TAXPAYERS for COMMON SENSE

REPORT

August 2024

Trouble on the Horizon: Pitfalls of the Sixth-Generation Fighter Aircraft

Senior Airman Brent Kyzar, an air traffic control apprentice, scans for aircraft on the flightline at Fairchild Air Force Base, Washington. Jan. 5, 2023. U.S. Air Force photo by Airman 1st Class Stassney Davis.

Executive Summary

The Air Force and Navy are both in the early stages of developing distinct sixth-generation fighter aircraft programs. Both services are pursuing a "family of systems" approach, which currently includes manned fighter aircraft, unmanned drones acting as wingmen, and ground-based command and control systems. The Air Force estimates that each manned fighter could cost up to $300 million. The Navy has yet to publicize cost estimates for its fighter.

As the Pentagon presses ahead with these programs, it must learn from the mistakes of the fifth-generation F-35 Joint Strike Fighter program, which has faced calamitous cost overruns, schedule delays, and performance problems. The Pentagon has announced steps to avoid similar pitfalls, such as eschewing a joint program, reducing design and production overlap or "concurrency," adopting open system architecture, and ensuring access to necessary technical data needed for sustainment. However, it risks repeating these and other mistakes by pursuing a large and complex set of capabilities under one platform and failing to adequately assess alternatives for meeting strategic requirements.

These programs also face next-generation challenges, including the risks of fielding autonomous weapons systems and resource constraints driven by a confluence of modernization programs requiring unsustainable levels of spending. Taxpayers cannot afford another Pentagon boondoggle like the F-35. Therefore, it is crucial that

the Air Force, Navy, and Congress carefully consider the strategic rationale, cost risks, and schedule delays for each component of these sixth-generation fighter programs.

This report recommends that Congress require analyses of alternatives to evaluate other options for meeting strategic needs, including questioning the necessity of sixth-generation fighters. It recommends policymakers pause all funding for these programs pending the results of these analyses. Additionally, Congress should require that at least 90 percent of sixth-generation fighter programs' designs be completed before their critical design reviews. Congress should also mandate that the Air Force and Navy report on plans to avoid duplicative and wasteful spending on interoperable subsystems for Collaborative Combat Aircraft (CCAs). Lastly, this report recommends that Congress require the Pentagon to report on regulations and procedures for using autonomous weapons in conflict and any associated cybersecurity risks.

6th Generation Fighter Programs

There are currently two major programs pursuing sixth-generation fighter aircraft: the Air Force's Next Generation Air Dominance (NGAD) program and the Navy's "Next Generation Fighter" program. Both are classified, though some characteristics of each program are known.

Air Force Plans

The NGAD program was initially intended to replace the F-22 Raptor (which had its own costly, troubled acquisition) within the next decade, with deployment expected to begin in 2030. The Air Force has said it plans to purchase 200 sixth-generation manned fighter jets and 1,000 CCAs—autonomous unmanned aerial vehicles that can either deploy independently or fly alongside manned fighters. Each sixth-generation fighter jet is expected to be paired with two CCAs, as would 300 F-35 Joint Strike Fighter aircraft.[1] Air Force Secretary Frank Kendall, however, cautioned that the ultimate inventory of CCAs may be higher, saying "It could be more than that (1,000 CCAs). It's going to be a question of what the technology will support and what works out best for operational forces."[2] In separate statements, Secretary Kendall highlighted that up to "four or five" CCAs could be linked to a single manned fighter, and that the Air Force might procure up to 2,000 CCAs.[3]

The NGAD fighter, the centerpiece of the program, is being designed for both air-to-air combat and air-to-ground attacks.[4] In June 2022, Secretary Kendall said the NGAD program was ready to move to the Engineering, Manufacture, and Design (EMD) phase, and in May 2023, the Air Force issued a solicitation for the EMD contract, which was originally expected to be awarded in 2024.[5]

CCAs will serve as wingmen for both the sixth-generation fighter and the fifth-generation F-35. Characterizing CCAs during the 2023 Air and Space Forces Association Warfare Symposium, Secretary Kendall said, "One way to think of CCAs is as remotely controlled versions of the targeting pods, electronic warfare pods, or weapons now carried under the wings of our crewed aircraft."[6]

Five companies were originally vying to design the CCAs: Lockheed Martin, Boeing, Northrop Grumman, General Atomics, and Anduril. In April, the Air Force selected Anduril and General Atomics to continue developing their designs but, bucking standard practice, it is considering using different companies for design and production phases, allowing other companies to compete for production contracts.[7] In a press release, the Air Force wrote, "The companies not selected to build these production representative CCA vehicles, and execute the flight test program, will continue to be part of the broader industry partner vendor pool consisting of more than 20

companies to compete for future efforts, including future production contracts."[8] The service expects to award one or more contracts for CCAs in late September or early October, possibly to both Anduril and General Atomics.[9]

The Air Force first requested funds for its NGAD program in its Fiscal Year (FY) 2015 budget request, which sought $15.7 million for the program.[10] Since then, spending has grown rapidly. Between FY2015 and FY2023, Congress appropriated over $4.7 billion for the NGAD program.[11] In FY2024, Congress matched the Air Force's $2.3 billion request, which included $1.9 billion for the NGAD fighter and $392 million for CCAs, bringing total appropriations to over $7.1 billion.[12] In July 2024, the Air Force requested permission to reprogram an additional $150 million for the CCAs, a nearly 40 percent increase for the fiscal year.[13]

For FY2025, the Air Force is requesting $3.3 billion, $2.7 billion (83 percent) for the NGAD fighter and $557 million (17 percent) for CCAs.[14] The House-passed Defense Appropriations Act for FY2025 would fund almost the entire request, cutting just $3.3 million.[15] Over the next four fiscal years, the Air Force plans to request an additional $25.1 billion for the NGAD program.[16]

These figures do not include funding for certain programs that will be integral to the eventual fielding of a sixth-generation fighter program, like the Next Generation Adaptive Propulsion (NGAP) program, which is responsible for the NGAD fighter's engine. The Air Force requested $562.3 million for the NGAP program in FY2025.[17] Importantly, this development funding does not cover procurement, operation, and sustainment expenses for each component of the NGAD program.

Air Force Secretary Frank Kendall speaking at the Air & Space Forces Association 2024 Warfare Symposium in Aurora, Colorado. Feb. 14, 2024. U.S. Air Force photo by Eric Dietrich.

Secretary Kendall has said that each NGAD fighter could cost as much as $300 million, roughly three times the per-unit cost of the F-35, and that each CCA could cost about $27 million.[18] These estimates include procurement costs but do not include the cost to sustain and operate the aircraft over their lifecycle.

Recognizing these immense and growing costs alongside other modernization plans, the Air Force is considering changes to bring the cost down. During a June event, Air Force Chief of Staff Gen. David Allvin was asked, "Do you think you can still do NGAD, or is that going to have to change into something that turns over every couple of years?" In response, he said "we're going to have to make those choices, make those decisions, across the landscape. That's going to probably play out in the next couple years or by this '26 POM (Program Objective Memorandum) cycle. So those are things in work."[19] These comments led some observers to question whether the program would move forward at all.

Addressing those concerns, Secretary Kendall told Defense News that, "The family of systems concept of Next Generation Air Dominance is alive and well. I can tell you that we are looking at the NGAD program design concept to see if it's the right concept or not… We're looking at whether we can do something that's less expensive and do

some trade-offs there." Asked what an acceptable per-unit cost for the fighter would be, Kendall said, "Ideally, I'd like to get it down to less than an F-35, or at least in the ballpark of an F-35. F-35s, as you know, are not cheap airplanes."[20]

One piece of the program the Air Force is eying for cost reductions is the adaptive engine for the fighter. "The way you do that is if you can reduce the complexity, but also the size of the engine," said Kendall.[21]

Further uncertainty arose when, Gen. Kenneth Wilsbach, head of Air Combat Command, revealed that the Air Force is no longer considering the NGAD program as a replacement for the F-22, saying, "Right now, frankly, there isn't an F-22 replacement… The F-22 is a fantastic aircraft. We're actually planning several upgrades to the jet as we speak, and there is no official replacement to the F-22 right now."[22]

While Kendall's remarks suggest the program will move forward in some form, questions about the program's ultimate design and cost remain unanswered. Observers are looking to him for clarity. When asked if the Air Force still intended to award an engineering and manufacturing development contract for the manned fighter in 2024, Kendall said, "I'm not ready to talk about any specific changes yet."[23]

In a later interview with *Breaking Defense*, Secretary Kendall left the door open to building an unmanned rather than manned fighter, alongside the CCAs, stating, "I'm confident there's going to be a sixth-generation fighter. I'm reasonably confident that it's going to be crewed."[24]

Opting for an uncrewed fighter may have benefits, both in terms of cost reduction and capabilities. The redundancy of safety systems needed on a manned aircraft is costly, and the additional space needed for pilots affects design and means more tonnage and in turn more cost. Regarding capability, uncrewed platforms could also be capable of higher-G force maneuvers, making them more useful in certain combat situations. At the same time, pursuing an uncrewed fighter would bring more uncertainty to the program, as developing and fielding the new technology needed for such a system may or may not be a smooth process.

As the Air Force grapples with these considerations, Kendall has suggested it might delay awarding the EMD contract for the fighter. Remarkably, he also conceded that, "if you look at what we do in our five-year plan—that is on the Hill now—to our foundational accounts in the out years, it's clear we did something there that's not going to be, you know, sustainable."[25] However, Kendall emphasized that the need to rethink the program was not solely about cost, adding, "we also have to go look at and verify, if you will, that we had the right concept."[26]

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>
> – Air Force Secretary Frank Kendall

Navy Plans

Compared to the Air Force's NGAD program, even less is publicly known about the Navy's plans for its own sixth-generation fighter. The F/A-XX, a temporary name for the Navy's sixth-generation fighter, is intended to replace the F/A-18 Super Hornet as the service's next strike fighter. While details of the program remain classified, it appears the Navy is pursuing an approach similar to the Air Force's NGAD program—a manned strike fighter linked with CCAs.[27]

The Navy's first request for funding for its sixth-generation fighter came in FY2015 under a program element called "Studies & Analysis Supt – Navy." The request and eventual appropriation totaled $4.8 million.[28] In its FY2016 budget request, at the request of Congress, the program was given its own program element, named "(U)Next Generation Fighter."[29] From FY2016 to FY2020, Congress appropriated $19.3 million for the next-generation fighter under this program element.[30] In FY2021 and 2022, the Navy zeroed out its request for the program, and in FY2023, the program element was eliminated altogether.[31]

In FY2024, the Navy's next-generation fighter found its way into a longstanding classified program element called "Link Plumeria." Within this program, the Navy requested $1.5 billion for the F/A-XX, and an additional $572.2 million for a project line called "1978: Link Plumeria."[32] Given the Navy's stated desire to pursue a family of systems approach for its next-generation fighter, it is plausible that the $572 million was meant to fund complementary systems for the fighter, such as CCAs, though given the classified nature of the program it is impossible to know. Congress appropriated just over $2 billion for Link Plumeria in FY2024, $90 million less than the Navy requested.[33]

In its FY2025 budget request, the Navy zeroed out the funding request for the F/A-XX within the Link Plumeria program element, though it still requested an additional $346.5 million for "1978: Link Plumeria."[34] Instead, it requested $453 million for the F/A-XX in a new program element simply called "Next Generation Fighter."[35] According to a news report citing senior military leaders, the significantly lower request for the fighter compared to FY2024 represents a delay in funding to support near-term investments rather than an indication that the Navy is abandoning plans for its next-generation fighter.[36]

The House-passed Defense Appropriations Act for FY2025 fully funds the Navy's request for both Link Plumeria and the Next Generation Fighter.[37] However, the Senate Armed Services Committee cut another $400 million from the Next Generation Fighter program in its draft of the FY2025 National Defense Authorization Act (NDAA).[38] Given that the Senate's draft NDAA would increase the Pentagon budget topline by $25 billion, it appears that the Senate Armed Services Committee sees the Navy's sixth-generation fighter as a lower priority than other fully funded programs, at least for the time being.

Lockheed Martin, Boeing, and Northrop Grumman have all expressed interest in securing the production contract for the F/A-XX, while Pratt & Whitney and GE Aerospace are facing off for the contract to build its engine.[39]

The Navy has yet to publicize a cost projection for its sixth-generation fighter, but it has said that CCAs for its program will need to cost no more than $15 million per unit.[40]

Lessons from the F-35

As the Air Force and Navy each pursue plans for fielding a sixth-generation fighter in the 2030s, program officials have publicly voiced their intention to learn from the mistakes of the embattled F-35 Lightning II Joint Strike Fighter program, which has faced crippling cost overruns, schedule delays, and performance problems. An in-depth look at those challenges is warranted to assess the Pentagon's progress thus far in implementing lessons learned from the F-35.

The F-35 has been plagued by poor planning and bad decisions since its inception. At a projected cost of over $2 trillion through 2088, it is currently far and away the most expensive weapon system the U.S. has ever built.[41] Despite this enormous cost, the F-35's full mission capable rate—the percentage of time it can fly and perform all

of its missions—is abysmal, about 30 percent on average across the fleet.[42] Understanding how choices made in acquisition led to a range of bad outcomes for the program can help ensure that the Pentagon does not repeat the mistakes of the past as it forges ahead with plans for the next generation of fighter aircraft.

In the case of the F-35, at least two motivations drove several bad decisions over the course of the program's development and acquisition. The first was the Pentagon's desire to field the F-35 as quickly as possible. The second was its desire to make the F-35 a catch-all platform capable of performing a wide variety of missions. The decisions that followed fueled cost growth, schedule delays, and performance problems that continue to haunt the program.

Immature Technologies

In 2005, the Government Accountability Office (GAO), Congress' nonpartisan investigative arm, found that contrary to best practices, the F-35 program had begun development "without adequate knowledge of the aircraft's critical technologies or a solid design."[43] At the time, only one of eight critical technologies for the program was expected to be mature by 2007, when the program planned to enter low-rate production. The remaining seven critical technologies included integrated flight propulsion control, prognostics and health management, an integrated support system, an integrated core processor, radar, mission systems integration, and manufacturing—all of which were not expected to reach maturity before production began.[44]

Concurrency

GAO also found in 2005 that the F-35 program only expected 35 percent of the engineering drawing packages to be released at the program's critical design review, compared to the 90 percent called for under best practices, and that prototype testing would not be finished when the design review began. As the 2005 report explained, "knowing that a product's design is stable before system demonstration reduces the risk of costly design changes occurring during the manufacturing of production representative prototypes—when investments in acquisitions become even more significant." Addressing the potential impacts, GAO warned that design and production "overlap frequently results in costly design changes and parts shortages during manufacturing, which, in turn, result in labor inefficiencies, schedule delays, and quality problems."[45]

That presumption proved prescient as the program progressed. In 2008, Lockheed Martin found that the F-35's engine, designed by Pratt & Whitney, did not generate enough air pressure to cool the aircraft's subsystems. In 2013, Lockheed requested a new engine design to address the issue, but according to GAO, "program officials determined that it was too late to redesign the engine given the cost and schedule effects of such a change because the program had completed design and verification activities."[46] Instead, they decided to accept "increased wear and tear, more maintenance, and reduced life on the engine," which added $38 billion to the F-35's projected life-cycle cost.[47] Currently, Pratt & Whitney is in the process of designing an upgrade for its F-35 engine to increase its power and cooling capabilities in support of the latest suite of capability upgrades. But according to GAO, as of May 2023, the Pentagon had "not fully defined the power and cooling requirements" for the engine upgrade and had "not fully assessed the costs and some of the technical risks of the different engine and thermal management system upgrade options."[48]

In a broader illustration of the complications caused by concurrency, in 2019, GAO found that due to repeated design changes to the aircraft, spare parts, and software, fielded F-35s had at least 39 different configurations of parts, complicating maintenance and sustainment for the aircraft. It also found that between training and

operational squadrons, the Pentagon was flying F-35s from three different mission software blocks, each with different sustainment needs.[49]

Three Different Variants

Setting aside the various configurations of F-35s stemming from technology and design updates, the F-35 is still best understood as not one aircraft, but three. The F-35A variant, operated by the Air Force, was designed for conventional takeoff and landing. The F-35B, operated by the Marine Corps, was designed for short takeoff and vertical landings. The F-35C, operated by the Navy and Marine Corps, was designed for takeoff and landings on aircraft carriers.

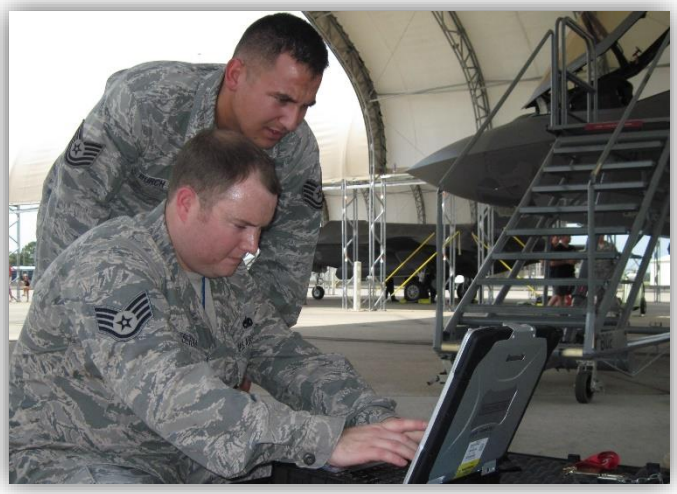
GAO characterized the decision to pursue three variants of the F-35 as follows:

> *The JSF Program is attempting to develop three different aircraft, for three different services. All want to fly at supersonic speeds, shoot air-to-air missiles, and drop bombs on a target, but they all have vastly different operational concepts. While each of the variants may look similar externally, subtle design differences provide many needed capabilities that are unique to each service. As a result, the program will attempt to design, build, and test simultaneously three distinct aircraft designs.*[50]

In conjunction with the aircraft's concurrent design and production, which necessitated repeated design changes and technology updates, the decision to build three variants of the F-35 effectively multiplied the production and sustainment challenges facing the aircraft, contributing to cost growth, schedule delays, and performance issues.

Lack of Access to Technical Data

Sustainment for the F-35 program has been more costly and complicated than anticipated, partly due to the Pentagon's lack of access to proprietary technical data necessary for performing maintenance and repairs on the fleet. This technical data includes specifications for parts, engineering drawings, and operation and maintenance manuals.[51] According to GAO, "one (F-35) location reported that when maintainers find negligible (and fixable) damage to a basic part, they lack the technical data that would allow them to fix the part. Instead, the maintainers have to request the technical data from contractors, which takes time, delays aircraft maintenance, and may prevent the maintainers from acquiring the knowledge needed to maintain the aircraft on their own in the future."[52]



Tech. Sgt. Matthew Burch and Staff Sgt. Jason Westberry of the 58th Aircraft Maintenance Unit review post-operations tasks on their portable maintenance aid after an F-35 taxied into a hangar at Eglin Air Force Base, Florida. Aug. 31, 2011. U.S. Air Froce photo by Maj. Karen Roganov.

Another problem with the military's lack of access to technical data is that it forecloses the possibility of a competitive bidding process for contracts to upgrade the F-35, essentially granting the prime contractor Lockheed Martin a monopoly over such upgrades (with some exceptions such as the F-35's engine, which is made by Pratt & Whitney). As GAO put it, "Identifying technical data

needs, costs, and ownership of technical data are essential for DOD's effectively maintaining [sic] the F-35 and maximizing competition for future product support of the F-35."[53]

Frustration over this lack of access to critical data led to a push in Congress to amend the Fiscal Year 2025 National Defense Authorization Act (NDAA) with a provision that would have authorized the Secretary of Defense to seize intellectual property related to the F-35 from Lockheed Martin to create a competitive process to address ongoing software problems plaguing the program. Concerns that the law would have required the Pentagon to compensate Lockheed Martin for the data, at great cost to taxpayers, led Congress to drop the proposal.[54]

Cost Impacts

The F-35 program began in 1996, and system development started in 2001.[55] At the time, the Pentagon estimated the program's total acquisition cost—which includes development, procurement, and military construction costs—at $289 billion in 2024 dollars. As of September 2023, that cost estimate grew by 54 percent, to more than $446 billion.[56]

Projected operation and sustainment costs have also been rising. From 2018 to 2023, the projected cost to sustain and operate the F-35 over its lifecycle rose 44 percent, from $1.1 trillion to $1.58 trillion. This increase was partly due to an extension of the aircraft's planned service life from 2077 to 2088, but those extra years only increased the aircraft's service life by about 18 percent, so the bulk of the price jump originated elsewhere. It also occurred despite several cost-saving measures the program has implemented, including the Air Force and Navy cutting their projected annual flying hours by 19 percent and 45 percent respectively, as well as various initiatives to reduce sustainment costs.[57]

In 2005, the projected lifecycle cost of the F-35 was under $600 billion.[58] Adjusting for these increases, the total lifecycle cost of the F-35 program is now expected to surpass $2 trillion. As time goes on, these cost projections may continue to grow. The F-35 program office is expected to release a new acquisition program baseline and Selected Acquisition Report in July 2024, following its March 2024 decision to begin full-rate production on the F-35.[59]

Schedule Impacts

Initial Operational Capability (IOC), when the organizations operating the F-35 have been equipped and trained and are capable of executing missions, was severely delayed for all three variants, with each reaching IOC about three and a half years behind schedule.[60]

Originally slated for December 2019, a decision on Milestone C (the decision point for the program that allows it to move to full-rate production) was also severely delayed. The delay was caused by challenges in developing and integrating the Joint Simulation Environment (JSE) onto the F-35. The JSE, a virtual wargaming capability used to assess the tradeoffs involved in incorporating various capabilities onto a platform, had to contend with technical challenges as well as the COVID-19 pandemic, which impacted global supply chains.[61] At first, officials said Milestone C would be delayed for "up to 13 months."[62] In August 2020, after multiple extensions, officials granted another extension until March 2021, saying at the time that they had "high confidence" in meeting that goal.[63] Ultimately, the F-35 program was not approved for full-rate production until March 2024, over four years behind schedule.[64]

Even at this late stage in the acquisition process, delays are ongoing. The F-35 is currently working through its latest modernization effort, known as Block 4. To enable many of those capabilities, the F-35 program is working to integrate Technology Refresh 3 (TR-3), hardware and software improvements including a more powerful processor and an upgraded cockpit display, among other upgrades.[65] Originally slated for delivery starting in July 2023, TR-3 was first delayed until June 2024.[66] Addressing hardware delays, Lockheed Martin cited supply chain issues, workforce shortages, and product quality testing issues.[67] Software delays have also plagued TR-3. According to GAO, "Problems with aircraft software supporting the radar and electronic warfare systems have been especially prevalent, with some test pilots reporting that they had to reboot their entire radar and electronic warfare systems mid-flight to get them back online."[68] As a result of the many challenges facing TR-3, complete delivery will now be delayed into 2025.[69]

In early 2023, the F-35 program paused aircraft deliveries to investigate the root cause of an F-35 crash that took place in December 2022. The investigation revealed that the crash was caused by an engine issue. Parts shortages caused by supply chain challenges and manufacturing issues tied to workforce challenges have also contributed to delivery delays. As a result of these overlapping and compounding challenges, 91 percent of F-35s delivered in 2023 were delivered late.[70]

These ongoing production challenges and resulting late deliveries contributed to the Pentagon's decision to request 15 fewer F-35s than planned in its Fiscal Year 2025 budget request.[71] Congress may take these cuts even further. A provision in the House-passed FY2025 National Defense Authorization Act (NDAA) would cut F-35 purchases down to 58, a reduction of ten aircraft on top of the Pentagon's already-reduced request. The measure would redirect the resulting funds to "make the contractors spend the money" to address the problems leading to late deliveries.[72] House Appropriators took a different approach in the House-passed Defense Appropriations Act for FY2025, adding eight additional F-35s to the Pentagon's request of 68 in the name of sending a clear demand signal to the industry.[73]

While the House NDAA's approach may effectively force the prime contractor, Lockheed Martin, to invest in solutions to these production challenges, in the long run, it could also serve to incentivize bad behavior on the part of Pentagon contractors. Cutting ten F-35s would free up about $1 billion to address the production challenges, but arguably Lockheed Martin, not taxpayers, should be covering that cost. Clearly, cash flow is not the issue—in the first quarter of 2024 alone, Lockheed Martin spent $1 billion on stock buybacks, passing profits to shareholders and company executives.[74] By redirecting funds to address the production challenges, Congress would effectively be incentivizing contractors to underinvest in workforce growth, industrial base capacity, and other production inputs with the knowledge that Congress will step in when challenges inevitably arise.

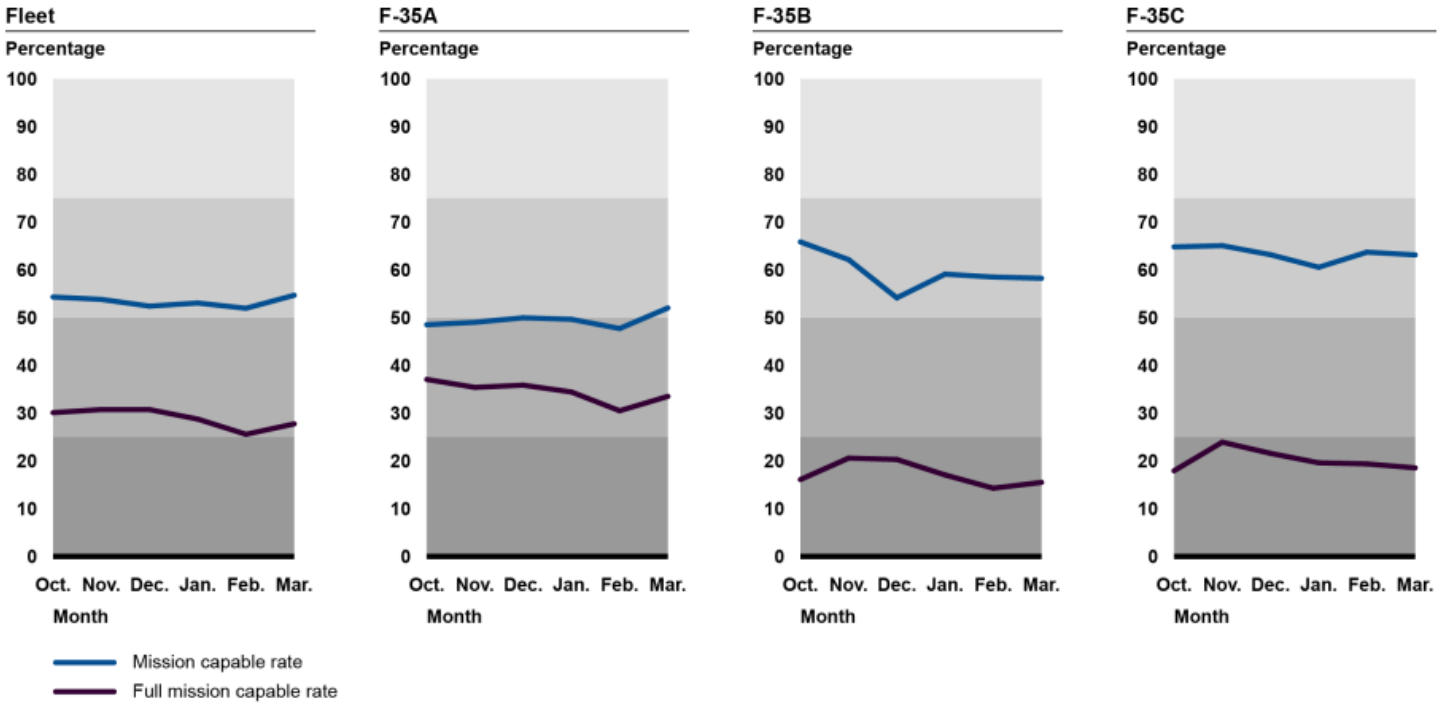
In other words, the two congressional approaches to addressing the F-35's ongoing production challenges present a lose-lose situation for taxpayers, with one paying upfront for aircraft that will not be delivered on time, and another paying for industrial base investments that should have been made by the prime contractor.

Performance Impacts

In one of the clearest measures of the F-35's performance, the aircraft's full mission capable rate—the percentage of time it can fly and perform all of its tasked missions—was a mere 30 percent during the 12-month period ending in September 2023.[75] The F-35's mission capable rate, the percentage of time it can fly and perform at least one of its tasked missions, was about 55 percent across the fleet as of March 2023, as shown in the GAO figure below.[76]

That is far short of the program's goals, which call for a 90 percent mission capable rate for the F-35A, and 85 percent for the F-35B and the F-35C.

Figure 25: Performance of F-35 Aircraft by Variant, October 2022 through March 2023



Source: GAO analysis of Department of Defense data. | GAO-23-105341

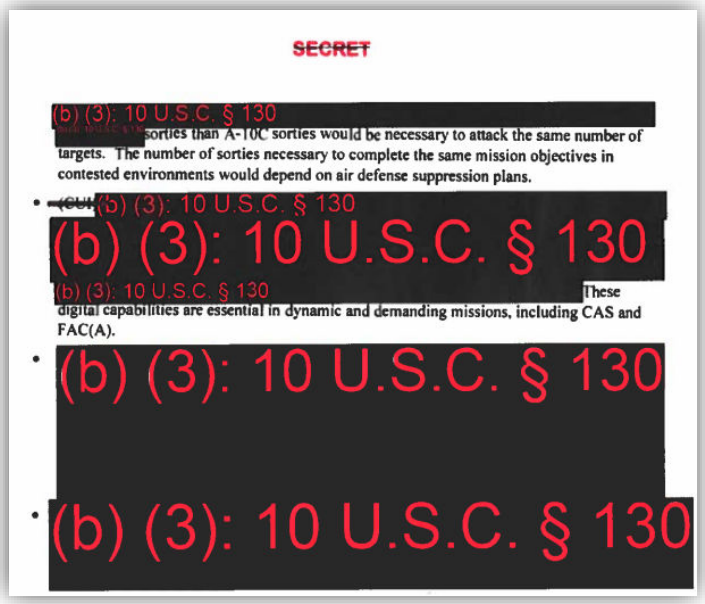
The F-35 has also faced repeated crashes, most recently on May 28, 2024, when a U.S. Air Force pilot ejected at low altitude after taking off from Kirtland Air Force Base in New Mexico.[77] Lockheed Martin stated that "the pilot ejected safely," though the pilot was in fact seriously injured.[78] The cause of the crash is still being investigated.

Another crash occurred on September 17, 2023, when an F-35 went missing over the skies of South Carolina. The pilot ejected after experiencing an "aircraft failure," but the plane continued flying on autopilot and eventually crashed in a rural area some 60 miles from where the pilot ejected.[79] The pilot landed in the backyard of a local residence and called 911 for medical attention. It took the military over 24 hours to locate the crash site, during which time it asked for the public's help to find the missing fighter jet.[80] In total, the F-35 has been involved in 30 crashes since it began flying.[81]

One key measure of success where the F-35 falls short is in its ability to outperform one of the aircraft it is meant to replace, the A-10. When the Pentagon initially pitched the F-35 to Congress, it claimed the F-35 would replace the A-10 in its close air support role.[82] Some reporting suggests that the Air Force only assigned the F-35 a close air support mission so that it could save money by retiring the A-10, even though officials knew the F-35 would be no match for the A-10 in this area.[83] That may be why then-Air Force Chief of Staff Gen. Mark Welsh said in 2015 that the F-35 was never intended to replace the A-10.[84] Yet, in June 2023, the Air Force announced that Moody Air Force Base would host F-35As starting in FY 2029, replacing the A-10s on the base that are slated for retirement.[85] A 2023 GAO report on tactical aircraft also indicates that the F-35A is slated to replace the A-10, suggesting the current plan aligns with the original intent of replacing the A-10 with the F-35.[86]

Between 2018 and 2019, at Congress's request, the Air Force conducted comparative tests between the F-35A and the A-10C.[87] The Pentagon did not produce a report on the results until February 2022 and only released it in 2023 after the Project on Government Oversight (POGO), a nonprofit government accountability organization, secured a heavily redacted copy "through a Freedom of Information Act (FOIA) request and subsequent litigation…"[88]

POGO's analysis of the report identified several problems with the tests. It noted the absence of ground troops during the tests as a shortcoming, as close air support often requires close communication with ground forces to pinpoint enemy targets. It also criticized the test location—an open desert—as unrealistic for measuring search and rescue capabilities.[89]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(b) (3): 10 U.S.C. § 130

sorties than A-10C sorties would be necessary to attack the same number of targets. The number of sorties necessary to complete the same mission objectives in contested environments would depend on air defense suppression plans.

(b) (3): 10 U.S.C. § 130

(b) (3): 10 U.S.C. § 130

(b) (3): 10 U.S.C. § 130

These digital capabilities are essential in dynamic and demanding missions, including CAS and FAC(A).

(b) (3): 10 U.S.C. § 130

(b) (3): 10 U.S.C. § 130

A heavily redacted section of the F-35A and A-10C Comparison Test Report, dated February 2022.

Despite these test design flaws, which POGO contends were intended to favor the F-35, the results were unfavorable for the F-35. The report indicated that F-35s would need to fly more sorties than the A-10C to attack the same number of targets. It also noted that the A-10C's typical loadout enabled more attacks than the F-35A's, and that A-10C pilots typically flew closer to targets than F-35A pilots, due to the A-10C's stronger armor and redundancies, which allow it to withstand more fire than F-35s. As POGO highlighted, the comparison looks even worse considering the F-35's miserable mission capable rate, which further hampers its ability to fulfill the A-10's close air support role.[90]

Lessons Learned, More or Less

Pentagon leaders have vowed to learn from the F-35 program and adopt a different approach for sixth-generation fighter programs. In some respects, their plans are on track to deliver on that promise, though it bears mentioning that plans can change as delays and other hurdles appear. In other respects, Pentagon officials appear to be repeating past mistakes.

Technical Data and Open System Design

The Air Force has made it clear that it plans to secure rights to technical data for its Next Generation Air Dominance (NGAD) program, enabling the military to sustain the program without relying solely on the prime contractor. Air Force Secretary Frank Kendall stated in 2023, "We're not going to repeat the, what I think frankly was a serious mistake that was made in the F-35 program," referring to the failure to obtain necessary technical data rights. "What that basically does is create a perpetual monopoly," he continued. "I spent years struggling to overcome acquisition malpractice, and we're still struggling with that to some degree. So we're not going to do that with NGAD."[91]

The Air Force has also indicated that NGAD projects will use modular open system design, allowing for competitive bidding on future upgrade contracts.[92] This marks another lesson learned from the F-35, though it should be noted that many "competitively" awarded contracts often receive only one or two bids, given the monopolies some companies hold over certain types of programs.

"Less" Concurrency

Secretary Kendall acknowledged the problems concurrency caused for the F-35, promising less concurrency in the NGAD program, and that any concurrency will happen "in a rational way, that doesn't take excessive risk."[93] A 2005 GAO analysis of the F-35 program highlights one measure of concurrency: the percentage of engineering drawing packages released by the time of a program's critical design review. For the F-35, only 35 percent of these drawings were expected to be released before the critical design review, compared to GAO's best practice of 90 percent.[94] This discrepancy leaves room for significant improvement, raising the question of what level of concurrency Secretary Kendall considers "rational." Congress should demand the Air Force and Navy specify publicly what levels of concurrency are reasonable before any production begins. Based on their responses, Congress could require the services to develop their programs to near-completion prior to beginning production.

Variants and Interoperability

Navy Rear Adm. Andrew Loiselle gives opening remarks at the Amphibious Ready Group and Marine Expeditionary Unit Staff Planning Course. Aug. 10, 2020. U.S. Marine Corps photo by Brandon Holmes.

The Air Force and Navy have stated they do not intend to combine their programs for sixth-generation fighters into a joint program like the F-35. Instead, each service plans to build its own fighters and CCAs under separate programs but in close coordination with one another.

Navy Rear Adm. Andrew Loiselle, Director of the Air Warfare Division within the Office of the Chief of Naval Operations, remarked in 2023 that there is "unbelievable cooperation with the Air Force right now in the development of mission systems for both sixth-gen [fighters] and CCAs… I'm very close to getting a signed agreement with the Air Force where we're going to have the ability for the Navy to control Air Force CCAs and the Air Force to control Navy CCAs."[95]

Lt. Gen. Dale White, then-Air Force Program Executive Officer for Fighters and Advanced Aircraft, expanded on the collaboration in 2023, characterizing aircraft architecture, communications links, autonomy architecture, and ground-control segments as "four focus areas that allow us to leverage the interoperability that we think we need [for] a CCA because this is not just a single-service solution, and we know that going in."[96]

Andrew Hunter, the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics, explained that "in many ways, the missions we're looking to perform are very common. If the Navy has a solution that really works—and in some cases they do—then it pays for us to adopt it and vice versa…" Despite this collaboration, pursuing separate programs means "each service has a little more flexibility to go off and address specific

requirements," said Hunter. "In the Navy's case, marinization is very different. I don't have that challenge. So that's the kind of flexibility."[97]

Given the high level of interoperability the Air Force and Navy are pursuing for CCAs, Congress should critically examine their acquisition strategies to avoid duplicative and wasteful spending. For example, if both services need an interoperable autonomy architecture, it might be more cost-effective to design modified versions of the same software and share the costs rather than develop two separate systems serving the same function. Modular open systems design could allow the services to use some system components in both programs, but that does not mean they will. While joint programs come with serious risks, subsystem-scale joint projects could lower costs without creating sustainment headaches like the F-35's three variants did. Congress must ask these questions and receive forthright answers from the Pentagon before any costly and potentially avoidable redundancies become irreversible.

Pursuing separate programs with one aircraft design each, paired with less concurrency, should result in fewer configurations of sixth-generation fighters than the F-35, potentially reducing sustainment costs. However, the cost of sixth-generation fighter programs relative to the F-35 must be understood as the combined cost of the Air Force and Navy programs.

Lessons Ignored

While the sixth-generation fighter programs are working to avoid some pitfalls of the F-35 program, they are on track to repeat others.

Capabilities vs. Performance Accountability

The Air Force and Navy's family-of-systems approach to their next-generation fighter programs risks repeating the F-35's mistake of pursuing too wide a range of capabilities under a single program. The F-35 program's pursuit of too many missions resulted in a plane capable of many tasks, but its versatility came at the expense of performance in some areas, such as close air support.

Moreover, the complexity of the F-35 made it far easier for Lockheed Martin to spread sub-contracts for the program around the country, a practice known as political engineering. Essentially, by dispersing contracts across as many states and congressional districts as possible, companies can generate political buy-in that can be hard to overcome, no matter how deeply flawed a program may be. In the case of the F-35, Lockheed managed to divvy up work under the program across 47 states, all but guaranteeing enduring political support in spite of its many shortcomings.[98]

The family-of-systems approach for the sixth-generation fighter programs is poised to repeat this practice, whether by design or not. From the manned fighter aircraft to the collaborative combat aircraft to new command, control, and communications systems needed to support these platforms, there will be plenty of work to go around. The Air Force's assurance that companies not selected to build CCAs will continue to be part of the vendor pool suggests a high likelihood of securing political support across many congressional districts.[99]

While contracting with diverse suppliers can help avoid monopoly prices like those secured by Lockheed Martin for the F-35, it could also help lock in political support through more geographically dispersed contracts. If the Pentagon then decides to significantly alter its plan (a distinct possibility based on recent Air Force statements),

the political inertia generated by these contracting decisions could make course corrections more difficult, potentially saddling taxpayers with a massive bill for a system the Pentagon does not actually need.

This does not mean the Pentagon should avoid building complex programs or engaging multiple contractors. However, it underscores the importance of rigorously testing the strategic rationale for these programs before they become too big to fail.

Strategic Rationale

In the case of the F-35, the Pentagon and Congress arguably failed to adequately question the strategic need for its close air support mission, as evidenced by the A-10's stronger performance in comparison tests.[100] Whether that was because the Pentagon tacked on the close air support mission as an afterthought to justify retiring the A-10 or simply failed to predict that the F-35 would not be as capable is almost irrelevant—the result was a more expensive aircraft that underperformed in a key mission compared to its less expensive predecessor. In the case of sixth-generation fighter programs, the Pentagon may be making a similar mistake. While officials like Secretary Kendall deserves some credit for recognizing that current spending plans are unsustainable, and for reevaluating sixth-generation fighter plans to find cost savings and make sure it has "the right concept," there is no indication the Pentagon is revisiting the broader strategic rationale for these programs.

The rationale for developing sixth-generation fighter aircraft, whether manned or unmanned, rests largely on two assumptions: that it is necessary to project air superiority deep into enemy territory and that it is necessary to hold targets deep in enemy territory at risk.[101] However, as Dan Grazier, a Senior Fellow for the National Security Reform Program at the Stimson Center, explained in a 2023 analysis for the Project on Government Oversight, "if the real problem U.S. officials are trying to solve is how to defend American forces from enemy aircraft, improving and expanding ground-based defenses should be made a higher priority. You don't need to gain air superiority right up to the enemy's capital to be effective. You need to have local air superiority where friendly forces are operating. If the problem is how to penetrate an adversary's air defenses, many solutions other than manned aircraft already exist, with several new solutions on the horizon."[102]

Grazier highlighted surface-to-air missiles like the Patriot system as a viable alternative for ground defense. For hitting targets deep in enemy territory, he argued that standoff cruise missiles, which can be launched from aircraft or ships outside of enemy air defenses, and long-range precision fires systems are better alternatives to manned aircraft.[103]

If Congress hopes to avoid buying another generation of aircraft with missions that can be achieved at lower cost with other new and existing platforms, it needs to examine the rationale and possible alternatives for each and every mission being discussed for the sixth-generation fighter.

Next-Generation Challenges

Compared to the strategic rationale for the sixth-generation fighter, the rationale for CCAs is sound, at least in theory. The idea is to create a large force of relatively affordable aircraft capable of tethering to existing and future manned aircraft and operating independently when needed. They are also being built to allow for a wide variety of configurations. These features would complicate enemy planning by increasing the number of aircraft in the U.S. force and ensuring that an enemy will have to treat each CCA as if it has *all* of the capabilities that might be

included on a CCA. From a military planning standpoint, that is a powerful combination. However, for that strategy to work, the technology behind it must deliver on functionality and price, which is far from assured.

Planned Obsolescence

A cursory look at the Pentagon's record of fielding new technology at the promised price is not encouraging. Furthermore, comments made by Air Force Chief of Staff Gen. David Allen suggest that CCAs are not being built to last:

> *'Built to last' is a tremendous 20th-century bumper sticker, but the assumption was: whatever you had was relevant as long as it lasted. I'm not sure that's relevant anymore. So that's why we aren't building in a sustainment structure. Ten years after this, I'm hoping the technology will make it so that CCA won't be as relevant, but it might be adaptable, and that's what we're building into modularity and adaptability.*[104]

Echoing that sentiment, Navy Rear Adm. Stephen Tedford said, "I want something that's going to fly for a couple hundred hours. The last hour it's either a target or a weapon. I'm either going to hit something with it or I'm going to train [a sensor on it] and shoot it down. But I'm not going to sustain them for 30 years."[105]

If these comments prove true, the Pentagon may find itself purchasing a generation of CCAs only to retire them ten years into their service. There is nothing inherently wrong with that approach, but it does rest on the assumption that CCAs will actually be affordable. At a projected cost of $27 million per Air Force CCA, with current Air Force plans calling for anywhere from 1,000 to 2,000 CCAs, the procurement costs alone could range from $27 billion to $54 billion, and that does not include costs for the Navy's CCAs. It also assumes zero cost growth, which is clearly unrealistic. Should the Pentagon opt to upgrade CCAs to improve their capabilities or extend their lifecycle, the sustainment challenges of retrofitting and maintaining thousands of CCAs with different configurations across two military service branches could make the F-35's sustainment challenges look like a walk in the park.

Artificial Intelligence

Even if the Pentagon manages to build affordable and relatively functional CCAs, other strategic and ethical risks associated with their autonomous capabilities abound. One of the Pentagon's hopes for CCAs is that they can shorten the "kill chain," the steps between identifying targets and destroying them.[106] One challenge the Pentagon has encountered with efforts to shorten the kill chain is processing the increased amount of data at its disposal, a result of the Pentagon's expanding use of new sensor and communications technology. Artificial intelligence (AI) can sort through all the data more quickly.[107]

A U-2 Dragon Lady landing at Beale Air Force Base, California on Dec. 15, 2020. This marked the first demonstration of artificial intelligence aboard a military aircraft, with an AI algorithm performing in-flight tasks normally performed by a pilot. U.S. Air Force photo by Airman 1st Class Luis Ruiz-Vasquez.

While that may offer tactical advantages, it also raises broader strategic questions about the potential escalatory impact of dramatically expanding target lists with AI. In the event of a peer-level conflict, if the U.S.

starts using AI to attack a much broader range of targets than it has in the past, that could provoke a proportional response from enemy forces.

Another concern is the potential for AI to make mistakes, like misidentifying targets or misinterpreting data and relaying bad information to its human counterparts as a result. As the Arms Control Association (ACA) pointed out in a report on threats posed by emerging military technology, "Many of these technologies are still in their infancy and prone to often unanticipated malfunctions."[108]

AI also poses serious cybersecurity risks. As ACA put it in its report, "no matter how much is spent on cybersecurity, computer systems will always remain vulnerable to hacking by sophisticated adversaries."[109] As the military becomes increasingly reliant on autonomous networked platforms, the potential impacts of cyber-attacks will become more severe.

All of this underscores the need to both examine the risks and to thoroughly develop and test the AI technology for CCAs before moving to production. While Deputy Defense Secretary Kathleen Hicks has argued that "congressional trust will need to substantially expand" for innovative technologies like AI to be successful "at the speed and scale we need," the Pentagon's recent record of failure in fielding new technology on time and on budget has not earned that trust.[110] Just as efforts to field the F-35 as quickly as possible backfired and led to serious delays, cost overruns, and performance issues, so too could efforts to accelerate the production timeline for CCAs at the expense of congressional oversight.

Even with thorough scrutiny ahead of production, we cannot be sure how these weapons will perform in an actual conflict. This reality should prompt the global community, including the United States, to aggressively pursue negotiations to regulate the deployment of AI in conflict, negotiations which could be imperiled by the global rush to deploy these weapons as soon as possible.

Unsustainable Spending Plans

In addition to the risks associated with autonomous weapons, the Pentagon now faces another next-generation challenge: a confluence of modernization programs that it cannot afford. The Air Force and Navy's ambitious plans for sixth-generation fighter programs are symptomatic of a larger trend within the national security establishment—the presumption that resources for wildly expensive programs can always be found. In the F-35's case, with the exception of occasional cuts and pauses in purchases, that presumption has so far proven accurate, for better or worse.

However, a holistic look at military spending plans suggests current plans are not financially feasible, particularly considering the Pentagon's history of lowballing cost estimates. A recent Stimson Center issue brief describes "the coming bow wave" of military spending in dire terms, concluding that "Policymakers should carefully reconsider current defense plans to prevent the coming fiscal bow wave from turning into a tidal wave."[111]

This bow wave is driven in large part by the pursuit of modernization projects across the board. These include Air Force programs for a sixth-generation fighter, the B-21 nuclear bomber, and the Sentinel, a new intercontinental ballistic missile (ICBM). They also include Navy programs for its own sixth-generation fighter, the new Constellation-class frigate, the new Virginia-class attack submarine, and the new Columbia-class ballistic missile submarine. The Army for its part is also pursuing modernization projects including long range precision fires artillery, next-generation combat vehicles, and future vertical lift technologies for Army aircraft, among others.[112]

Most of these programs are already over budget and behind schedule.[113] As schedule delays mount, the need to spend more than previously budgeted on existing programs to extend their service lives while their replacements are built also increases.

For example, the Sentinel saw its cost projection balloon by 37 percent in January 2024 compared to projections made in 2020. Following this revelation, Taxpayers for Common Sense published a report calling for the program's cancellation.[114] Instead, after a congressionally required review of the cost growth, the Pentagon certified the need for the program but stated the restructured program would cost 81 percent more than the 2020 projection and enter service "several years" behind schedule.[115] Speaking to the resulting need to extend the life of the Sentinel's predecessor, Pentagon officials said, "we'll do what it takes to sustain the Minuteman III to meet these warfighter requirements in the interim."[116] With the Air Force now saying the NGAD program will not replace the F-22 as originally planned, the F-22 may also require a more extensive life-extension plan.[117]

Pentagon officials also certified to Congress that the Sentinel was a higher priority than programs that will face cuts to cover its cost growth, but did so without identifying any specific programs for cuts, claiming those decisions would be made down the road when the projected cost growth actually kicks in.[118] However, with the Air Force now looking for ways to lower the cost of its NGAD program, from a less complex engine to potentially nixing the manned fighter portion of the program altogether, the Air Force is arguably already deciding what to cut to pay for the Sentinel.[119]

Notwithstanding strong arguments for canceling the Sentinel program, assessing alternatives that might allow for canceling or at least scaling back the fighter portion of the Air Force's NGAD program is a good place for the Air Force to start. The Navy could similarly seek to cover the growing costs of its ambitious plans by canceling or scaling back plans for the F/A-XX.

Conclusion

Pentagon plans for sixth-generation fighter aircraft programs represent a major undertaking. In its pursuit of a fifth-generation fighter aircraft, the Pentagon fell years behind schedule and now projects the program will run $1.4 trillion over budget. Despite its delays and cost overruns, the F-35, more than 20 years after its inception, is only fully mission capable 30 percent of the time. At the root of these shortcomings are a series of decisions meant to accelerate procurement of the F-35 and enable it to perform a wide array of missions. From pursuing development and production concurrently, to building three variants with incredibly complex designs, to failing to adequately weigh the alternatives, the Pentagon's decisions have saddled taxpayers with a $2 trillion fighter program that is not meeting our national security needs.

Absent strong and consistent congressional oversight, the Pentagon is poised to repeat many of the mistakes of the calamitous F-35 program, including overly concurrent development and production, overly ambitious capability requirements, and a failure to adequately assess alternatives. These programs also face new risks and challenges, from the risks associated with autonomous weapons, to the fiscal reality that current modernization plans require unsustainable spending.

The solution to these challenges is not endlessly increasing Pentagon spending. Adjusting for inflation, military spending has grown nearly 50 percent since the turn of the century.[120] Over that same period, our national debt has skyrocketed from $5.6 trillion to nearly $35 trillion.[121] That is not a coincidence. With the United States on the

verge of spending more each year on interest payments on this debt than on the military, current military spending plans are blatantly unsustainable.[122] Fiscal responsibility and national security are not mutually exclusive; in fact, they are inextricably linked.[123] As plans for sixth-generation fighter programs move forward, Congress must insert itself early on in the process if it hopes to avoid repeating the failures of the F-35 and overcome new challenges. In defense of taxpayer interests and national security, Taxpayers for Common Sense offers the following recommendations.

Recommendations

- **Conduct Analyses of Alternatives**: Congress should require the Air Force and Navy to conduct analyses of alternatives to assess other options for meeting the strategic needs that sixth-generation fighter programs aim to address.
  - These analyses should include assessments of whether or not sixth-generation fighter aircraft are necessary for meeting those needs, whether achieving air superiority deep in enemy territory is a strategic imperative, and whether alternative options for striking targets deep in enemy territory are sufficient.
  - These analyses should evaluate both manned and unmanned sixth-generation fighter aircraft.
  - These analyses should also be made available to the public, with classified annexes as necessary.
- **Pause Funding**: Policymakers should pause all funding requests and appropriations for sixth-generation fighter programs pending the results of these analyses of alternatives.
- **Design Completion**: Congress should require completion of at least 90 percent of the sixth-generation fighter programs' designs prior to their critical design reviews.
- **Avoid Duplicative Spending**: Congress should require the Air Force and Navy to report on their plans to avoid duplicative and wasteful spending on interoperable subsystems for CCAs.
- **Regulate Autonomous Weapons**: Congress should require the Pentagon to report on current and planned regulations and procedures for governing the use of autonomous weapons in conflict, as well as cybersecurity risks associated with autonomous weapons platforms including CCAs.

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