our ongoing review of F-35 maintenance; and our body of work issued from 2014 through 2022 addressing F-35 reliability and maintainability, sustainment, affordability, the Autonomic Logistics Information System (ALIS),[2] operations and the global supply chain.[3]

[1]The other U.S. services—the Army, Coast Guard, and Space Force—are not acquiring F-35s.

[2]ALIS is intended to provide the necessary logistics tools for F-35 program participants to operate and sustain the aircraft. ALIS consists of multiple software applications designed to support different squadron activities, such as supply chain management, maintenance, training management, and mission planning.

[3]The National Defense Authorization Act for Fiscal Year 2022 included a provision for us to review, among other things, the status of DOD's sustainment strategy for F-35 aircraft. We plan to complete this review in fall 2022.

To perform our work, we collected and analyzed performance metrics, such as mission capable and full mission capable rates that are key indicators of health and readiness of an aircraft fleet, from fiscal years 2019 through 2021 for the U.S. F-35 fleet. We reviewed documents related to aircraft and engine sustainment, including the Life Cycle Sustainment Plan, the Life Cycle Sustainment Plan Supplement, the Global Support Solution, the Weapons Systems Planning Document, and information associated with the contracts between DOD, Lockheed Martin, and Pratt & Whitney. We analyzed data from the F-35 Joint Program Office and Pratt & Whitney on engine performance from fiscal year 2020 through 2022 as well as DOD's sustainment strategy and plans for addressing engine sustainment challenges.

For our ongoing work on F-35 aircraft maintenance, we visited two depot maintenance facilities—Fleet Readiness Center East at Marine Corps Air Station Cherry Point, North Carolina and Ogden Air Logistics Complex at Hill Air Force Base, Utah. We also visited three installations—Naval Air Station Lemoore, California; Marine Corps Air Station Yuma, Arizona; and Hill Air Force Base, Utah—that are home stations for F-35 squadrons. We also 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, the Office of Cost Assessment and Program Evaluation (CAPE), and Pratt & Whitney to discuss sustainment-related challenges affecting the fleet. In regard to our prior issued work on F-35 sustainment, more detailed information on the objectives, scope, and methodology for that work is available in the issued reports cited throughout this statement.

The work upon which this statement is based has been conducted 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

F-35 Program

The F-35 program is a joint, multinational acquisition program intended to develop and field a family of next-generation strike fighter aircraft. As

shown in figure 1, program participants include the Air Force, the Navy, and the Marine Corps; seven international partners; and multiple foreign military sales customers.[4]

Figure 1: F-35 Program Participants as of March 2022

Source: GAO analysis of Department of Defense information. | GAO-22-105995

As shown in figure 2, the program has developed and has been delivering three variants of the F-35 aircraft: F-35A, F-35B, and F-35C. DOD is in the process of replacing a variety of its legacy fighter aircraft with the F-35, including the F-16 Falcon in the Air Force, and the AV-8B Harrier and the F/A-18 C/D Hornet in the Marine Corps.[5]

[4]Seven partner nations contribute to F-35 development, production, and sustainment. In addition, as of February 2021, the program has six foreign military sales customers. In July 2019, DOD decided to remove Turkey from the development program due to its government's decision to procure Russian-made radar systems. Multiple other countries are at various stages of foreign military sales consideration.

[5]For sustainment-related information on these legacy fighters, 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), and *Military Depots: The Navy Needs Improved Planning to Address Persistent Aircraft Maintenance Delays While Air Force Maintenance Has Generally Been Timely,* GAO-20-390 (Washington, D.C.: June 23, 2020).

Figure 2: Variants of the F-35 Aircraft

Source: GAO analysis of Department of Defense documents and interviews with officials. Photos (left to right): U.S. Air Force/ Staff Sgt. Andrew Lee, U.S. Navy/Petty Officer 1st Class Jeremy Starr, and U.S. Air Force/Defense Visual Information Distribution Service. | GAO-22-105995

Text of Figure 2: Variants of the F-35 Aircraft

F-35 purpose: Counter present and future advanced threats through counter air, strike, and surveillance and reconnaissance missions

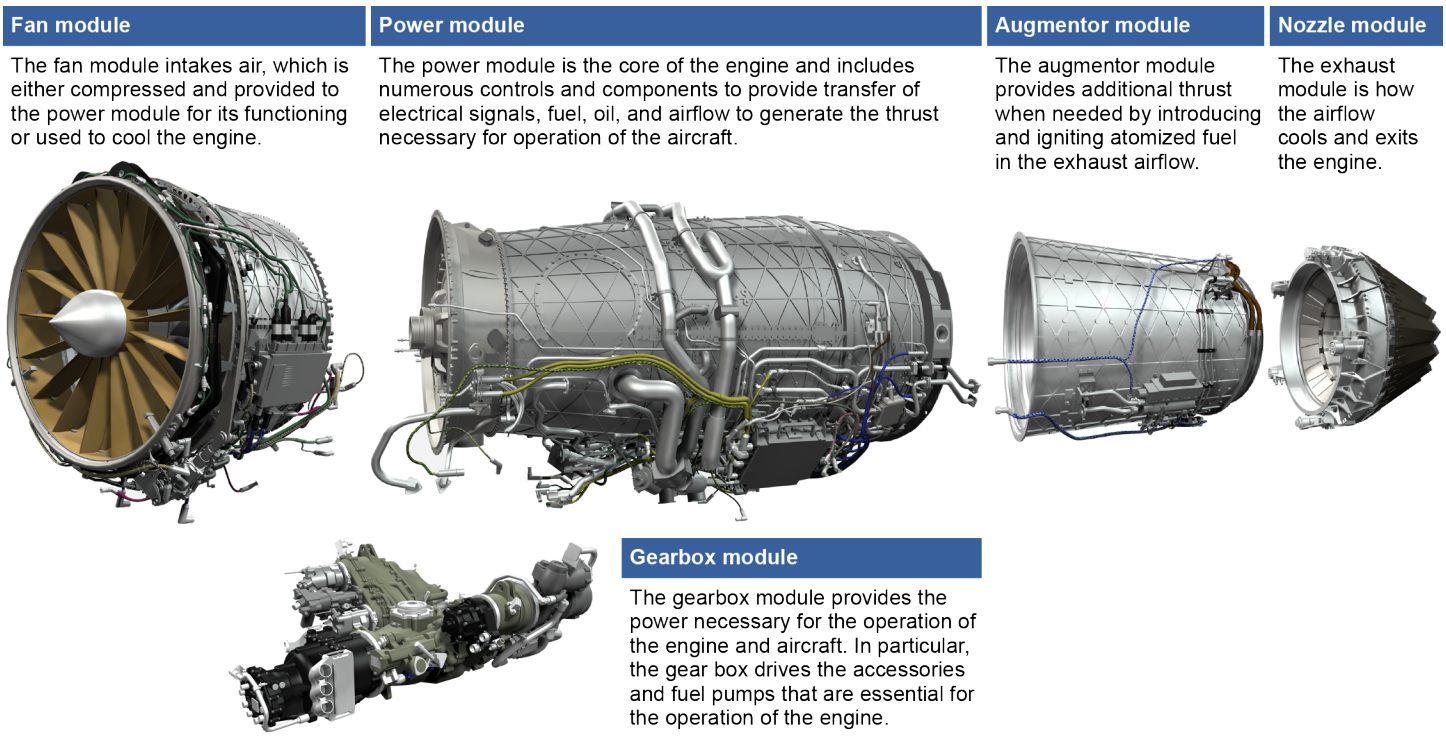
- F-35A. Conventional Take-off and landing. Initial operating capability in 2016. Air Force variant that supports primarily air to ground missions and comprises majority of partner aircraft and foreign military sales
- F-35B. Short take off and vertical landing. Marine Corps variant that is capable of short take-off and vertical landing to support expeditionary basing ashore and deployment at sea
- F-35C, Carrier. Navy and Marine Corps variant with larger wing span and greater fuel storage to support aircraft carrier operations and expeditionary roles

Source: GAO analysis of Department of Defense documents and interviews with officials. Photos (left to right): U.S. Air Force/Staff Sgt. Andrew Lee, U.S. Navy/Petty Officer 1st Class Jeremy Starr, and U.S. Air Force/Defense Visual Information Distribution Service. | GAO-22-105995

The three F-35 variants have the same basic engine design with some variations to support the short takeoff and vertical landing capability for the F-35B. Specifically, the F-35A and F-35C have the same engine with four modules: fan, power, augmentor, and nozzle (see figure 3). The gearbox module is included in the power module. The F-35B's engine

also has four main engine modules, though the power, augmentor, and nozzle modules have F-35B-specific parts and features that enable short takeoff and vertical landing operation, in addition to the F-35B's unique lift system (lift fan and roll post) hardware.

Figure 3: Diagram of the F-35's Engine



Source: Pratt & Whitney. | GAO-22-105995

Text of Figure 3: Diagram of the F-35's Engine

- Fan module: The fan module intakes air, which is either compressed and provided to the power module for its functioning or used to cool the engine.
- Power module: The power module is the core of the engine and includes numerous controls and components to provide transfer of electrical signals, fuel, oil, and airflow to generate the thrust necessary for operation of the aircraft.
- Augmentor module: The augmentor module provides additional thrust when needed by introducing and igniting atomized fuel in the exhaust airflow.

- Nozzle module: The exhaust module is how the airflow cools and exits the engine.
- Gearbox module: The gearbox module provides the power necessary for the operation of the engine and aircraft. In particular, the gear box drives the accessories and fuel pumps that are essential for the operation of the engine.

Source: Pratt & Whitney. | GAO-22-105995

Sustainment of the F-35

DOD's sustainment effort for the F-35 aircraft is a large and complex undertaking involving many stakeholders.

- 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.
- Lockheed Martin, the prime contractor for the aircraft, maintains the aircraft (i.e., the air vehicle) and that associated work is largely authorized in sustainment contracts.
- Pratt & Whitney, the contractor that designed and builds the engine, maintains the engine.

All aircraft and engine maintenance is conducted under the F-35 sustainment strategy's two-level maintenance concept. Under this concept, maintenance is either conducted at the organizational level by squadron-level personnel where the aircraft is stationed or deployed, or at the depot level. Depot-level maintenance includes structural repair, software upgrades, engine system overhaul and repair, component repair, and other activities that require specialized skills, facilities, or tooling to conduct the repairs. The Navy also operates a limited intermediate-level maintenance capability for the aircraft. Depots and organizational-level units conduct both scheduled and unscheduled maintenance. Scheduled maintenance is periodic prescribed inspections or servicing of equipment accomplished on a calendar, cycles, or hours of operation basis. Unscheduled maintenance is maintenance actions that occur outside of the normal schedule. Several key organizations conduct maintenance for the F-35 aircraft and engine:

- Military services and their personnel generally conduct organizational-level aircraft and engine maintenance.

- Lockheed Martin manages all activities, products, and services related to aircraft maintenance, component repair, and support equipment repair that are beyond the organizational-level capability. This includes providing depot maintenance planning and management.
- The F-35 Joint Program Office and Pratt & Whitney jointly manage depot-level engine maintenance through government employees located at military service-operated depots in the continental U.S. and contractor logistics support arrangements inside and outside the continental U.S.
- Military service depots and the Air Force's Heavy Maintenance Center at Tinker Air Force Base, Oklahoma City, OK conduct most of the major depot-level repair and overhaul for the aircraft and engine, respectively. Various other maintenance and contractor sites conduct the remaining depot-level engine and component maintenance.

The F-35 Program Has Made Progress on Key Sustainment Metrics, but Continues to Not Meet All Program Goals

F-35 mission capable rates have improved since fiscal year 2019, but continue to be at least about 9 percentage points below minimum performance targets established by DOD. In addition, the performance of the F-35 against metrics for reliability and maintainability remains a concern.

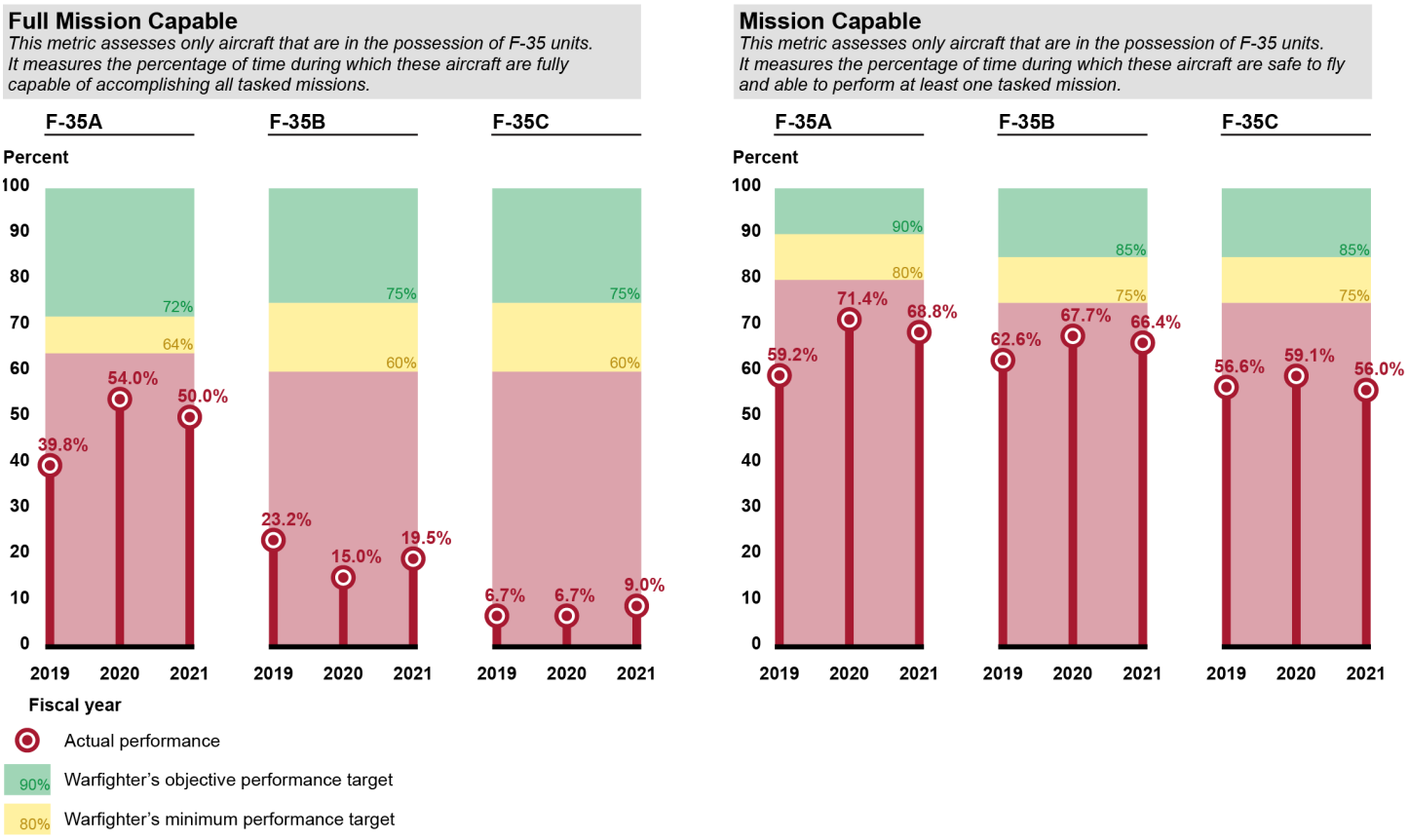
F-35 Mission Capable Rates Have Improved since 2019 but Still Fall Short of Program Goals

Our ongoing work shows that the F-35 program has improved the F-35's mission capable rates since fiscal year 2019. Specifically, the:

- full mission capable rate—the percentage of time during which the aircraft can perform all of its tasked missions—increased from 32.4 percent in fiscal year 2019 to 39.1 percent in fiscal year 2020 before slipping to 38.1 percent in fiscal year 2021.
- mission capable rate—the percentage of time during which the aircraft can fly and perform at least one of its tasked missions—increased from 59.8 percent in fiscal year 2019 to 69.2 percent in fiscal year 2020 before slipping to 66.7 percent in fiscal year 2021.

Even with the improvement since fiscal year 2019, the F-35's full mission capable and mission capable rates have not met program-established targets for each of the F-35 variants, as shown in figure 4.[6] For example, in fiscal year 2021, the F-35A and F-35B were below the full mission capable minimum performance target by 14 and 41 percentage points, respectively. Furthermore, each F-35 variant in fiscal year 2021 did not meet its target for mission capable minimum performance by at least about 9 percentage points.

Figure 4: U.S. F-35 Fleet's Rates for Full Mission Capable and Mission Capable, Fiscal Years 2019 through 2021



Source: GAO analysis of Department of Defense and Lockheed Martin information. | GAO-22-105995

[6]The warfighters' 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.

Text of Figure 4: U.S. F-35 Fleet's Rates for Full Mission Capable and Mission Capable, Fiscal Years 2019 through 2021

Full mission capable. 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.

- F-35A. 2019 = 39.8%; 2020 = 54.0%; 2021 = 50.0%.
- F-35B. 2019 = 23.2%; 2020 = 15.0%; 2021 = 19.5%.
- F-35C. 2019 = 6.7%; 2020 = 6.7%; 2021 = 9.0%.

Mission Capable. his 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.

- F-35A. 2019 = 59.2%; 2020 = 71.4%; 2021 = 68.8%.
- F-35B. 2019 = 62.6%; 2020 = 67.7%; 2021 = 64.4%.
- F-35C. 2019 = 56.6%; 2020 = 59.1%; 2021 = 56.0%.

Note: The 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.

Source: GAO analysis of Department of Defense and Lockheed Martin information. | GAO-22-105995

The 2021-2023 sustainment contract with the prime contractor, Lockheed Martin, placed financial incentives on improving full mission capable rates of each F-35 variant rather than mission capable rates. According to DOD officials, previous sustainment contracts placed incentives on the program's ability to achieve specific mission capable rates across the enterprise, which measures an aircraft's ability to complete at least one mission. While an aircraft's ability to achieve one mission is useful, the F-35 is a multimission platform. An inability to conduct all required missions limits the effectiveness of the aircraft. Furthermore, given the F-35's role in the future of tactical aviation—including its enhanced situational awareness and next-generation stealth capabilities—it is increasingly important that the F-35 has its full capabilities available to the warfighter.

Our prior and ongoing work show that two key challenges—spare parts availability and maintenance—have resulted in the F-35 program not

being able to meet its performance targets.[7] While some improvements have been made, these challenges continue to prevent the program from meeting its minimum performance targets, much less its performance objectives. Specifically:

Spare parts availability has shown some improvement over the years, but continues to be a significant challenge. Spare parts availability is measured by non-mission capable due to supply rates. This term refers to the percentage of time during which aircraft in the possession of F-35 units are unable to fly or conduct any of their tasked missions due to a lack of spare parts. In April 2019, we reported that from May through November 2018, F-35 aircraft across the fleet were unable to fly almost 30 percent of the time due to spare parts shortages.[8] Our ongoing work shows that the non-mission capable due to supply rate was about 25 percent in fiscal year 2019 and this rate decreased further, hovering around 17 percent in fiscal years 2020 and 2021. In particular, the power module for the engine was the number one driver of non-mission capable aircraft and is discussed in more detail below.

- In July 2021, we reported that the F-35 Joint Program Office stated that the program plans to fund enough spare parts to achieve an approximately 15 percent non-mission capable due to supply rate.[9] According to program officials, achieving a lower non-mission capable due to supply rate was not affordable, and would provide only near-term benefits. Therefore, the program has focused on other priorities, such as improving depot repair capacity. Our ongoing works shows that as of September 2021, average depot-level repair times improved to 131 days, from 188 days in November 2018. However, this figure remains well above the program's 30-day program objective. In January 2022, the Director, Operational Test and Evaluation, reported that the limited component-level depot repair capacity contributes to the shortfalls in the supply of spares.[10] According to program officials, part repair times continue to lag because the depots do not yet have

[7]GAO, *F-35 Sustainment: DOD Needs to Cut Billions in Estimated Costs to Achieve Affordability*, GAO-21-439 (Washington, D.C.: July 7, 2021).

[8]GAO, *F-35 Aircraft Sustainment: DOD Needs to Address Substantial Supply Chain Challenges*, GAO-19-321 (Washington, D.C.: Apr. 25, 2019).

[9]GAO-21-439.

[10]Director, Operational Test & Evaluation, *FY 2021 Annual Report*, January 2022.

the capacity to meet program goals for repair time, and they are years away from having sufficient capacity to achieve these goals.

- In April 2019, we reported on the F-35 supply chain and its associated challenges.[11] For example, we recommended that DOD clearly define the strategy by which DOD will manage the F-35 supply chain in the future and update key strategy documents accordingly, to include any additional actions and investments necessary to support that strategy. In October 2021, DOD published a business case analysis that assessed its supply chain strategy, but has not updated its strategy. Implementing this recommendation would allow DOD to provide better supply support for the F-35.

Organizational-level maintenance challenges have increased slightly since 2019. Our prior and ongoing work shows that the non-mission capable due to maintenance rate was almost 15 percent in fiscal year 2019 before decreasing to almost 14 percent in fiscal year 2020 and rising to almost 16 percent in fiscal year 2021.[12] The non-mission capable due to maintenance rate is the percentage of time during which aircraft in the possession of F-35 units are unable to fly or conduct any of their tasked missions due to a maintenance requirement. In July 2021, we reported that two specific challenges were negatively affecting organizational-level maintenance: (1) flight line maintainers' lack of access to technical data (i.e., details about how the aircraft should perform and how to maintain its continued performance) to conduct certain maintenance activities and (2) the availability of support equipment to conduct maintenance efficiently.[13] During our visits to three F-35 installations from January 2022 through March 2022 for our ongoing work on F-35 maintenance, maintenance officers and maintainers continued to report that these issues negatively affected performance.

[11]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-19-321.

[12]GAO-21-439.

[13]"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. § 2.101. See GAO-21-439.

Reliability and Maintainability Remain a Concern

In April 2019, we reported that the F-35 Operational Requirements Document (ORD)—the document that outlines the requirements DOD and the military services agreed the F-35 should meet—identified reliability and maintainability goals for the aircraft.[14] The reliability and maintainability goals lay out specific quantitative metrics aimed at ensuring that an aircraft will be available for operations as opposed to out-of-service for maintenance. DOD also established flight hour thresholds in which the aircraft would be considered mature—the point at which the aircraft has flown enough hours to predictably determine reliability and maintainability over its lifespan.[15] For example, as of June 2021 the F-35A had accumulated over 200,000 flight hours—surpassing the flight hours designated for maturity (75,000 hours), making it eligible for an assessment against the ORD goals.[16] In January 2022, the Director, Operational Test and Evaluation, reported "maintenance data gathered through June 2021 from the U.S. fleet of all three variants show that the F-35A and F-35B are not meeting—and the F-35C is not projected to meet—the full set of ORD reliability and maintainability requirements for mature aircraft."[17]

Reliability and maintainability metrics declined over the last year. In March 2021, we reported that, as of June 2020, the program was meeting or close to meeting 17 of its 24 reliability and maintainability goals.[18] In April 2022, however, we found the program was meeting or close to meeting 11 of its 24 goals as of December 2021, meaning that

[14]GAO, *F-35 Joint Strike Fighter: Action Needed to Improve Reliability and Prepare for Modernization Efforts,* GAO-19-341 (Washington, D.C.: Apr. 29, 2019). An operational requirements document provides a number of performance parameters that a program must meet to provide useful capabilities to the end user by closing identified capability gaps. The F-35 ORD was last updated in August 2008.

[15]GAO, *F-35 Joint Strike Fighter: Development Is Nearly Complete, but Deficiencies Found in Testing Need to Be Resolved*, GAO-18-321, (Washington, D.C.: June 5, 2018).

[16]As of June 2021, the F-35B fleet also had flown just over its 75,000-hour threshold. The F-35C has not yet reached its individual variant threshold of 50,000 hours having flown almost 42,500 flight hours.

[17]Director, Operational Test & Evaluation, *FY 2021 Annual Report*, January 2022.

[18]GAO, *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).

performance fell across 6 of the metrics.[19] Although reliability and maintainability metrics declined this year, the F-35 program office is prioritizing funding and implementing initiatives to improve its reliability and maintainability metrics consistent with our previous recommendations.

In recent years, we made a number of recommendations to improve the F-35's reliability and maintainability, and the program has taken some actions to address them. Specifically, in 2018, 2019, and 2020, we made six reliability and maintainability–related recommendations, including that the program office take steps to ensure those goals are met by aircraft maturity (based on executed flight hours) or revise those goals to be more achievable.[20] DOD concurred with our recommendations and identified actions aimed at addressing them.[21] To date, DOD has implemented four out of the six recommendations.

In particular, in April 2019, we recommended that the F-35 program office assess whether the ORD reliability and maintainability goals are still feasible and to revise the ORD accordingly. This recommendation remains unimplemented.[22] DOD concurred with our recommendation and stated that it would review its reliability and maintainability requirements and possibly revise them. In August 2021, the F-35 Joint Program Office told us it plans to complete the updated ORD by July 2022.

In January 2020, we reported that the F-35 program had set unrealistic operational requirements for reliability.[23] These requirements were, therefore, unachievable during development and before fielding the systems to warfighters. As we have previously reported, when programs overpromise a weapon's prospective performance and deliver systems

[19]These metrics represent a 3-month average and reflect a snapshot in time. Measurable improvements can take time to manifest and metrics can fluctuate substantially from month-to-month. See GAO, *F-35 Joint Strike Fighter: Cost Growth and Schedule Delays Continue*, GAO-22-105128 (Washington, D.C.: April, 25, 2022).

[20]GAO-19-341.

[21]GAO-18-321, GAO-19-341 and GAO-20-339.

[22]GAO-19-341.

[23]GAO, *Defense Acquisitions: Senior Leaders Should Emphasize Key Practices to Improve Weapon System Reliability*, GAO-20-151 (Washington, D.C.: Jan. 14, 2020).

that cannot achieve their requirements, such as reliability goals, the warfighter receives less capability than originally promised.[24]

Furthermore, in January 2020, we found that a weapon system's reliability directly affects how much DOD must spend to operate and support it over its lifetime. Specifically, according to leading reliability engineers, the earlier a change is made to a design, the less costly it will be to the program. As we reported, however, the F-35 program deferred key reliability engineering activities intended to improve system designs, until later in development. As a result, we reported that the program missed opportunities to identify, understand, and mitigate reliability issues early in the development process that could have reduced sustainment-related costs for the program—an issue that has challenged the program as we reported in July 2021 and is discussed in more detail below.[25]

DOD's Strategy for Sustaining the F-35 Engine Does Not Meet the Needs of the Military Services

An increasing number of F-35 aircraft have not been able to fly because they do not have an operating engine. DOD has begun implementing multiyear plans to address engine sustainment challenges, but risk remains. Effective execution of these plans is key and contingent on DOD budgeting for certain levels of funding in fiscal years 2023 and 2024. Even with DOD's improvements in its engine sustainment efforts and its plans to address the issues moving forward, the sustainment strategy for the F-35 engine does not meet the needs of the military services. The military services desire outcomes similar to their other tactical fighter aircraft, which since 2017, have generally experienced 1 percent or less of aircraft being unable to operate due to engine issues.

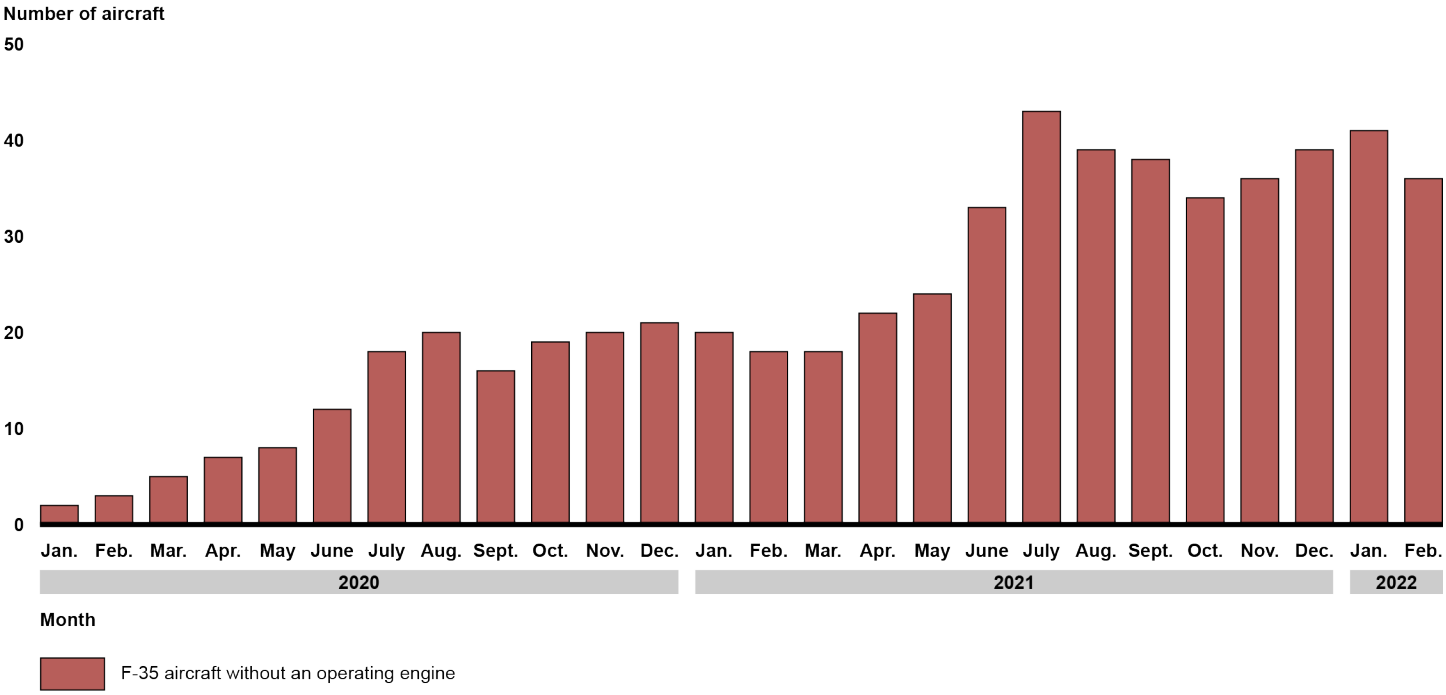
[24]GAO, *Defense Acquisitions: A Knowledge-Based Funding Approach Could Improve Major Weapon System Program Outcomes*, GAO-08-619 (Washington, D.C.: July 2, 2008).

[25]GAO-20-151 and GAO-21-439.

Increasing Number of F-35 Aircraft Have Not Been Able to Fly Because of a Lack of Operating Engines

As described in our draft report, since the beginning of 2020, an increasing number of F-35 aircraft have not been able to fly due to the lack of an operating engine, as shown in figure 5. According to DOD officials, almost all of the aircraft affected by engine issues are operated by the Air Force. In February 2022, 36 of about 450 F-35 aircraft were without an operating engine.

Figure 5: F-35 Aircraft without an Operating Engine, January 2020 – February 2022



Source: GAO analysis of Pratt & Whitney data. | GAO-22-105995

To meet the needs of its mission, DOD has set a goal for the F-35 program that no more than 6 percent of available aircraft should be grounded at any time due to engine status. Prior to January 2021, the F-35 program met the goal for operable engines in 45 of 49 months from 2016 through 2020. However, the non-mission capable rate due to engine issues was above 6 percent from April 2021 to February 2022. The rate has increased over time due to challenges in sustaining the F-35 engine, including insufficient depot capacity to repair the engine—specifically the power module of the engine. Also, the rate has increased due to

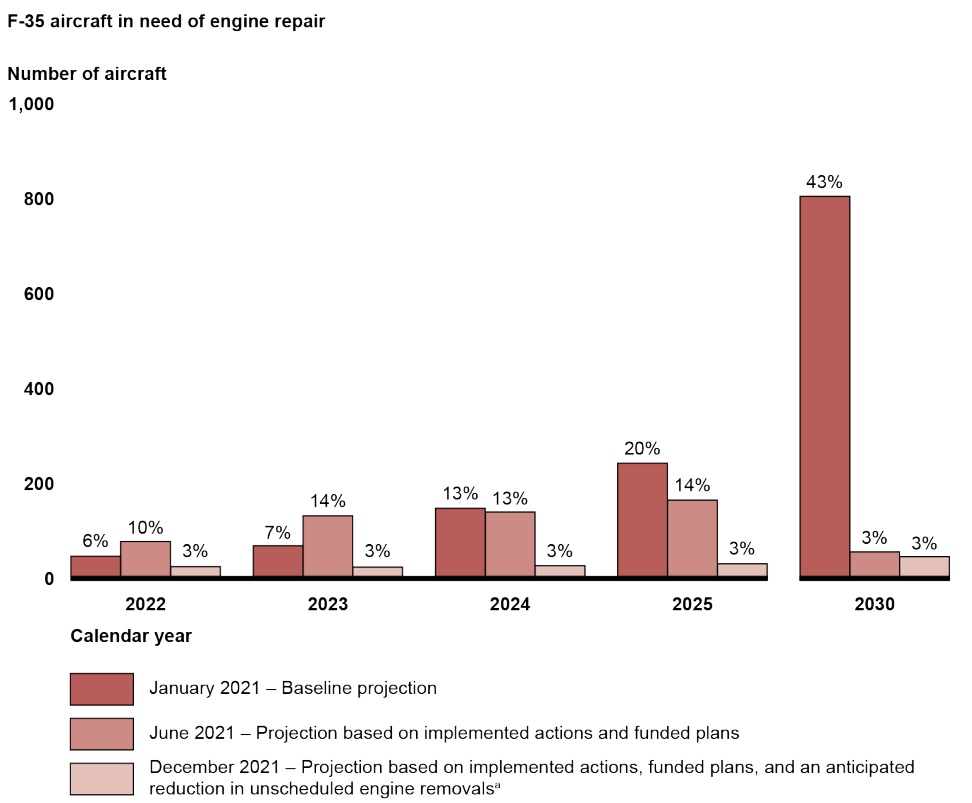
problems with the reliability of certain spare parts. DOD officials stated they recognized that they have not had adequate depot capacity to repair the power module and do not have sufficient capacity to meet the demand of future unscheduled and scheduled engine repairs.

DOD Has Begun Implementing Multiyear Plans to Address Engine Sustainment Challenges, but Risk Remains in Execution of Its Plans

Beginning in the fall of 2020, the F-35 Joint Program Office simultaneously developed and implemented corrective action plans to address sustainment challenges for the engine. In our draft report, we found that these plans focus on (1) improving depot capacity—the facilities, personnel, support equipment, and necessary spare parts—to make the necessary repairs to the engine's power module and (2) taking actions to reduce maintenance demands by improving the reliability and maintainability of spare parts and extending the time the engine can remain on the aircraft.

DOD's implementation of its plans has resulted in improvement in its projected capacity to repair power modules and reduce the number of aircraft without operating engines over the course of the 2020s. Specifically, in December 2021, the F-35 Joint Program Office projected that these actions will result in sustainment improvements so that only 3 percent of F-35s will not have an operating engine by the end of 2022, as shown in figure 6.

Figure 6: Projected Percentage of F-35 Aircraft without Operating Engines, 2022–2025 and 2030



Source: GAO analysis of DOD data. | GAO-22-105995

Text of Figure 6: Projected Percentage of F-35 Aircraft without Operating Engines, 2022–2025 and 2030

- 2022:
  - January 2021 – Baseline projection = 6%
  - June 2021 – Projection based on implemented actions and funding plans = 10%
  - Dec. 2021 – Projection based on implemented actions, funded plans, and an anticipated reduction in unscheduled engine removals = 3%
- 2023:
  - January 2021 – Baseline projection = 7%
  - June 2021 – Projection based on implemented actions and funding plans = 14%

    - Dec. 2021 – Projection based on implemented actions, funded plans, and an anticipated reduction in unscheduled engine removals = 3%
- 2024:
    - January 2021 – Baseline projection = 13%
    - June 2021 – Projection based on implemented actions and funding plans = 13%
    - Dec. 2021 – Projection based on implemented actions, funded plans, and an anticipated reduction in unscheduled engine removals = 3%
- 2025:
    - January 2021 – Baseline projection = 20%
    - June 2021 – Projection based on implemented actions and funding plans = 14%
    - Dec. 2021 – Projection based on implemented actions, funded plans, and an anticipated reduction in unscheduled engine removals = 3%
- 2030:
    - January 2021 – Baseline projection = 43%
    - June 2021 – Projection based on implemented actions and funding plans = 3%
    - Dec. 2021 – Projection based on implemented actions, funded plans, and an anticipated reduction in unscheduled engine removals = 3%

Note: These projections are based on the latest removal forecast (April – June 2021) for F-35 engines that was provided by Pratt & Whitney to the Department of Defense (DOD) and other factors, such as the projected repair capacity of depots.

Source: GAO analysis of DOD Data. | GAO-22-105995

However, our review of these plans and their projected effects determined they are highly dependent on DOD's projected reduction in demand for repairs of power modules. The projection is based on the successful implementation of their initiatives to keep operable engines on the aircraft longer and to improve the reliability of engine parts. Furthermore, DOD's projections are highly dependent on assumptions about (1) the level of funding the F-35 Joint Program Office receives during the fiscal year 2023 and 2024 appropriations processes and (2) how the program addresses risks that could hinder implementation of its plans over the coming years. For example, continuing to enhance the capacity of the depot

maintenance network to meet increasing demands for engine repairs as the fleet grows is contingent on the effective execution of military construction projects at Navy Fleet Readiness Center Southeast in Jacksonville, FL, and the standing up of the engine depot maintenance activities at the facility. Furthermore, these plans assume that additional issues do not arise that affect engine sustainment.

The Sustainment Strategy for the F-35 Engine Is Not Meeting the Needs of the Military Services

In our draft report, we found that DOD's sustainment strategy for the F-35 engine does not meet the needs of the military services, in part because this strategy differs significantly from the sustainment strategy of other fighter aircraft within DOD. The military services desire outcomes similar to their other tactical fighter aircraft, which since 2017, have generally experienced 1 percent or less of aircraft being unable to operate due to engine issues.

For example, DOD's F-35 engine sustainment strategy differs considerably from the strategies developed for other fighter aircraft engines—specifically the engines for the Air Force's F-16 Fighting Falcon and F-22 Raptor and the Navy's F/A-18E/F Super Hornet. In developing a sustainment strategy for the F-35 engine, DOD aimed to balance the performance of the aircraft and the engine with the affordability of sustainment, according to DOD, military service, and Pratt & Whitney officials.

There are three key areas where aircraft sustainment strategies differ:

DOD's goal is having no more than 6 percent of F-35s being without operable engines. This means that DOD has decided it is acceptable for up to 6 percent of F-35 aircraft at any one time to be waiting for a repair part or undergoing engine related maintenance. In contrast, Air Force and Navy officials told us that they calculate a spare engine inventory requirement for other programs to help ensure that those aircraft will be available to meet mission needs. They also maintain a breakdown of the number of engines that need to be ready for use within that inventory. This sustainment approach, in combination with other sustainment aspects discussed in more detail below, has resulted in a lower percentage of inoperable engines—generally 1 percent or less since 2017—for the following aircraft: the Air Force's F-16 and F-22 and the Navy's F/A-18 E/F aircraft, according to service officials.

F-35 program has limited spare engines. The F-35 engine is modular, meaning that specific modules of the engine can be removed and replaced without having to replace the entire engine. Program officials told us that this strategy resulted in the F-35 needing fewer spare engines than other programs. However, since mid-2020, the F-35 program has been unable to repair power modules quickly enough to meet demand, resulting in an increasing shortage of power modules. This led to more than 9 percent of F-35 aircraft being inoperable in February 2022. In contrast, Air Force and Navy officials told us that the F-16, F-22, and F/A-18 E/F programs designed their engine sustainment strategies to ensure they have a certain number of spare engines designed to meet their wartime needs so that aircraft almost always have an operable engine.

F-35 program uses a two-level maintenance approach for its engine. The two levels are organizational-level and depot-level maintenance, while the programs for other DOD fighter aircraft have a third level of maintenance called intermediate. In our draft report, we found that the two-level approach has likely contributed to a depot maintenance backlog because all but the most basic maintenance must be performed at a depot. F-35 Joint Program Office officials stated that the two-level approach costs less than a three-level approach. However, an intermediate-level of maintenance is able to perform more intensive maintenance, such as diagnostic testing and repair or replacement of damaged or unserviceable parts, than the organizational-level. For example, the Air Force maintains the F-22 Raptor engine (also manufactured by Pratt & Whitney) under a three-level maintenance approach with intermediate maintenance shops that can make minor repairs on the engine, preventing some engine maintenance beyond the most basic repairs from being sent to the depot.

Figure 7 shows differences between the sustainment of the F-35 engine and selected Air Force and Navy fighter aircraft engines.

Figure 7: Sustainment for F-35 Engines Compared with Other DOD Fighter Aircraft Engines

	F-35 Lightning II *Joint*	**F/A-18E/F** Super Hornet *Navy*	**F-16** Fighting Falcon *Air Force*	**F-22** Raptor *Air Force*
				
Engine	F135-PW-100 Pratt & Whitney F135-PW-600 Pratt & Whitney	F414-GE-400 General Electric	F100-PW-200/220/229 Pratt & Whitney F110-GE-100/129 General Electric	F119-PW-100 Pratt & Whitney
Number of engines	Single engine	Twin engine	Single engine	Twin engine
Engine attributes	• More than 40,000 pounds of thrust • 1,227 miles per hour	• 22,000 pounds of thrust per engine • 1,381 miles per hour	• 27,000 pounds of thrust • 1,500 miles per hour	• 35,000 pounds of thrust per engine • 1,534 miles per hour
Engine non-mission capable rate goal	No more than 6 percent	None	None	None
War readiness engines (WRE)[a]	None	Yes	Yes	Yes
Levels of maintenance	Two-level maintenance: field and depot	Three-level maintenance: field, intermediate, and depot	Three-level maintenance: field, intermediate, and depot	Three-level maintenance: field, intermediate, and depot
Depot maintenance	Led by the contractor and conducted by service and contractor personnel	Led by the Navy and conducted by Navy personnel	Led by the Air Force and conducted by Air Force, Air National Guard, and civil service personnel	Led by the contractor and conducted by Air Force, contractor, and government personnel

Source: GAO analysis of Department of Defense and Pratt & Whitney information. Photos (left to right): U.S. Air Force/Staff Sgt. Brian Kelly, U.S. Navy/Chief Petty Officer Shannon Renfroe, U.S. Air Force/Airman 1st Class Matthew Seefeldt, and U.S. Air Force/Tech. Sgt. Natasha Stannard. | GAO-22-105995

Data table for Figure 7: Sustainment for F-35 Engines Compared with Other DOD Fighter Aircraft Engines

	F-35, Lighting II, Joint	**F/A-18E/F, Super Hornet, Navy**	**F-16 Fighting Falcon, Air Force**	**F-22, Raptor, Air Force**
Engine	F135-PW-100 Pratt & Whitney F135-PW-600 Pratt & Whitney	F414-GE-400 General Electric	F100-PW-200/220/229 Pratt & Whitney F110-GE-100/129 General Electric	F119-PW-100 Pratt & Whitney
Number of engines	Single engine	Twin Engine	Single Engine	Twin Engine
Engine attributes	• More than 40,000 pounds of thrust • 1,227 miles per hour	• 22,000 pounds of thrust per engine • 1,381 miles per hour	• 27,000 pounds of thrust • 1,500 miles per hour	• 35,000 pounds of thrust per engine • 1,534 miles per hour
Engine non-mission capable rate goal	No more than 6 percent	None	None	None
War readiness engines (WRE) /a/	None	Yes	Yes	Yes
Levels of maintenance	Two-level maintenance: field and depot	Three-level maintenance: field, intermediate, and depot	Three-level maintenance: field, intermediate, and depot	Three-level maintenance: field, intermediate, and depot

	F-35, Lighting II, Joint	F/A-18E/F, Super Hornet, Navy	F-16 Fighting Falcon, Air Force	F-22, Raptor, Air Force
Depot maintenance	Led by the contractor and conducted by service and contractor personnel	Led by the Navy and conducted by Navy personnel	Led by the Air Force and conducted by Air Force, Air National Guard, and civil service personnel	Led by the contractor and conducted by Air Force, contractor, and government personnel

[a]The Air Force uses the term war readiness engines, which are engines required to support a weapon system from the start of the war until resupply is established. The Navy uses a similar concept referred to as the engine readiness goal, which is the number of ready-for-issue engines, modules, or propulsion sub-systems that must be available to execute the national military strategy and its Optimized Fleet Response Plan.

Source: GAO analysis of Department of Defense and Pratt & Whitney information. Photos (left to right): U.S. Air Force/Staff Sgt. Brian Kelly, U.S. Navy/Chief Petty Officer Shannon Renfroe, U.S. Air Force/Airman 1st Class Matthew Seefeldt, and U.S. Air Force/Tech. Sgt. Natasha Stannard. | GAO-22-105995

DOD policy requires maintenance programs, including those for weapons systems, to be structured for meeting readiness and sustainability objectives, including surge capabilities, to meet national defense requirements.[26] Further, DOD's highest priority is to provide warfighters with the capabilities urgently needed to overcome unforeseen threats, achieve mission success, and reduce risk of casualties.

However, the F-35 Joint Program Office, in collaboration with the military services, has not assessed and updated the F-35 engine sustainment strategy to address shortcomings and future challenges. In particular, DOD has not assessed and documented whether the goal of the 6 percent non-mission capable rate goal, spare engine and module inventory levels, and the two-level maintenance approach remain appropriate for achieving DOD's desired outcomes now and in the future.

In our draft report that we provided to DOD for comment, we are recommending that the Secretary of Defense should ensure that the F-35 Joint Program Office assesses and updates the F-35 engine sustainment strategy, including its goals and the necessary actions to achieve its goals. By doing so, the F-35 program could improve its ability to meet the needs of the military services. Also, DOD and the military services could be positioned to make informed, cost-effective decisions given the interrelated nature of the potential actions. Such actions could provide the required number of spare engines and modules and the levels of maintenance and capacity needed to repair the modules.

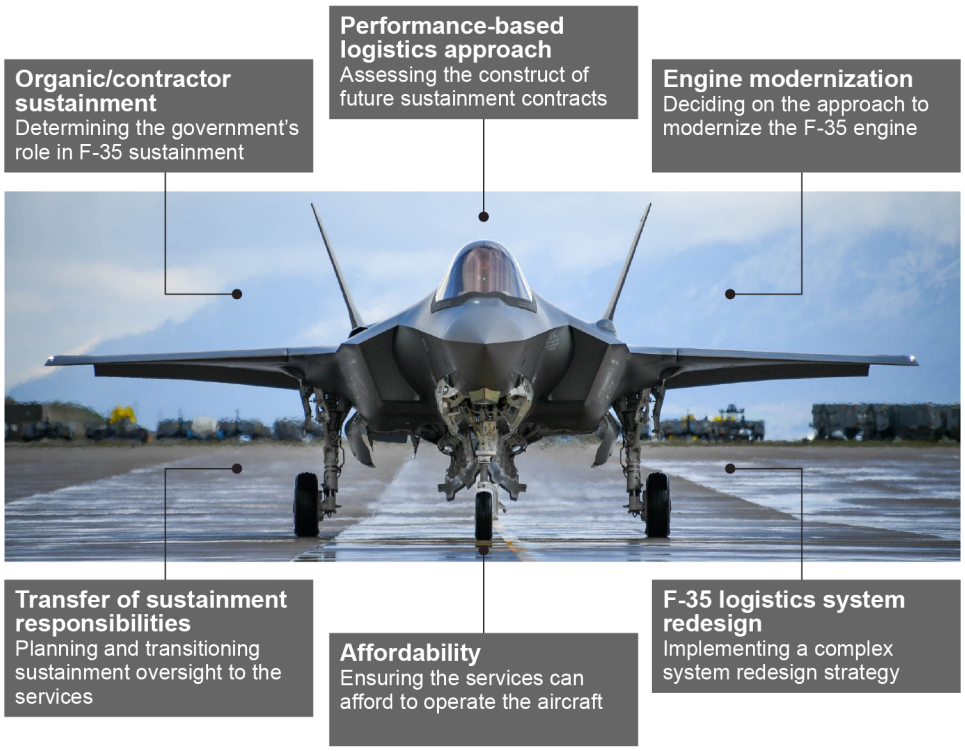
[26]DOD Directive 4151.18, *Maintenance of Military Materiel* (Mar. 31, 2004) (incorporating Change 1, Aug. 31, 2018).

DOD Faces Several Uncertainties as It Determines the Future of F-35 Sustainment

Since 2014, we have reported on several operational and affordability challenges associated with sustainment of the F-35.[27] DOD officials are aware of these challenges and agreed that changes must be made to F-35 sustainment to improve both aircraft readiness and program affordability. The department is taking encouraging steps with its increased focus on F-35 sustainment and its ongoing assessments to determine how to achieve improved sustainment-related outcomes. However, our ongoing work shows that DOD still faces several uncertainties as it works to determine the future of F-35 sustainment, as shown in figure 8. These uncertainties, all of which are independently complex, are also inherently connected. This will require DOD to address them concurrently, further complicating DOD's efforts to plan for the future of F-35 sustainment.

[27]GAO, *F-35* Sustainment*: Need for Affordable Strategy, Greater Attention to Risks, and Improved Cost Estimates*, GAO-14-778 (Washington, D.C.: Sept. 23, 2014); 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); GAO-18-75; GAO-19-321; GAO, *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); and GAO-21-439.

Figure 8: Uncertainties Shaping the Future of F-35 Sustainment



Source: GAO analysis of Department of Defense information; U.S. Air Force/R. Nial Bradshaw (photo). | GAO-22-105995

Organic and Contractor Sustainment Options and Impacts on F-35 Sustainment

Our ongoing work shows that DOD officials are trying to determine what options the F-35 program has to expand organic (i.e., government owned and operated) sustainment.[28] According to DOD, the F-35 program was originally structured under a concept in which the contractor, rather than the government, conducted the majority of sustainment. DOD called this concept Total System Performance Responsibility (TSPR). As a result, the government did not procure technical data that the government could eventually use, as needed and depending upon the circumstances, to promote vendor competition and increase government control over specific elements of sustainment. According to DOD officials, after

[28]Generally, in the context of weapon system sustainment, the term organic is used to refer to capabilities the military services manage and operate. Organic assets are non-contractor and non-commercial.

several years of procuring, flying, and sustaining the F-35, DOD officials realized that the TSPR concept was unsustainable due to high costs. Therefore, in 2016 the department shifted toward a Global Support Solution, with the goal to provide government oversight of sustainment through a hybrid mix of organic (i.e., government) and commercial organizations.

Since the transition to the Global Support Solution, DOD has been assessing how it can transition more aspects of sustainment to the government. For example, the department designated the Defense Logistics Agency and U.S. Transportation Command as the global providers for warehousing and transportation for the F-35 program in 2019. Both organizations are beginning to provide the F-35 program with a range of limited organic capabilities for storage and distribution. However, Defense Logistics Agency and U.S. Transportation Command officials told us that the prime contractor, Lockheed Martin, continues to have substantial control in these areas. According to officials from both organizations, the government still has very limited control over the F-35 supply chain, including ordering, part procurement, and inventory.

On site visits to three F-35 installations and two F-35 aircraft depots from January 2022 through March 2022, organizational- and depot-level maintenance officials told us that the contractor is embedded in day-to-day sustainment operations. For example, maintainers at all three F-35 installations told us that they are frequently constrained with what they are allowed to repair due to the proprietary nature of several elements of the aircraft that require contractor labor or oversight. Furthermore, government officials at both aircraft depots told us that beyond providing facilities and labor, the government has little control over depot operations, especially as it relates to planning and management. Depot officials told us they are in an awkward position—a government entity, but one that must work through and is reliant on Lockheed Martin and other commercial sub-contractors responsible for respective components on the F-35.

DOD is aware of how embedded contractors remain within F-35 sustainment and continues to explore avenues to expand government management and control. For example, in October 2021 DOD released a Business Case Analysis that assessed, among other things, organic and contractor sustainment within the F-35 program. Furthermore, DOD officials told us the F-35 Joint Program Office created an Organic Pathfinder Initiative in 2021 to identify more elements of sustainment that the government could potentially undertake. However, according to DOD

officials, specific actions have yet to be taken as a result of these initiatives.

It will be a challenge for the department to reclaim more government control of sustainment in a program that began with total contractor reliance and little-to-no technical data. In September 2014, we recommended that DOD should develop a long-term Intellectual Property Strategy to include, but not be limited to, the identification of current levels of technical data rights ownership by the federal government and all critical technical data needs and their associated costs.[29] Such action could promote competition, address affordability, and inform DOD's overarching sustainment strategy. However, as of February 2022, this recommendation remained unimplemented as DOD had not produced a completed strategy.

Performance-Based Logistics Approach for F-35 Sustainment

We previously reported that historically DOD has contracted for F-35 sustainment support with the prime contractor, Lockheed Martin, through annual contracts.[30] This changed in September 2021 when, according to DOD and Lockheed Martin, they finalized a fiscal year 2021-2023 multiple-year (base year plus options years) sustainment contract, including a mix of cost-plus-fixed-fee, and cost-plus and fixed-price incentive fees. Officials previously noted that a multiple year sustainment contract would be an attempt to achieve system level performance outcomes and cost reductions. However, DOD still reports that it eventually wants to transition to multiple-year, fixed-price, performance-based logistics contracts for at least some aspects of F-35 sustainment.[31]

Understanding that DOD wanted to transition eventually to performance-based logistics contracts, we recommended in October 2017 that DOD reexamine the metrics that it will use to hold the contractor accountable under a performance-based logistics contract.[32] We reported that the

[29]GAO-14-778.

[30]GAO-21-439.

[31]Performance-based logistics is a support strategy that emphasizes performance in contracts, rather than delivery in goods and services; payment is related to the degree to which performance meets contracted standards.

[32]GAO-18-75.

metrics used needed to be objectively measurable and fully reflective of processes over which the contractor has control. Furthermore, we recommended that DOD ensures it has sufficient knowledge of actual sustainment costs, such as the actual costs of parts and repairs, and the technical characteristics of F-35 aircraft, such as reliability and maintainability of systems and parts, before entering into these types of contracts. DOD concurred with these recommendations. However, as of April 2022, these recommendations remained unimplemented.

The National Defense Authorization Act for Fiscal Year 2022 placed conditions on DOD to enter into a performance-based logistics sustainment contract for the F-35.[33] Specifically, the Secretary of Defense must certify to the congressional defense committees that a performance-based logistics contract will reduce sustainment or operating costs or increase readiness rates, full and partial mission capability rates, or airframe and engine availability rates.

Our ongoing work shows that the F-35 program plans to assess current cost-plus sustainment contracts and which areas of the enterprise are mature enough to leverage performance incentives and become fixed-price contracts. In October 2021, DOD published a business case analysis that evaluated the program's current sustainment strategy and explored alternative sustainment solutions to help the department make an informed decision on tradeoffs between commercial performance-based logistics and traditional, government solutions. Although DOD has not made definitive decisions based on the business case analysis, the department will use its results as one of several points to shape the suture sustainment strategy. In our ongoing work, DOD officials have told us that there is disagreement within the department on whether DOD is ready to enter a performance-based logistics contract with the prime contractor and what specific elements the contract would contain.

Furthermore, some DOD officials we spoke to were hesitant to accept the outcomes of the business case analysis on the basis that the study's scope was limited solely to the F-35 program without consideration for broader departmental concerns. Specifically, DOD officials were unclear if such a performance-based logistics contract is an appropriate approach considering the department is working to divest from legacy aircraft, as it has proposed for fiscal year 2023.

[33]Pub. L. No. 117-81, § 356.

If legacy aircraft are divested over the coming years, according to those same officials, there would be greater organic capacity at both the organizational and depot levels that could and may need to transition to maintaining F-35 aircraft. Some DOD officials told us that they are concerned about the operation and financial solvency of the defense-wide and service-specific working capital funds used to sustain many of the department's weapon systems.[34] These funds are used to provide goods (e.g., spare parts) and services (e.g., depot maintenance) to consumers within DOD. However, according to DOD officials, the F-35 program does not use the working capital funds to support its operations. According to DOD officials, when legacy aircraft that are supported through these working capital funds are divested, the department's and services' working capital funds will likely experience less business over time, which could diminish the organic industrial base.[35] For example, the working capital fund—given that it operates like a business—could need to cut costs resulting in the loss of civilian positions that manage spare part requirements and broader weapon system sustainment efforts. These civilians may no longer have spare parts or weapon systems to manage due to the divestment of legacy aircraft, and due to these functions being overseen and managed by the contractor for the F-35.

F-35 Engine Modernization and Sustainment Implications

As we reported in April 2022 and in our draft report, the F-35 program is in the early planning stages of F-35 engine modernization that is necessary to support future Block 4 capabilities.[36] In our draft report, we noted that Air Force officials told us that the F-35 is being flown harder than originally anticipated, and an upgraded engine that meets its needs

[34]A working capital fund relies on sales revenue rather than direct appropriations to finance its continuing operations and is intended to (1) generate sufficient resources to cover the full costs of its operations and (2) operate on a break-even basis over time—that is, neither make a gain nor incur a loss. Customers use appropriated funds to finance orders placed with the working capital fund.

[35]For additional information on working capital funds, see GAO, *Defense Management: Defense-Wide Working Capital Fund Agencies Apply Most Key Operating Principles but Should Improve Pricing Transparency*, GAO-20-65 (Washington, D.C.: Nov. 1, 2019) and *Depot Maintenance: DOD Should Adopt a Metric That Provides Quality Information on Funded Unfinished Work*, GAO-19-452 (Washington, D.C.: July 26, 2019).

[36]Block 4 is a modernization effort that includes efforts to enhance and add capabilities—beyond the F-35 baseline program—through hardware and software upgrades. See GAO-22-105128.

is imperative for meeting its mission. The National Defense Authorization Act for Fiscal Year 2022 directed the Secretaries of the Air Force and Navy to develop competitive acquisition strategies for F-35 engine modernization that would be integrated into the fleet starting no later than fiscal year 2027. DOD is considering two options for the modernization:

- **Enhanced current engine:** Pratt & Whitney is exploring ways to improve the current engine. This option would work with all three F-35 variants and increase overall performance of the current engine, such as improved range and thrust.
- **Two new engines:** The Air Force is exploring a different engine for the U.S.'s F-35A and C variants to provide additional thrust and range, among other things.[37] However, officials from the F-35 Joint Program Office stated this engine would not work for the F-35B variant, so another engine modernization effort would still be required for that aircraft.

According to officials from the F-35 program, military services, and Office of the Secretary of Defense, modernization of the F-35 engine—regardless of which option is decided upon—is likely to increase the overall costs of the program, including the cost of the engine's sustainment. Furthermore, depending on which option is chosen, DOD will need to determine how the approach fits within its overall engine sustainment strategy and any effect on existing infrastructure that will need to be replaced, upgraded, or obtained. As DOD moves forward with engine modernization, it will be key for the department to consider implications to sustainment as the department makes decisions on its overall engine sustainment strategy, as we are recommending in our draft report.

Transfer of Sustainment Responsibilities from F-35 Joint Program Office to Services

The National Defense Authorization Act for FY 2022 requires transfer of U.S. F-35 oversight responsibilities from the F-35 Joint Program Office to the Department of the Air Force and the Department of the Navy. Specifically, all responsibilities relating to acquisition functions and the management, planning, and execution of sustainment will transfer away from the F-35 Joint Program Office to the military departments. Both

[37]The Air Force is exploring a different engine as part of its Adaptive Engine Transition Program.

functions will be taken over by the Secretary of the Air Force for F-35As and the Secretary of the Navy for the F-35Bs and F-35Cs. With respect to sustainment, each military department will adopt all F-35-related sustainment functions by the start of fiscal year 2028.[38]

Our ongoing work shows that DOD is in the process of creating a plan to chart a path forward on what acquisition and sustainment oversight management will look like under the purview of the Air Force and Navy. However, there remain differing perspectives within DOD on the extent to which this transfer amends the current sustainment concept between the program's various stakeholders, including the future role of the F-35 Joint Program Office. Furthermore, DOD officials told us they were unsure how this transition would unfold since they are still finalizing a transfer plan. Ultimately, the transition will give the military departments more decision-making responsibility in the best interest of their respective aircraft. However, questions remain as to how this transition will fit into the future sustainment concept that will, inevitably, include international partners.

Ensuring Continued Progress in Improving the F-35's Central Logistics System

We have reported on numerous, long-standing challenges with the F-35's Autonomic Logistics Information System (ALIS) dating back to 2014.[39] 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). However, as we reported in April 2022, due to multiple factors that included budget cuts, lack of access to proprietary ALIS software code, and ongoing improvement to ALIS, the F-35 Joint Program Office decided to incrementally improve and modernize ALIS instead of replacing it with a new system.[40] DOD officials stated that when key elements of the ALIS system are significantly improved, they intend to rename the system ODIN.

In March 2020, we recommended that DOD develop and implement a strategy for the redesign of ALIS that clearly identifies the goals, key

[38]Pub. L. No. 117-81, § 142.

[39]GAO-14-778, GAO-16-439, and GAO-20-316.

[40]GAO-22-105128.

risks, and costs of redesigning the system.[41] In November 2021, DOD released the ALIS Redesign Strategy that included an identification of goals, key risks, and other important aspects of the desired pathway for the redesign, which fully implemented our recommendation. While we are encouraged by the department's development of a strategy for the redesign of ALIS, implementing the complex technical and programmatic aspects of the strategy, several of which we highlighted in our March 2020 report, will be challenging.[42] The government has limited access and control over ALIS infrastructure, restricting DOD's ability to reduce sustainment costs and improve warfighting outcomes. Furthermore, according to DOD officials, a planned date for the completion of the redesign and its renaming to ODIN is undetermined. While the department has made progress in addressing challenges with the F-35's central logistics system, sustained management attention in the coming years will be important to continuing this progress.

Affordability of F-35 Sustainment

The F-35 program faces a considerable affordability challenge as it continues to procure aircraft and determine the future of sustainment. In July 2021, we reported that since 2012, estimated F-35 life-cycle sustainment costs have increased steadily from $1.11 trillion to $1.27 trillion, even though DOD has made efforts to reduce costs.[43] At the time of our report, 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. Collectively, the services will be confronted with tens of billions of dollars in sustainment costs that they project as unaffordable during the program's life cycle. We reported that within DOD there are differing perspectives on the best course of action to achieve the affordability constraints and the program does not have a strategic approach for ensuring the services can afford to operate and support the F-35.

In our July 2021 report, we suggested that Congress consider (1) requiring DOD to report annually on progress achieving the services' affordability constraints, and (2) making future F-35 aircraft procurement

[41]GAO-20-316.

[42]GAO-20-316.

[43]GAO-21-439.

decisions contingent on DOD's progress in achieving F-35 sustainment affordability constraints. In the National Defense Authorization Act for Fiscal Year 2022, Congress took steps to address one of these suggestions by limiting the quantity of F-35s maintained by the military services beginning in fiscal year 2029 based on their ability to achieve affordability cost targets.[44] Additionally, we made four recommendations to DOD to help the program define a pathway to achieving affordability. For example, we recommended that DOD assess and document changes in service-related program requirements (e.g., the number of aircraft purchases and flying hours) to achieve cost-reductions. Reducing sustainment costs becomes more difficult as the fleet grows and aircraft mature, which increases the imperative for all stakeholders to work together.

DOD agreed with the substance of each recommendation and identified actions it is currently taking or planning to take to address them. However, DOD stated that it was uncertain whether it could take actions to address it prior to a Milestone C decision—a decision point for moving into full-rate production of the aircraft, as we recommended. DOD stated that it would not be able to determine this until the department identified a new date for declaring Milestone C. DOD has not yet identified a date for its Milestone C decision.[45] We maintain that DOD should address these recommendations before a Milestone C decision. As we previously reported, prior to declaring Milestone C the program is to weigh, among other factors, the program's sustainment planning and affordability to make a sound investment decision committing the department's financial resources.[46] Given the magnitude of the gap between projected sustainment costs and the services' affordability constraints, we believe that the department, the services, and the F-35 Joint Program Office should not delay critical decisions necessary for ensuring the affordability of the program. Implementing our recommendations before declaring

[44]*See* Pub. L. No. 117-81, § 141.

[45]In April 2022, we reported that DOD postponed the F-35 full-rate production decision due to delays in completing initial operational testing for the F-35, but continues to buy aircraft at near full-production rates. Our past work indicates that purchasing large numbers of aircraft before completing testing, resolving deficiencies, and reaching the full-rate production milestone and its associated requirements, increases the risk of additional retrofit costs. See GAO-22-105128 and *KC-46 Tanker Modernization: Aircraft Delivery Has Begun, but Deficiencies Could Affect Operations and Will Take Time to Correct*, GAO-19-480. (Washington, D.C.: June 12, 2019).

[46]GAO-21-439.

Milestone C and moving into full-rate production would help ensure that DOD can afford to sustain the F-35 program.

In summary, the F-35 program has enhanced its focus on sustainment issues and has made improvements over the past several years. However, the F-35 is not meeting its minimum mission capable performance targets or its reliability and maintainability metrics. DOD is also confronted with several complex, connected challenges and uncertainties in achieving its sustainment objectives for the program. DOD would improve the department's ability to meet these challenges and uncertainties by implementing our prior recommendations. Looking ahead, our oversight work will continue to help the department and Congress address key decisions for the future of F-35 sustainment.

Chairman Garamendi, Ranking Member Waltz, and Members of the Subcommittee, this completes my prepared statement. I would be pleased to respond to any questions that 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 (Assistant Director), Jeff Hubbard (Analyst-in-Charge), Leslie Bharadwaja, Vincent Buquicchio, Christopher Gezon, Kevin Keith, Amie Lesser, Marshal Pennock, Janine Prybyla, Richard Powelson, Terry Richardson, and Mike Silver.

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