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F–35 ACQUISITION PROGRAM UPDATE

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES,
Washington, DC, Tuesday, December 12, 2023.

The subcommittee met, pursuant to call, at 2:40 p.m., in room 2118, Rayburn House Office Building, Hon. Robert J. Wittman (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. ROBERT J. WITTMAN, A REPRESENTATIVE FROM VIRGINIA, CHAIRMAN, SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES

Mr. WITTMAN. I call the Subcommittee on Tactical Air and Land Forces to order. I would like to welcome everybody to our last subcommittee hearing of the year to receive an update on the F–35 program.

Given that we started the 118th Congress with our first hearing on tactical fighter aircraft, it is very fitting that we finish this first session of the 118th Congress discussing what the Department notes as the cornerstone of its future tactical fighter aircraft fleet, the F–35 Joint Strike Fighter.

I thank our witnesses today for testifying this afternoon and look forward to your testimony. As I stated throughout this year, the National Defense Strategy is clear in its focus on China as our Nation's pacing threat.

And given the continuing provocative actions of the Chinese that we've all witnessed in the Pacific theater this year, it is critically important that we continue to evaluate our military capabilities to ensure we are postured for robust deterrence and, when necessary, prosecute combat operations to overwhelmingly prevail against any aggressor that tests our Nation's military resolve.

As I emphasized this past spring while reviewing the tactical fighter aircraft plans for each of our military services, two common threads were evident. First, our fighter force structure continues on the decrease. And second, we are not able to deliver replacement aircraft at affordable prices to achieve similar quantities going forward.

Meanwhile, our adversaries continue to outpace us, building and fielding their own lethal fighter aircraft capacities and capability.

As it relates to the F–35 program, this subcommittee has made clear our expectations in the oversight of key areas of this program.

Technical Refresh 3, better known as TR–3, hardware upgrades and Block 4 software capability development, air system and propulsion modernization, depot standup, and supply chain maturations, operations and sustainment cost reduction, and increasing

the full mission capability rates above what the F–35 fleet has demonstrated today are all critical elements of what must be addressed in this program going forward.

While program challenges and setbacks always seem to dominate the discussion, I would be remiss if I didn't acknowledge some of the F–35 program's successes from the past year.

With the nearly $1 billion in additional investment last year, propulsion system mission capability rates have increased, and the non-mission capable rates of the aircraft due to power module removals has decreased.

The program has brought on new foreign military sales customers, expanding the worldwide capability and commonality for operations with our partners and allies.

And most recently the F–35 Joint Program Office has moved at a breakneck speed to support our closest partner and ally in the Middle East, Israel.

They have done this by accelerating F–35 weapons capabilities and increasing spare part supply rates in their fight against the atrocities committed by Hamas.

And now as I pivot to reviewing some of the program's continuing challenges, I want to unequivocally state upfront that the F–35 will be the most advanced tactical fighter aircraft that the U.S. has ever built.

But our patience with the program development is wearing thin. Once again, we're going to talk about the prior planned schedules that have slipped and costs that have unexpectedly grown.

I want to focus on four issues today. First, TR–3 development and fielding challenges, Second, propulsion and thermal management system modernization and requirements. Third, sustainment strategy planning, given the recent setback regarding the performance-based logistic supply contract. And fourth, potential strategies related to the development and testing of software and mission capabilities, both now and in the future.

My friends, the F–35 is a technological marvel, but the delays in fielding required capabilities are disturbing. As the Department of Defense's largest acquisition program, I am committed to providing rigorous oversight to deliver required capability at a reasonable cost.

With that, I turn to my good friend from New Jersey, and distinguished ranking member of the subcommittee, Mr. Norcross.

STATEMENT OF HON. DONALD NORCROSS, A REPRESENTATIVE FROM NEW JERSEY, RANKING MEMBER, SUBCOMMITTEE ON TACTICAL AIR AND LAND FORCES

Mr. NORCROSS. Thank you, Chairman, and I would like to welcome our witnesses. This subcommittee's last F–35 oversight hearing was 2½ years ago. Given the fact that it is the DOD's [Department of Defense's] largest weapon program, I think this public hearing is long overdue, and I look forward to our government witnesses updating Congress and the public on the F–35.

The F–35 is one of [the], if not the, most capable fighters on the planet. When I speak to military leaders around the world, I always hear how much they enjoy the flying F–35, how impressed

they are with its performance. And I don't want that to be lost in today's hearing. It is a very impressive fighter.

But what's important is that we continue to deliver future capabilities to operational forces as soon as possible and at a cost that the Department can afford. That's what this hearing is about, oversight, the execution of development, production, sustainment of this key weapon.

Two months ago marked the 22nd anniversary of the start of the F–35 development. Today, the program continues to suffer unforeseen cost overruns and schedule delay. Much needed Technical Refresh 3, or TR–3, will ultimately deliver Block 4 capabilities, and it's not ready. And the government ceased to accept deliveries of this new aircraft until TR–3 testing is complete.

Moreover, the Department notified the committee a few months ago of another scheduled delay that pushes delivery of TR–3 to mid-2024. Assuming this schedule holds, and that's a big assumption, that would result in an almost an 18-month delay and almost $1 billion of cost overrun.

I hope our witnesses today will explain the root causes of these delays and update us on executing the new schedule.

We need to deliver Block 4 capabilities to the operational forces ASAP [as soon as possible], and TR–3 is the hardware that supports future capabilities.

The F–35 program is also in early development stages of the future engine necessary to sustain the aircraft through the F–35's life cycle. This issue is broader than just a discussion on an engine. It encompasses propulsion, system cooling, electrical power generation, and electrical distribution. We want this system and its air system subprogram to meet its cost, schedule, and performance metrics. We want it to be on time and on budget. And we want it to meet the requirements.

I look forward to hearing from the witnesses regarding this development effort and hope that they will clearly identify critical paths to success and any mitigating efforts to drive out or minimize the execution risk.

Turning to sustainment, fiscal year 2022 NDAA [National Defense Authorization Act] prohibited the Department from entering into a multiyear performance-based logistic and sustainment contract unless and until the Secretary of Defense certified to Congress that this contract would either reduce sustainment costs or increase readiness.

I understand the Department recently ceased negotiations with Lockheed Martin regarding a potential sustainment and indicated the primary reasons is they could not meet the congressionally mandated certification requirements.

I find it puzzling that a multiyear sustainment contract as compared to the annual sustainment contract could not either deliver and drive down costs or increase readiness.

Ultimately, sustainment costs will determine whether the Department can afford to procure its objective fleet of 1,763 aircraft for the Air Force, 420 for the Marines, and 273 for the Navy. I think it would be helpful for our witnesses to update the subcommittee on the sustainment strategy and explain how the strategy will deliver the readiness we need at an affordable cost.

And finally, to our GAO [U.S. Government Accountability Office] witness, Mr. Ludwigson, we are very interested in your perspective on many of these thorny issues. This subcommittee relies heavily on the GAO to provide independent objective analysis of the program execution. And your testimony here today will help the subcommittee determine where to best focus our attention as we go forward.

In closing, Tactical Air and Land Forces Subcommittee remains supportive of this program. But the Department must continue to work to drive out schedule delays and avoid those cost overruns. And I would like to thank our witnesses for their appearance today, and I look forward to their testimony. And I yield back.

Mr. WITTMAN. I'd like to thank Mr. Norcross, our ranking member, and now I would like to introduce our witnesses.

We have today with us the Honorable William LaPlante, Under Secretary of Defense for Acquisition and Sustainment, and the Milestone Decision Authority for the F–35 program; Lieutenant General Michael Schmidt, F–35 Program Executive Officer; and Mr. Jon Ludwigson, director of the Contracting and National Security Acquisition team for the Government Accounting Offices.

Gentlemen, with that, I will go to your testimony. Dr. LaPlante.

STATEMENT OF HON. WILLIAM A. LaPLANTE, UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND SUSTAINMENT, OFFICE OF THE SECRETARY OF DEFENSE

Dr. LAPLANTE. Thank you, Chairman Wittman, Ranking Member Norcross, and thanks to the committee for your key role in the oversight. And I think just already in the opening statements, you show a balanced view of both the accomplishments of F–35 but the real challenges. And I'm going to address some of those one by one in this opening and then hopefully lead later on with my colleagues with more and back and forth to your questions.

The F–35 delivers the most lethal and survivable tactical fighter to U.S. allies and partners. I think it is in the world actually the most lethal. We have still work to do because of the changing threat and the rapidly changing threat.

We are now up to—I have to remind ourselves—nine FMS [foreign military sales] partners. We have seven partners in the partnership. In addition to that, nine FMS partners with two more on the way. So we are doing something there that obviously partners and allies are seeing the benefit of this.

And so with that happening, and we have nearly 1,000 of these airplanes around the world, including our partners and allies, we have these challenges. And I'm going to go through and kind of address each one at a high level, but then later we can get to it. And I will try to follow the format of the chairman on his four items.

A reminder that we are also approaching a full-rate production decision now that we're done with the joint simulation environment mission trials.

This would—right now if it's on track, it's going to be in March of this next year. It's important to do that. It's important to close that out. And this is subject to the IOT&E [initial operational test and evaluation] and independent costs estimates.

Technology Refresh 3. The chairman and the ranking member correctly identified this as the top modernization issue right now in the program. A reminder again is that TR–3 is the hardware upgrade from TR–2, which as I remember I was putting that back in when I was the Air Force acquisition executive in 2013. But then the software that goes with it, and as the committee knows, and we will be able to talk to, while there has been significant progress, the software maturity is not such that it runs on the hardware in a manner that we are yet to be satisfied with, and hence that's the issue of the delay that was mentioned.

So that's point number one. Point number two, I will just cover the propulsion. There has been a lot of work, and this committee, I know, has been very interested in the Engine Core Upgrade work that's been done as well as to extend the engine life of the F135 engine. But also the cooling and thermal management requirements to get to some future power requirements that these new systems we need for the threat have to deliver. So there is a lot of work that has been done there in getting that started.

And, of course, the related, I would call it adjacent issue, of the technology of the AETP [Adaptive Engine Transition Program] program, which we have been tracking like for 10 years and where that goes. We can talk about all of that.

Mentioned the sustainment. And the core of that, of course, was to get to a good and effective performance-based logistics [PBL] contract at the system level. And we took very seriously the NDAA guidance about having it certified both for performance and cost.

And simply put, in the negotiations we have gone through with the industry, up until about a month ago, it was clear we were not going to get a satisfied cost proposal with performance that we would feel comfortable with and that we had to take the team that was very busy working on that and put them on essentially extending where we are now and then come back to the PBL. And simply, we were not going to approve a PBL that did not perform well and didn't get the cost savings.

And for the ranking member and how you expressed your question about how could we not have a better price and performance, I completely agree with you. That almost took the words out of my mouth when we made this decision. So we have not given up on it, but we have got a lot more to do there with industry.

The other piece on sustainment that I will be happy to talk about in the last year, and this is, I would say, a positive thing, is that we have been doing sustainment tabletop exercises assuming a contested environment, particularly one in the Indo-Pacific, and we are learning a lot. So we have done that there.

And finally, what is central to this discussion on PBL, and frankly has been essential to the program since I have been with the program, has been the data itself, and the quality of the data, and the ownership of inventories and understanding the inventories. It impacts lots of things, including our ability to pass an audit.

This has also been a factor in the PBL negotiations is making sure that the data that we are getting from industry is something that we can rely on. So we are going to continue to push on that.

The legislation of 356 that allowed us to get data from the contractor has been very helpful, and we look forward to working with you further on that.

I will close my testimony. I look forward to your questions. Thanks.

[The prepared statement of Dr. LaPlante can be found in the Appendix on page 31.]

Mr. WITTMAN. Thank you, Dr. LaPlante. We will now go to Lieutenant General Schmidt.

STATEMENT OF LT GEN MICHAEL J. SCHMIDT, USAF, PROGRAM EXECUTIVE OFFICER AND DIRECTOR FOR THE F–35 LIGHTNING II PROGRAM, DEPARTMENT OF DEFENSE

General SCHMIDT. Sir, thank you. Chairman Wittman, Ranking Member Norcross, and distinguished members of the subcommittee, thank you for the opportunity to provide an update on F–35 development and production plans and progress as well as strategies to maximize readiness and reduce sustainment costs.

I am grateful that topics such as Tech Refresh 3, engine power and cooling modernization, test infrastructure, and sustainment are priorities for this subcommittee. And I assure you they are also top priorities of mine.

Today, our Lightning Sustainment Center is delivering global support to U.S. services, F–35 partners, and foreign military sales customers around the world.

We are executing an F–35 war on readiness, war on cost, and war on cyber to get after key program challenges. We are placing strategic focus on depot stand-up, organic warehousing and transportation, and logistics information system modernization.

Meanwhile, organic pathfinder initiatives are driving cost-effectiveness as we de-layer our F–35 supply chain. It is clear there is no shortage of innovation and progress being achieved across this enterprise. And there is undoubtedly much work to be done.

While maximizing readiness is at the forefront of my mind today, our program-wide focus on TR–3 stability and Block 4 delivery aims to ensure this air system is ready and able to win tomorrow's advanced fight if called upon.

We are pursuing game-changing modeling and simulation efforts to minimize requirements for costly real-world flight tests and training. We are combating challenges associated with concurrency to deliver the necessary capabilities on relevant timelines in future lots. And we are closing in on Milestone C in a full-rate production decision.

I look forward to the opportunity to update you on progress and plans associated with these and other efforts today.

Since I last testified before this subcommittee, the F–35 program has overcome significant challenges and made tremendous progress. Many recent operational and programmatic accomplishments are detailed in my written testimony.

Since March, the F–35 program has stood up capability at four new bases and on one new ship. To date, F–35 users have logged over 750,000 flight hours and 450,000 sorties around the globe. F–35 capability and international collaboration are increasing every single day.

Within 10 years, there will be over 600 F–35s operating in the European theater alone, and fewer than 60 of them will be U.S. owned. The F–35 partnership's shared commitment and mission brings game-changing value not only for coalition combat, but for our taxpayers as well.

I am tremendously proud of our multinational F–35 JPO [Joint Program Office] team members who deliver, innovate, and grow every single day. Together, we are leaning into this "dig-in" mentality as we enable fifth-generation capability and pursue readiness and excellence across the F–35 fleet.

Thank you once again for the opportunity to join Dr. LaPlante and Mr. Ludwigson as we discuss F–35 progress, challenges, and opportunities.

This subcommittee's support and oversight are essential to the success of this program.

[The prepared statement of General Schmidt can be found in the Appendix on page 41.]

Mr. WITTMAN. Thank you, Lieutenant General Schmidt. And now we will go to Mr. Ludwigson.

STATEMENT OF JON LUDWIGSON, DIRECTOR, CONTRACTING AND NATIONAL SECURITY ACQUISITIONS, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. LUDWIGSON. Chairman Wittman, Ranking Member Norcross, thank you for the opportunity to discuss our work examining the F–35.

The F–35 remains critical to U.S. national security and to that of our international partners and allies. After years of development and the completion of testing, the baseline program is poised to move out of the acquisition phase.

Completing baseline development is good news, but the work to keep the F–35 ahead of our potential adversaries continues. The program is committed to modernize the aircraft through the Block 4 and TR–3 efforts aimed at providing enhanced capabilities to keep ahead of evolving threats.

The program also plans to upgrade the cooling system, engine, and related systems intending to reduce wear on the engine and reduce costs while enhancing the foundation of the F–35 to receive advancements developed through Block 4 and potentially beyond. Both of these modernization efforts are critical to the future of the F–35.

Over the past several years, we have reported multiple concerns about Block 4 and TR–3 and made recommendations aimed at improving them. In particular, we have reported that the program was struggling to develop and field Block 4 capabilities and made numerous recommendations, including updating the schedule to better reflect actual development timeframes and to use better tools for monitoring software development.

Earlier this year, we reported that the limited availability of test aircraft posed a risk to the Block 4 test schedule and noted the program was planning on increasing the number of test aircraft to address this.

Over the years, we have also raised higher level concerns about how Block 4 is organized. Originally, Block 4 was comprised of 66 capabilities, expected to be completed for $10.6 billion by 2026.

In 2016, at the inception of Block 4, we recommended that DOD take steps to manage Block 4 as a separate program and that Congress consider directing DOD to do so. We believe this would provide more visibility and the foundation to hold the program accountable for meeting cost, schedule, and performance goals.

The program did not implement our recommendation, but Congress took steps to require enhanced reporting for Block 4.

However, we reported that the program has routinely made changes to Block 4. And last year we reported the most recent data indicated Block 4 had grown to 80 capabilities and grown to $16.5 billion and wasn't expected to be completed until 2029.

This evolving picture has made it difficult to identify whether cost and schedule increases are a result of increasing scope, developmental challenges, contractor challenges, or something else.

Despite enhanced reporting, we continue to face challenges tracking costs for Block 4 capabilities. In our report earlier this year, we recommended that the program take steps to improve how it reports Block 4 costs for individual capabilities.

With our impending transition out of acquisition, the concerns we raised are increased in importance. And we continue to believe that the effort would benefit from enhanced oversight as a separate program as we recommended.

More recently, the program has taken steps to address longstanding problems with the aircraft cooling system, the engine, and related systems.

The original requirements for cooling proved to be incorrect and accelerated wear and higher maintenance costs were the result.

Over the past year, the program examined options for addressing this. Earlier this year, we reported that the analysis done to examine these issues lacked some key information. We identified five recommendations aimed at enhancing the basis for proceeding with this modernization effort.

For example, we recommended the program office define its estimated future cooling needs, conduct an independent technology readiness assessment, and obtain independent cost estimates.

Similar to our Block 4 concerns, we also reported that modernization of the cooling system, engine, and related systems would benefit from enhanced oversight. We recommended that the program take steps to manage these efforts as a separate program and raised a matter for Congress to consider requiring the Department to do so.

As the program transitions out of acquisition, it could be difficult to oversee these efforts without traditional acquisition management tools.

Much has been accomplished in the development of the F–35, but the modernization efforts appear costly, complex, and critical to staying ahead of our potential adversaries. As such, we believe providing sufficient visibility into these efforts will be important for timely and impactful congressional oversight.

Our past recommendations could help Congress oversee these efforts as the baseline program transitions out of the acquisition phase.

Chairman Wittman, Ranking Member Norcross, this concludes my statement. I would be happy to answer any questions the subcommittee members may have.

[The prepared statement of Mr. Ludwigson can be found in the Appendix on page 63.]

Mr. WITTMAN. Thank you, Mr. Ludwigson. I want to thank our witnesses. And General Schmidt, I will begin with you. We had you all here last spring. You said the delivery date for TR–3 upgrade would be between December and April. Now it looks like it's April to June.

I want to drill down and get from you, what are the specific areas that the contractors are having difficulty in delivering the TR–3 upgrade? And I want to ask specifically about what are they doing in trying to replicate the aircraft's operational systems in the laboratory?

And it seems like to me that this ought to be a fairly simple paradigm because contractors have done it for other platforms. They've done it for *Arleigh Burke* destroyers with Aegis systems. They have done it for *Virginia*-class submarines. So it is not like this is an unknown.

Can you give me some drill down about why there is a failure there to deliver this? Is there something in the laboratories? Is there something there that is not connecting in how this TR–3 upgrade is being pursued?

General SCHMIDT. Yes, sir. That is a great question. You know, as I discussed previously, sir, you are absolutely correct. Our labs are not properly representing the flight environment, and there is way too much discovery happening in flight test.

Dr. LaPlante directed a tech baseline review that started last summer that they are just wrapping up. And we will get the results.

Just in summary, sir, we have seen way too much discovery in flight tests. Also I would say in this program concurrency has been an issue. But especially when we introduce concurrency in the form of hardware in this program, we have a history in this program of not being able to, in a timely manner, deliver hardware fully integrated from a software program, software aspect into the program.

We are better on the tactical application side, but when we introduce hardware into a lot in this program and not have the full engineering rigor required to identify what the work scope is required to deliver in that specific lot, we run into problems in this program.

And I am happy to discuss, sir, what we are doing going forward if you would like me to do that?

Mr. WITTMAN. Yeah, I would. I would like to know what the course of action to correct this, to be able to get back on track. Because this doesn't only affect TR–3, but it also affects Block 4. And as we have aircraft back up and we are looking at what are the capabilities of these aircraft once they get the TR–3 upgrade, are they going to be as capable as TR–2 aircraft? I think that question, too, comes up. So I wanted to get your specifics about that situation.

General SCHMIDT. In the near term, sir, relative to the stability issues that we are seeing, we are working through them. I wish, I wish I had all of the solutions in place that proved to me that when I do something in the lab, it is going to show up that way in the air.

We have a number of fixes addressing the stability challenges. We will get to a stable, capable, maintainable airplane here. The data tells me it will be in the middle of spring. But I would have had a more positive answer 6 months ago of when I thought it would be. So I don't have a super solid I can guarantee you this date.

I will tell you that going forward—by the way, the competition in the labs and the limited capacity in the labs between the latest TR–2 software that has great capabilities that will go out to the field early next year, it will be good to get it out of the lab.

We are competing right now between the first version of TR–3 hardware and software and the next version, which takes that combat capability in the field that we're about to deliver early in the year and puts it into a TR–3 version. So we are trying to create capacity in the labs to do that.

I will say that for all Block 4 capabilities going forward the team has done, I think, a very good job of taking the many contracts we had across all of the Block 4 capabilities and putting rigorous capability decision points with rigorous system engineering processes so that we don't get ourselves into a situation where we commit hardware or software—but specifically hardware—to a specific lot without all the rigors required to say I can put that into that lot and have that contractually binding with Lockheed or Pratt & Whitney, depending on which it may be.

Mr. WITTMAN. I think this also begs the question about the enterprise on advance systems, especially F–35. It has taken now, we are at year 18 if you count every minute of when it started from concept to where we are now, and then making sure this platform is operational. It really begs the question, if we are going to do things quickly at the speed of relevance, software needs to inform hardware. That is the way things need to go.

Listen, a great hardware platform, but it can't do the things that we need for it to do if it is not software enabled. So we want to make sure that that is the baseline.

Let me go to performance-based logistics. Dr. LaPlante, I wanted to get your mindset on this.

We looked at a performance-based logistics contract to be able to reduce cost, to have more certainty in the supply of spare parts, mission capability metrics. As you know, the non-mission capable rates due to lack of parts is currently at 42.5 percent, absolutely unacceptable.

We looked at what you are proposing, and now you seem to be moving away from performance-based logistics because you say it is going to be more expensive than doing sort of one-off, one aircraft mission capable maintenance and mission capability performance efforts.

Can you explain where negotiations have led you to come to that point now and why a performance-based logistics contract is not the way to go forward?

Dr. LAPLANTE. Well, thank you, Mr. Chairman. Well, to be clear, we have not made the decision to walk away from performance-based logistics overall at the system level. We had to pause just because of the manpower we had that was doing negotiation to extend the current contract. We have not walked away from the system-level performance-based logistics.

Where we were—to do the pause, as I mentioned earlier, is in the proposals that we had received from industry at that time, they were at not sufficient cost savings, if any, and not performance savings. And so we knew we wanted to wrap up the negotiations by about February to be able to switch to the new contract and just didn't have the time.

So we put pause on the PBL to focus on extending the current contracting. But I say overall, this is the way we understand it. The key thing is, you know, with performance-based logistics is, number one, picking the right metric——

Mr. WITTMAN. Yeah.

General SCHMIDT [continuing]. To measure the contractor with. And you also want to do it of some period of time, 5 years, even longer.

Sometimes at the system level, a performance-based logistics is very hard to do, and I'll explain an example why. If the contractor themselves or the program office doesn't have control over the metric. I was talking to one of my colleagues in another country who had one system-level performance-based logistics that was actually not working for him because the metric was in there. It was things like flying hours. And he didn't have control of it nor did the contractor. So sometimes you have to get the right metric.

Where we have been in the metrics with this discussion is something called the gross issue effectiveness rate requirements. With the percentage of total demands filled at the base with onsite inventory divided by total number of demands and supply response time.

We think those are good metrics. But for us to get a good idea on whether we will meet the metrics, that data has to be something that is reliable. And that was part of the issue, but we haven't given up on it.

The other piece, and this may be the case, is there is something called in the sustainment community market basket approaches where you decide maybe for subsystems or what we might call systems to do a PBL, but not have one single PBL for the entire plane. So we are looking at all of that.

And actually, we were looking at this as part of section 142, because section 142 that you all helped us with really directed us to begin really standing up the organic government management of sustainment. And to do that, the government has to know what it's going to do itself organically and what it's going to contract to do.

And so a market basket approach may be there. It's just we were not going to wrap up the negotiation on this one in the time we needed. And I wouldn't have been able to satisfy the requirement to have it certified for the price savings. But we are not walking away from it overall.

Mr. WITTMAN. I think you hit the nail on the head as far as metrics. I would encourage you to look at other organizations out

there that do performance-based logistics. When you go to the airport, the airlines make sure they keep their aircraft in the air. They are pretty aggressive about making sure that when that aircraft is at the gate—now some of us had experiences where the aircraft gets rolled away from the gate, but their operational availability is pretty impressive. So they don't make money if they're not in the air. So I would argue there are a lot of things that could be learned from that. Obviously tactical aircraft is different than those passenger aircraft, but I think some of the concepts are probably the same.

With that, I will go to our ranking member, Mr. Norcross.

Mr. NORCROSS. Thank you, Chairman. Mr. Ludwigson, in your hearing statement, you referenced Block 4 development effort in 2016. Baseline was at 66 capabilities at a cost of $10.6 billion to be delivered in 2026, that baseline.

Presently, Block 4 is comprised of 80 capabilities at a cost of $16–1/2 billion to be delivered 3 years late, 2029. Help us understand. You talked briefly about some of the suggestions that you have made and some of the issues, but the root causes for this, drill down a little bit more. Help us understand what those delays, the cost overruns for delivery, how do we address them given the history as a lesson for us?

Mr. LUDWIGSON. Yes, sir. That is a great question. Block 4 when it was conceived, I think, was this longitudinal idea that you would just continually add new capabilities as the threat evolved.

Unfortunately, that's hard to do in a public sector space where you have got—the Congress has to decide to provide the money and provide the other support necessary to proceed. And it was that—and I should say that 66 capabilities number, that is something that was difficult for us to get our hands around from the beginning. But the original——

Mr. NORCROSS. The original requirement of 66?

Mr. LUDWIGSON. The original 66 capabilities is not something that I think the program wanted to sort of carry forward. They wanted this to be rather an evolving situation. And that is what happened because it wasn't bounded with a specific set of requirements, a specific limitation in terms of this is what it is going to be in terms of composition, cost, and schedule.

It didn't have those baseline sort of documents that you would have for a traditional acquisition. And people added capabilities or capabilities were unpacked and some may have been dropped. And eventually you got to what we report as the most recent as 80 capabilities, $16.5 billion, to be completed in 2029.

I think when you get to the root cause, some of the challenges that have emerged is because they didn't have requirements, they didn't necessarily have a firm sense of what was technically achievable. They didn't have a strong basis for understanding how long these things were going to take.

It became a bit of a journey of discovery and took time for them to figure out it's actually going to take longer. Software development is difficult. And I think they certainly had their fair share of difficulties. But some of it was not setting realistic expectations for the time that they would deliver it and then not executing to meet those or not staffing to meet those.

Mr. NORCROSS. Thank you. General Schmidt, TR–3 hardware, we talked about this at our last hearing as being the major issue in trying to get this going. It seems that that now is in place. But my question has more to do with not only the rate of our current line that is running, but for backfeeding those other ones.

Are we near where we need to be in terms of ramping up for those units to be produced so we can not only fill our line going forward but also backfill?

General SCHMIDT. Thank you, sir. Relative to the TR–3 hardware itself, the TR–3 hardware is coming up a ramp that is not where it needs to be. It is not meeting our contractual requirements. And there is really a couple of components within the TR–3 hardware that is driving that, but you need all the components to make a TR–3 kit.

The next-generation DAS [Distributed Aperture System], which isn't technically part of the TR–3 kit but it is very much a part of this lot of capability that's going forward, that next-generation DAS hardware is coming pretty well. But there are a couple components in TR–3 that needs to come up the curve very quickly in order to meet our production and really our retrofit requirements after TR–3 is delivered here.

Mr. NORCROSS. So just let me understand, it's not where you said it contractually should be. So do we have enough to fill the line going forward now? And we're missing retrofitting? Where are we in that scale?

General SCHMIDT. Currently, we do not have enough. There were 52 airplanes contractually if TR–3 was fully ready would have been delivered by the end of December. Twenty-one of those airplanes are—let's say crossed the last stage in the production line. The rest of the airplanes are being held in general for moving TR–3 hardware around.

But maybe that gives you the scope of where we're at. Again, if we can get these two components to come up, we will catch up quickly. But that's where we're at, sir.

Mr. NORCROSS. So, we are missing any retrofits, but we are not even keeping up moving forward.

General SCHMIDT. Well, the retrofits, sir, would start later, but when you add production and retrofit, so that requires your ramp to go up higher.

Mr. NORCROSS. Thank you.

General SCHMIDT. Yes, sir.

Mr. NORCROSS. Dr. LaPlante, 3 years ago the government prime contractor, Lockheed Martin—speaking of benefits, this is getting back to the PBL. And just to understand this, negotiations have ceased, at least temporarily. You mentioned you didn't have the manpower. Drill down that because, you know, manpower is extremely important but it falls off the table the amount of money for that versus a logistics contract.

Dr. LAPLANTE. Thank you for the question, and I appreciate the question. Let me—it is basically the team that General Schmidt has to do the negotiations and what they focus on. We could have surged manpower, that's exactly right, but we talked and thought about that. But it was probably not practical. And General Schmidt, it is your team. You can maybe talk about that.

General SCHMIDT. Yes, sir. Happy to. So there is a manpower challenge, sir, but part of it is that the people that understand and have been in—this has been years of negotiation moving forward. Whether it is the PBL or the annual sustainment contract, that team of people is rather limited.

And to include at Lockheed. You know, these are huge contracts with quotes from all the suppliers that come in. And we definitely got to the point where we had to pivot to something. I had to either show Dr. LaPlante that I had a closure plan that would get us there by right now or pivot to extending our current contracts, otherwise we would be at risk of sustaining our fleet.

I am proud of the team who has been working this 7 days a week for a long time. They have closed with Lockheed on a full handshake for the first extension, if you will, to March. We are quickly closing on the extension to June.

And as soon as I get that done here in the next, I hope, few weeks, we will pivot to me getting back to Dr. LaPlante with a plan on how we are going to get back to whatever the broader acquisition strategy that in my opinion must be incentive-based in order to drive the proper industry behaviors and commitments going forward, sir.

Mr. NORCROSS. We will pursue that a little bit later on, but I want to give the others a chance. I yield back.

Mr. WITTMAN. Very good. Thank you, Mr. Norcross. We will now go to Mr. LaLota.

Mr. LALOTA. Thank you, Chairman. Thanks to our witnesses for being here today. I represent the First Congressional District of New York, the eastern end of Long Island. And Long Island is the proud supplier of about 50 different F–35 components. And it is the reason for about 535 jobs. Our folks on Long Island make everything from avionics to the landing gear of Air Industries in Bay Shore, the town where I grew up.

I want to talk about supply chain issues. And my first question is for Dr. LaPlante.

Post pandemic, and now with real-world requirements in Israel and Ukraine, this committee has spent significant resources in an effort to improve our defense industrial supply chain.

Subcommittees like this have brought in experts like yourself to gain some lessons learned to improve our warfighting capabilities.

With those lessons learned in mind, can you please tell the committee what steps the DOD acquisition folks are taking to ensure America's defense industrial base is meeting important programs like the F–35?

Dr. LAPLANTE. Thank you for the question. Number one, we are imminently going to release for the first time ever a national defense industrial strategy that has four elements to it, also with an action plan following. That's going to be released any day now. And one of the four items is all about supply chain.

We have, under the auspices of the supplementals for Ukraine, but also under the regular budgetary process, pumped billions of dollars into the industrial base and building back in key areas.

For example, Defense Production Act on five key components across the industrial base. We have used, I think, up to $800 million there, whether it's for rare earth batteries, solid rocket motors,

et cetera. So it is what we do every day. And, yes, COVID threw us all for a loop.

The other piece of this that I would like the committee to think about because it is what we are sort of dealing with in munitions. Is one of the reasons that you do—one of the reasons to do multiyears or block buy, depending on what you want to do, is not just the savings in cost. You should get savings in cost. But to the stabilization of the supply chain, the sub-tier suppliers. Because if they see that they can get longer term contracts, it stabilizes them, and it makes them less certain.

To do that, a lot of times you have to put in what's called economic order quantity, which think of it as buying bulk, some of the parts, the first 1 or 2 years. And that's something that—that is what industry does in the commercial world. They don't buy things 1 year at a time. And those are things that we believe done right will really help with the supply chain, including on F–35.

Mr. LALOTA. Thank you and you kind of beat me to my next question for Mr. Ludwigson. What can Congress do better to help strengthen the supply chain?

I hear demand signals. We have heard that before. Both Chairman Rogers and Chairman Wittman are trying to get us to be in a better position with the power of Congress' purse to give the industry better demand signals. What else can Congress do to help on this issue? Are there issues of regulations or whatnot where Congress should endeavor to help strengthen our supply chain, Mr. Ludwigson?

Mr. LUDWIGSON. I think the progress that has been made with getting the baseline program through testing so that it can be approved for full-rate production through Milestone C, provides a greater degree of certainty. I would defer to General Schmidt and Dr. LaPlante to provide comments on that.

But my impression is that with greater understanding that this is—the program has achieved this goal. It is in a better position to enter into longer term arrangements, get a better understanding of that ramp rate and what the actual production rates are going to be as it relates for F–35. That would be one of the things that I think is going to be very important is that move and the ability to reach those economic order quantities that makes sense for the program with a known production rate and known experience with maintaining the aircraft in the field.

Mr. LALOTA. Thanks. And with the minute I have left remaining, I want to switch gears a little bit, get back into the field, and look at Israel. Lieutenant General Schmidt, how have the F–35s performed in Israel?

General SCHMIDT. Sir, in here, I will say absolutely outstanding. Their mission capable rates are high. Their full mission capable rates are high. As the chairman mentioned, we have added some capabilities to that airplane in a very short period of time. And our team is doing everything we can to continue to move the ball forward there, sir.

Mr. LALOTA. Thanks so much. Chairman, I am almost out of time, but Dr. LaPlante, I look forward to reading your report, sir. I yield.

Mr. WITTMAN. Thank you, Mr. LaLota. We will now go to Mr. Courtney.

Mr. COURTNEY. Thank you, Mr. Chairman. I can share with Mr. LaLota that I actually did get a sneak preview of the report, the industrial base strategy report and, again, I really compliment Dr. LaPlante for really doing it really for the first time or the first time in many, many years. And, you know, it answers the question that frankly every service branch is really—needs to get answered.

So we are about 2½ months into the fiscal year, 2024 fiscal year. It doesn't look great that we are going to have a budget passed or an appropriations bill passed before Christmas. And, you know, then obviously the next cliff is fast approaching in January.

You know, when we talk about the F–35 engine issue and the ECU [Engine Core Upgrade] upgrade, again, your budget, just to go back to last February or March when it was released, called for increasing the ECU line from $75 billion to over—sorry $75 million to over $400 million was, again, the budget request. And the two defense appropriations committee are sort of roughly in that ballpark that is there.

I mean, if, and look at, there has been some other talk about it all year—CR [continuing resolution]. I mean, given, again, the disparity between those two numbers, that doesn't sound pretty in terms of just, you know, moving this program along. So I was wondering if you could comment in terms of just where would that leave us?

Dr. LAPLANTE. Yeah. Well, we all hope it doesn't happen. But if we end up there, we may have to relook, and I will defer to General Schmidt, at the strategy for funding the engines and that work.

In some ways, the F–35 program is, believe it or not, faring a little bit better in CR than other programs because we already are in production. I could put a pitch here too. I really believe the key to supply chains is also production. And the F–35, for all the justified concerns we all have had over its program, is doing hot production. It's one of the few programs we have that is doing hot production, and it helps with the supply chains.

But, yeah, I would be concerned about the engine. I am also concerned about—we are talking about the industrial base, about the adaptive engine technology. We mentioned the AETP. I have been with that program on and off in the government for about 10 years and its predecessors. It has done more or less what we have asked it to do. It has gotten 30 percent savings in efficiency.

We just, we are not able, the Department was not able, to fund a full-scale development program of that. I hope that that, at least that technology keeps going as well. But I also defer to General Schmidt to talk about the budgetary implications for the engine work.

General SCHMIDT. Yes, sir. There are about 600 people at Pratt & Whitney that are honestly doing a great job. I was just up there a few weeks ago. It is very impressive what they are doing to try to quickly go down the road to an Engine Core Upgrade program. We need an appropriation to keep that program moving forward.

I also need an appropriation because the power and thermal management system part of that, that I think Ranking Member Norcross discussed, that program really needs to get started. And

I really need that funding to have Lockheed and the suppliers for a power and thermal management system really work through the engineering and all of that. So those are the implications. If we don't get an appropriation, I am at a rough spot here in a couple of months, sir.

Mr. COURTNEY. Well, thank you. I mean, I think that's obviously very helpful. So speaking of the power thermal management, actually your office put out an RFI [request for information] fairly recently, right, for my notes here. It's a new PTMS [power and thermal management system] requirement, a 62-kilowatt threshold and an 80-kilowatt objective of cooling. Can you sort of explain what that is sort of in the context of, you know, where the program is moving right now, clarify?

General SCHMIDT. Yes, sir. Well, those would be the requirements, if you will, that we are trying to make sure that this airplane can deliver that kind of electrical power to support all future upgrades to this aircraft.

To truly understand what it takes to get to those things, I first need to be able to have Lockheed do a full assessment of the airplane to understand. So there's the actual power in the requirements and then there is how much can every part of this airplane handle to include the electrical power system, the fuel thermal management system, all of those things that we need to get going forward on.

There are a number of great suppliers of power and thermal management systems out there that I want to be in this discussion and will be in this discussion. But I got to do some really good engineering work first to try to bring all of that together.

Mr. WITTMAN. Thank you, Mr. Courtney. We will now go to Mr. Gimenez.

Mr. GIMENEZ. Thank you, Mr. Chairman. I am going to be focusing in on the engine and the engine upgrades. We seem to be talking a lot about power and management and cooling and all that. But the one thing that I see that is missing from our dialogue or conversation is performance. And that is what matters to the pilot, to be honest with you.

And so is it correct that this engine that we currently have on the F–35 was built around a platform that was supposed to be 30 percent lighter and 13 percent smaller than the current platform?

General SCHMIDT. Sir, I don't know if those numbers are correct or not. You might be——

Mr. GIMENEZ. Well, there is obviously something wrong because the engine is overheating. And because of the increased demands on cooling, et cetera, that the life span of this engine is going to be shorter than what we thought. And so where are we going? Are we moving on the EEP [Enhanced Engine Package] program or are we looking at the AETP program, the new engines, or are we looking just to upgrade the engines that we have?

Dr. LAPLANTE. Yeah. I will hopefully help with the question here. We are going with the core, the life extension of the core, the 135, as well as the cooling for that engine.

Let me just say this, not knowing the history that you know, so I defer to you. What I have seen in the time I have been in this job, and this gets into the requirements issue that GAO mentioned,

the requirements have changed in thermal and power because the threat has changed and the systems that have been added to the airplane, even decided to be added in the last 5 years, were something we didn't envision 10, 15 years ago. That's simply true.

And so, now, you could argue that we—that is an argument for a much more modular architecture so you can upgrade when the threat changes. But it has changed. The systems that are now on the jet or are planning to be on the jet were not planned even 10 years ago.

Mr. GIMENEZ. I understand that. Now, again, are we looking just to upgrade or putting some kind of an add-on to the engines that we currently have to manage the problem or are we looking at an entirely new engine with new capabilities? And if we are not, could you answer why? Because apparently the new engine with entirely different capabilities are going to give you 30 percent greater range and will give you 20 percent more acceleration. And if we're looking at the INDOPACOM [U.S. Indo-Pacific Command] theater, range is going to be a premium. So what are we looking at? Where are you guys heading?

General SCHMIDT. Sir, so I absolutely understand the question. We did a business case analysis last year. We went out—our requirement was to address the life of the engine. We're running the engine too hot. Significant costs over the life of the engine. And we needed to solve that problem.

Additionally, we needed power and cooling, additional power and cooling capabilities. There was also the Advanced Engine Technology Program, which is a very, very promising program, sir, from a performance perspective.

One of the challenges in this program, with the AETP program, as we did the business case analysis, is that it is an option for the A model and maybe for the C model and doesn't work for the B model.

So if I was going to address all of the requirements of the program from a get the life back in the program perspective, only the Engine Core Upgrade to the current engine fit that.

Mr. GIMENEZ. Could I—I only got so much time.

General SCHMIDT. Yes, sir. Sorry.

Mr. GIMENEZ. I need to cut you off a second. In terms of the numbers of aircraft, A and C versus B, what is the percentage on that?

General SCHMIDT. The A is significantly higher, sir.

Mr. GIMENEZ. And the C?

General SCHMIDT. The A is significantly higher, sir.

Mr. GIMENEZ. But you said that the—a new engine could fit on the A, maybe the C, okay, but not the B. And so we are going to say, okay, because we want the—we are going to choose the least capable engine of all because of the B, which happens to be the smallest number of planes that we have.

Dr. LAPLANTE. That was—yeah, what went into the business case was lots of things. It also——

Mr. GIMENEZ. With all due respect, I am losing time.

Dr. LAPLANTE. Okay. Sorry.

Mr. GIMENEZ. Okay. So if I am in the jet, and I am the fighter pilot, I want the engine that takes me faster and takes me longer.

And I know about your business thing. And now maybe that business argument maybe it should be brought to us and say what is it because there has got to be a tradeoff? Is there a cost benefit to that upgrade?

And so, again, we need to delve into this a little bit deeper, Mr. Chairman, because I am not convinced that this is just a business decision. This is a performance issue, too. And for the life of our pilots and the capability of this airplane, especially in a theater which we may be finding ourselves in conflict is going to need this enhanced capability in the future. And thank you. I guess I yield back.

Mr. WITTMAN. Very good. Thank you, Mr. Gimenez. We will now go to Dr. McCormick.

Dr. MCCORMICK. Thank you, Mr. Chair. This is for both Lieutenant General Schmidt and Dr. LaPlante. Obviously, we have seen the aircraft perform very well in Israel. I think they were pretty satisfied with its ability to do precision munitions exactly where we want it and how we want it.

This goes back to what they have learned in their sustainment side of their aircraft though as they have deployed it more than they probably deployed it in recent years, just how they are feeling about their sustainment portion of their aircraft right now.

General SCHMIDT. Yes, sir. I had the opportunity to talk with their chief of staff just yesterday. I would say that we have a lot—that we are going to learn a lot. They are very satisfied with what their performance from a sustainment enterprise is giving them.

I think we could learn a lot from them in terms of the quickness with which they are turning airplanes, all of the things we are learning ourselves with moving parts around the world in support of a conflict.

So we are committed to—and I am looking forward to, and right now, collecting a lot of lessons learned for us, as we posture ourselves globally for our—the worldwide F–35 enterprise sustainment.

Dr. MCCORMICK. So on that note, actually related note, how is that when we scale that out to like an INDOPACOM, you know, how do we see that? Or do we have that sustainability capability for—we have a lot of things going on right now in a lot of different theaters that could blow up very quickly. Do we have that capability to ramp up as needed?

Dr. LAPLANTE. Yeah, I would add something, and it applies to Indo-Pacific and what we are learning from the current conflicts. One of the—the chairman talked about software and turning software fast. One of the good-news stories in F–35, it's still not where it needs to be on these mission data files.

What General Schmidt and his team did in about a week, week and a half, is turned around these mission data files. That is the brick that goes into the airplane. And that, I think, the lessons learned on how you did that can apply all the way around the world.

The other piece, and I mentioned earlier, is that we are doing tabletop exercises on sustainment in the Indo-Pacific. And what we are learning, not surprisingly, is that we have to be able to surge, and this gets back to the PBL. We want the PBL to be of some-

thing we can surge. So there are a lot of lessons that we are learning that may well affect that as well.

Dr. MCCORMICK. Okay. And with that also, I'm just going to go to another related topic, what about critical base shortages of impact, like the industrial base, like, materials? Do we have materials shortages that could affect, especially strategically different countries that control those sort of shortages?

Dr. LAPLANTE. I would say overall this is just the situation in the world right now. Energetics, energetics are a key issue around the world right now, whether it is solid rocket motors or other TNT [trinitrotoluene] or TNT-like things. And I think we are seeing that—we knew we were seeing that with 155 and the issue in Ukraine. But that is an issue we see everywhere in all the scenarios.

Dr. MCCORMICK. So are we able to—is there something that Congress can do to address that specific—to protect those assets?

Dr. LAPLANTE. Well, I think helping us with the Defense Production Act. We've already used the Defense Production Act to fund solid rocket motors and energetics. We need more of that. I think we also—then more companies will go into that business. So that is where Congress can help us. Thank you.

Dr. MCCORMICK. I see, secure those raw materials then. Okay. Very good. Lieutenant General Schmidt, specific to the importance of technological development, can you talk how the Engine Core Upgrade currently underway is leveraging investments made by the Navy's fuel burn reduction program and other advanced development programs?

General SCHMIDT. Yes, sir. The fuel burn reduction program was very much a precursor to the Engine Core Upgrade program. Pratt & Whitney has modeled the entire Engine Core Upgrade program. And it is my understanding that very much, sir, the fuel reduction program was a significant starter, if you will, to help move forward with the Engine Core Upgrade program.

Dr. MCCORMICK. Okay. I don't think I have enough time for another question. But thanks for your time, gentlemen.

Mr. WITTMAN. Thank you, Dr. McCormick. I want to pursue another round of questioning and then we will head from there if folks have questions that need to be answered in the classified setting.

I spoke a little bit earlier about how the enterprise today across the Pentagon needs to be a software informed process. Obviously, the F–35 is going to be with us for years. We are in—essentially from a blank sheet of paper and nearly 22 years now from the beginning.

Gentlemen, can you tell me, and I will start with Dr. LaPlante, can you tell me how you plan to pursue the enterprise of continued production and maintenance and upgrade of the F–35 in the current structure where we seem to be hardware driven and software is an afterthought. Is there any plan to reverse that to make this a software-informed enterprise?

Are there any plans to use digital twin technology where we can immediately test aircraft, download the information and make software updates and do that at the speed of relevance? Because obviously what's happening with TR–3 is not at the speed of relevance

with these continued delays. Something has to change with the paradigm as to how we operate within this particular realm.

We know that programs like CCA [Collaborative Combat Aircraft] are going to be software-informed programs. So can you give us some insight as to how you see us changing the paradigm for the F–35?

Dr. LAPLANTE. Yes. Thank you for the question. It is an extremely important question. I co-chaired the Defense Science Board study on software acquisition in 2018 that motivated going to the new software acquisition pathway where the old waterfall techniques that the Department had across everywhere needed to be changed to a modern DevSecOps [development, security, and operations] iterative with 8 weeks sprints and dropping to a minimal viable product.

One of the first programs that we looked at on the Defense Science Board study, with General Schmidt's predecessor, was F–35. And one of the questions we asked ourselves was could you go to modern DevSecOps on the mission software for F–35?

The challenge that we saw was the architecture. The architecture goes back to 2002. It is highly coupled and integrated. And it would be—you could do it in portions of it. But it was going to be hard to fundamentally do it unless you changed the architecture.

What I am very interested in is Aegis because I grew up at Johns Hopkins APL [Applied Physics Laboratory], and we were in the Aegis mafia as we called ourselves. And we were very frustrated in the other parts of Johns Hopkins that Aegis did not go open.

Well, finally Aegis has gone to an open system. And so I have not given up hope that we can go to some degree of open system.

I will also say this, and I will turn it over to General Schmidt, on the digital twin. We designed the acquisition strategy for B–21 in the wake of the Nunn-McCurdy breach of F–35. We made sure that that architecture was open. And getting to the changes in the threat, the changes to the requirements, with an open architecture, you can drop changes very quickly. And you can do it by software.

It is not that F–35 doesn't have software. It has got 30 million lines of code. It has just got it in a highly integrated way. I will turn it over to General Schmidt.

General SCHMIDT. Sir, I would only add, and we are just getting going here from my perspective. So we do have a digital twin, for instance, of the integrated core processor, which has helped us out significantly in TR–3. I should have it for the entire TR–3 program.

As we move forward, we are requiring digital models of each capability in the Block 4 as part of those capability decision points going forward.

Your point about the architecture and kind of the closed software environment that we have and Dr. LaPlante's points, we need to eventually get to an open systems architecture. And along the way, for sure, we need to figure out how to make sure we are taking advantage of, for instance, our services software engineering groups to have not only Lockheed working the software in this program but the government organic software developers who are outstanding.

Mr. WITTMAN. Are there additional ways that we can encourage the contractors and their mission system suppliers to adopt and im-

plement new methodologies to be able to do development, testing, and implementation of their changes in upgrades to software?

It just seems like to me that we are in a very archaic and antiquated test, failure, retry, test, failure, retry mode instead of changing the whole paradigm that has us operating at the speed of relevance.

The technology is there in all these other areas. It just seems like for whatever reason, we are still stuck in this archaic trap with F–35, and TR–3 unfortunately is the example of that.

I also understand, too, there may be other things we need to do to accelerate that. It seems like to me the test beds now are aging. Maybe we look at more modern test beds and make sure the test beds are aircraft that are dedicated to rigorous testing.

It seems like to me, too, that we have more up-to-date technology where we could immediately take streams of data from the aircraft, send it directly to programmers on the ground that in a digital twin technology can essentially be put into a simultaneously run model.

That information can really be put into the model. And you could fly that aircraft this afternoon in some cases and say let's try out these software modifications instead of what we have today, which is trying this in the lab. It fails in the lab. You put it in the aircraft. It crashes in the aircraft. You bring it back to the ground and say we have got to do it again.

The trial and error methodology ain't working. And the technology is out there all around us to do things differently.

Can you assure me that we are aggressively pursuing these paradigms going forward with how we are doing upgrades to the aircraft?

General SCHMIDT. Well, first, sir, I would say I thank you for the support for replacing our aging flight test aircraft themselves because that is very important to include the things we put on it to make the data flow better and all of the things.

Relative to our labs, ourlabs—we have a number of recommendations that are coming forth as part of the tech baseline review. And our teams are working through what kinds of investments we should be making in our labs to make them more realistic and relevant relative to the flight test environment.

Specifically, it appears to me that Lockheed is making significant investments in their future programs that are doing a lot of what you described there, sir.

Dr. LaPlante's Aegis example is another great example. How are we making sure? And I wish I had a good answer for you because all those things need to be in this program, sir.

Dr. LAPLANTE. I will just note that in 2014, when we put the RFP [request for proposals] out for what is now the B–21, and we said in the RFP you had to have an OMS [open mission systems] standard open system, all of the companies, there were three of them, two of them were teamed together, that were competing for it started putting out press releases on how they could do open systems.

So when you put it in the RFP and you make it part of the source selection, it motivates different behavior. The question on

F–35 given where we are in the program, that is why Aegis is so interesting.

Mr. WITTMAN. Yes.

Dr. LAPLANTE. We can look at that. The other piece I will just add is the other thing we said in the study about—the software study, it's not just the architecture but something called a software factor. And we defined what it was. That is where that testing, Mr. Chairman, was done. It was called fuzzing. We bombard the code with cloud overnight, and you find all these errors, exactly what you said.

Mr. WITTMAN. Yeah.

Dr. LAPLANTE. They should have a software factory at Lockheed Martin.

Mr. WITTMAN. No. I think software factory paradigm is great. Listen, this isn't a secret how to do this; as you pointed out, Aegis has done it for years. The prime contractor is the lead on that so it is not like this is a secret sauce somewhere that's underneath a pillow that we have to resurrect and put back out there.

This is a known entity. It is done on submarines. It is done on surface ships. No reason why it can't be done for F–35. So with that, I will turn it over to Mr. Norcross.

Mr. NORCROSS. Thank you. General, just to drill down a little bit on your statement that up at Pratt & Whitney there are 600 people working, yet you are talking about the CR. Those 600 aren't working on the ECU for the future or 600 dedicated people for the ECU upgrade?

General SCHMIDT. The ECU for the future, the ECU upgrade.

Mr. NORCROSS. Okay.

General SCHMIDT. Yes, sir.

Mr. NORCROSS. So if they are currently working, and we have a CR, how does that impact that other than ramping up?

General SCHMIDT. Yes, sir. We are limited to last year's funding——

Mr. NORCROSS. Right.

General SCHMIDT [continuing]. Under the CR. And we are good through about February-ish. But at that point, if I don't have the funding to keep—and we are supposed to be ramping up significantly this year in terms of, you know, investment in that program per our plan. So we are capped at the level and then we are actually at risk of it running out if we don't have an appropriation, sir.

Mr. NORCROSS. Nobody wants a CR. But at least we'll continue and hopefully get that. And that is what I wanted to talk about. And Joe has a question concerning the Defense Act.

But for this program, we made a decision. We can't fund two engines. Agree with it, disagree with it. This is where we are heading. Talk to me about some of the technical risks that are facing the ECU and how you are addressing that so that we don't run into a problem like we are with the TR–3 upgrade.

General SCHMIDT. For the program as a whole, I mentioned what I think are some of the technical risks is ensuring that the—so one of the requirements I have, sir, is that this engine program is retrofittable. So we have those power requirements, but at the same time our nations and our services have said this must be retrofittable.

So I need to do all the work on the airplane side and the power and thermal management system side because if I do run into a fuel thermal management system or wiring gauge that would require me to completely, you know, tear the airplane apart to retrofit the engine, that would drive me to go back to the requirements community and say, hey, we got to figure out the right balance here on the, you know——

Mr. NORCROSS. Are you suggesting that we need those answers for both the temperature management and the electrical management? That if they don't come in in an area that you can accommodate on the existing that we might have to go back to the decision we made?

General SCHMIDT. Sir, the engine requirements that they are designing to are to the worst case requirements of the worst case, is what we have directed them to design the engine to.

And if it turns out that we end up having a power and thermal management system that doesn't get to that, it allows us to go back, and Pratt & Whitney to go back, and adjust because there are changes that they can make in the engine to direct power in the gear box that we are going to go towards running that to additional performance out of the engine. But for right now, we are designing to the most stringent case from an aircraft side, sir.

Mr. NORCROSS. Okay. I yield back.

Mr. WITTMAN. I go to Mr. Courtney.

Mr. COURTNEY. Thank you, Mr. Chairman. And real quick, Dr. LaPlante, the exchange that you had a moment ago with Dr. McCormick about what can Congress do to sort of deal with the issue of these, you know, energetics and critical minerals.

When we were in California recently, we talked about one thing that Congress hopefully is in the process of doing is passing the NDAA which has the AUKUS authorization language, which will extend the Defense Production Act authorities to Australia and the U.K. [United Kingdom] as domestic sources, similar to what Canada enjoys today. And actually that is really a huge opportunity, particularly with Western Australia and the mineral resources that are there. So maybe you can just sort of talk about that for a second.

Dr. LAPLANTE. Yeah. Thank you, Congressman. It turns out, tomorrow, I am meeting with the head of strategic industry of Australia, they're in town. And specifically, we are going to talk about the provision that is in the NDAA on Defense Production Act with Australia. So I think they are very excited about it.

Actually, the national—the industrial strategy that you read, we are finding the partners are really interested in that, too, because they are looking at things that we have that they may want to do.

We are also getting the same interest from our European allies, from NATO [North Atlantic Treaty Organization], about a Defense Production Act like thing for them.

So a lot of folks are watching us. I think they see what this Congress has done and authorities. And I think they have seen the effectiveness of it. So I would just thank again, thank you all for what you are doing. And I know the Australians are very eager to talk to us.

Mr. COURTNEY. Again, hopefully we have got about 48 to, you know, 72 hours to wrap this up. So with that, I yield back.

Mr. WITTMAN. Thank you, Mr. Courtney. Mr. Norcross, any other questions? Okay. Very good. Well, I think we are finished with our line of questioning. Gentlemen, thank you all so much. We are—well, before we close, Mr. Ludwigson, I know that you had a comment that you were looking to make there on Mr. Norcross' question. So I'm going to yield the floor to you.

Mr. LUDWIGSON. Sure. Thank you very much. I think General Schmidt did a great job talking about the interconnections between the pieces of the puzzle in the power and thermal management and engine upgrade question. What we have been concerned about is that the program not repeat the mistake that got them here, which is that they underestimated the cooling requirements.

Mr. WITTMAN. Yeah.

Mr. LUDWIGSON. Those proved to be wrong. Then they had to steal from the engine and that caused them to have to get creative. And creativity got expensive in terms of the wear and tear on the engine and all of those sort of cascade of events that we are here talking about.

So we think that is why when you look at this, we prefer you think about this as an integrated package of changes that need to be done, not singularly looking at each piece of the puzzle because when you put them together, integration ends up being one of the biggest, most difficult pieces of the puzzle. Just how do you put it all back together.

Mr. WITTMAN. Listen, I think you are spot on. Power, thermal management, electrical system, all the different elements there of what you do, you know, you can put a larger engine in there that generates more power and cooling, but the question is is, you know, what other changes may be needed on the aircraft itself in order to sustain that?

And then the big question, I think you all have pointed this out, is that what is the end state of the power and cooling requirements of the aircraft? So where does it need to be before its ESL [extended service life] is expired?

So there is no use to say, well, you know, we are going to build an engine that can do 62 kilowatts and then you go, well, gosh, we really needed 80 kilowatts with future upgrades for the aircraft because this aircraft is at a price point where we cannot afford to go through another engine upgrade.

If you are going to do it, you want to do it one time. You want to determine what are the total costs, as you said, over the life cycle of the aircraft. Look at the number of hours that you get out of that engine, which obviously we aren't getting out of the current engine configuration, because you are going to have to do that in order to substantiate the cost that it is going to take essentially over a long window of time.

So I think those things are incredibly important questions that need to be asked before you take any next step in the final engine decision-making.

Mr. LUDWIGSON. I think when you face a difficult question, the carpenter's analogy springs to mind: measure twice and cut once. A pretty useful way to think of it.

Mr. WITTMAN. That is exactly right. So any other witnesses want to make any additional comments?

Dr. LAPLANTE. No. I think you just described to my GAO colleague, the fundamental systems engineering challenge is you have to get the system engineering right because the coupling between subsystems and the effect on that is something that often needs attention. And really good systems engineers are hard to find as well.

Mr. WITTMAN. Yeah. I think it's a matter, too, as you said, good systems engineering, good look at, you know, the whole element to a performance-based logistics. What do we do over the remaining life cycle of this aircraft? We ought to take every lesson learned in the first 22 years of this program and apply those lessons learned going forward.

There is no reason why we should have any of these hiccups going forward. Goodness knows, we probably experienced every one of them that you could in the current history of the aircraft. Let's make sure we get it right going forward so.

Gentleman, thank you all so much. I don't think that there is any need for us to go to the SCIF [sensitive compartmented information facility]. I think everybody has had their questions answered here in this open forum, and the others that needed to be answered have been answered previously in the SCIF.

So I want to thank you all so much for joining us. And if there is anything that you need from our subcommittee, we stand by ready, willing, and able to help. And with that, the subcommittee is adjourned.

[Whereupon, at 3:58 p.m., the subcommittee was adjourned.]

A P P E N D I X

DECEMBER 12, 2023

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

DECEMBER 12, 2023

NOT FOR PUBLICATION UNTIL RELEASED BY

THE HOUSE ARMED SERVICES COMMITTEE

STATEMENT OF

HONORABLE WILLIAM A. LAPLANTE

UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND SUSTAINMENT

BEFORE THE

TACTICAL AIR AND LAND FORCES SUBCOMMITTEE

OF THE

HOUSE ARMED SERVICES COMMITTEE

ON

THE F-35 ACQUISITION PROGRAM

DECEMBER 12, 2023

NOT FOR PUBLICATION UNTIL RELEASED BY

THE HOUSE ARMED SERVICES COMMITTEE

Chairman Wittman, Ranking Member Norcross, and distinguished members of the Tactical Air and Land Forces Subcommittee, thank you for the opportunity to testify today. I am pleased to join the F-35 Joint Program Office (JPO) Program Executive Officer, Lieutenant General Michael Schmidt, and the GAO Director of Contracting and National Security Acquisitions, Jon Ludwigson, to discuss the progress of the F-35 program to deliver integrated capabilities at speed and scale, sustain the growing F-35 enterprise, and foster a resilient defense industrial base.

I represent the Department's acquisition and sustainment workforce of nearly 187,000 dedicated military and civilian professionals who deliver capability to the warfighter quickly and cost effectively. Each and every day, I am impressed by the work these dedicated professionals do to provide our warfighters the materiel solutions needed to pace the evolving threats the United States faces in an increasingly complex security environment.

With more than 900 aircraft fielded across the F-35 enterprise, our U.S. and coalition warfighters are operating true cutting-edge fighter capability, strengthening our alliances and partnerships, and building steadfast fifth-generation capacity. The F-35 exhibits superior performance in peacetime and operational missions, serving as a strong deterrent and demonstrating resiliency of the global sustainment solution. Notably in Israel, we see surging sustainment support in operations that maximizes fleet readiness with 35 of 39 Israeli Air Force F-35A aircraft and exceeds expectations in combat. In many ways, this cooperative program exemplifies best practices for incorporating allies and partners at every phase of defense planning. Coupled with the strength of F-35 capability and capacity, the F-35 enterprise's international teaming construct, with a growing number of countries, sends a powerful message

to our adversaries. This holistic approach continues to provide integrated deterrence and enduring advantage for our joint forces.

As the Department's senior acquisition official, I am pleased to share updates on F-35 in the context of its next major acquisition milestones, modernization priorities, and improvements in affordability and readiness posture.

Milestone C and Full Rate Production Decisions

The Department appreciates the subcommittee's continued support for the F-35 acquisition program over the years. We acknowledge the ongoing imperative to control cost, meet schedule commitments, and demonstrate required performance of the weapon system. Program milestones serve as critical gates to assess the status of cost, schedule, and performance before proceeding to the next phase of the acquisition. As the Milestone Decision Authority for the F-35 acquisition program, I work with the enterprise to ensure the program meets criteria and satisfies statutory requirements ahead of the Milestone C and Full Rate Production decisions.

In September 2023, the F-35 enterprise completed the Joint Simulation Environment (JSE) F-35 mission trials. The final report is anticipated upon completion of further data analysis and adjudication of the test results. These trials represent advanced threats and densities and have produced data necessary to inform evaluation of F-35 mission effectiveness as part of the overall Initial Operational Test and Evaluation (IOT&E). Once the IOT&E report is complete and pending the finalization of other program milestone documentation, I project that the program will be ready to have the F-35 Milestone C and Full Rate Production decisions considered in March 2024.

Technology Refresh 3 and Block 4 Upgrades

Our nation's threats are not static and continue to evolve. We acknowledge many instances where adversaries' technologies and capability development rival our own weapon systems – challenging our national security. To counter these challenges, it is vital that we modernize our systems by delivering integrated capabilities at speed and scale. The F-35 Technology Refresh 3 (TR-3) and Block 4 upgrades are key to these efforts. The TR-3 upgrade consists of new computer processors and displays that increase computational power, serving as the foundation to host many of the Block 4 capabilities that improve electronic warfare systems, communication equipment, weapons integration, and other mission systems.

Over the past eighteen months, TR-3 development has accomplished many goals, although progress has been slower than desired. Many TR-3 hardware component qualifications were completed. The first flight of an aircraft configured with TR-3 occurred earlier this year. The flight test campaign has executed more than 150 TR-3 test flights, with a focus on closing out test objectives to demonstrate safety, stability, core mission capabilities, and new capabilities. However, the current version of software has not been approved for operational use and requires more verification before delivery to the fleet. As a result of software development delays, the TR-3-configured aircraft, currently in production, will be stored by the contractor until the aircraft are determined to be operationally acceptable by the partnership governments. The F-35 enterprise is laser focused on executing the priority integration activities required to resume aircraft deliveries as soon as possible.

Similar to TR-3, the Block 4 software development is behind schedule as the F-35 enterprise works to address challenges with design maturity and system integration. I recently directed an independent group of technical experts from the Military Departments to work with

the F-35 JPO to perform a Technical Baseline Review and provide recommendations on improvements related to the modernization schedule, development infrastructure, software tools, and workforce capacity. I expect to be briefed on the findings early in calendar year 2024. The F-35 enterprise team is exploring all opportunities to mitigate further delays to TR-3 and Block 4 and ensure the most lethal and capable fighter aircraft is in the hands of our joint warfighters at higher capacity and on quicker timelines.

Propulsion and Power Thermal Management System Upgrades

The Department is grateful for congressional support to begin initial design development for the F135 Engine Core Upgrade (ECU). Once fielded, the ECU will restore F135 engine life, provide performance improvements, leverage the existing integrated global sustainment network, and interface with power thermal management system upgrades to provide cooling for future F-35 modernization capabilities. The ECU effort is on track to have a preliminary design in early 2024. The F-35 JPO is assessing acquisition strategy details for power thermal management system upgrade options. Due to interdependencies, both subsystem development activities will be managed as one government effort under the title of Engine and Power Thermal Management System Modernization (EPM).

Test Aircraft

To accomplish all the planned modernization activities, the F-35 enterprise must recapitalize the program's test infrastructure. Software labs have not adequately represented the operational flight environment, and limited lab capacity prevents concurrent development of

multiple software configurations. Presently, the F-35 JPO and industry are innovating ways to mitigate the lab capacity challenge, such as using production-line aircraft to reduce some software risk.

Additionally, the current F-35 test aircraft fleet is aging, presenting additional challenges for the program. The Department thanks the Subcommittee for supporting efforts to procure additional flight sciences aircraft. These test aircraft will be required to test flying characteristics of many Block 4 capabilities, new weapons and stores, and the F135 ECU. Additional developmental test assets will help relieve pressures on the operational test fleet that are currently used to supplement development activities.

Affordability and Readiness

Section 141 of the Fiscal Year (FY) 2022 National Defense Authorization Act (NDAA) requires the Military Departments to provide Congress with updated FY2027 sustainment affordability constraints by October 1, 2025. The U.S. Air Force recently completed analysis for their updated FY2027 F-35A affordability constraint. Details regarding the approach to meeting those constraints will be documented in an update to the F-35 Life Cycle Sustainment Plan. The F-35 JPO is addressing F-35 affordability concerns via a PEO-led initiative called "The War on Cost." The effort is reemphasizing a culture of cost consciousness and cost control, creating a new way of thinking and operating to drive cost out of the F-35 program. The Military Department's affordability constraints and targets will set the context for specific initiatives to reduce operations and sustainment costs, timelines, resource requirements, assumptions, and risks.

I fully support the PEO's "War on Readiness" focus on driving government and industry collaboration and accountability to meet warfighter readiness expectations, and commitment to increasing mission capable rates by an additional ten percent by April 2024. To enable additional readiness improvements, the Department has prioritized depot activation funding of approximately $800M within the last Lot 15-17 contract award to accelerate depot repair activations. Increased depot repair capacity will improve both repair velocity and overall readiness performance.

Furthermore, in support of our National Defense Strategy and fostering a more resilient defense ecosystem, I tasked my Sustainment team – in collaboration with the Joint Staff – to sponsor F-35 sustainment tabletop exercises that stress our current sustainment strategy in a contested logistics environment. The lessons learned from these exercises have led to deliberate actions to ensure our sustainment enterprise is survivable, flexible, and responsive to combatant command wartime surge requirements.

Sustainment Strategy

The Department remains committed to ensuring contracts fairly and effectively motivate industry behavior to meet fleet readiness requirements. Historically, annualized sustainment contracts with F-35 prime contractors have not always yielded desired availability and mission capability. In 2020, the F-35 JPO, Lockheed Martin, and the U.S. Military Services determined a five-year Performance-Based Logistics (PBL) contract would improve Non-Mission Capable – Supply rates, supply chain response time, and gross issue effectiveness at lower or similar cost compared to existing contract methodologies. Section 356 of the FY2022 NDAA prohibited

entry into a supply chain PBL sustainment contract until DoD submits a report certifying that a PBL will reduce cost or increase readiness performance. As a result of review undertaken because of this certification requirement, the Department has already benefitted from valuable cost and performance insights and opportunities to improve data quality that underpin current and future sustainment contracts.

The F-35 JPO and Lockheed Martin faced challenges in PBL contract alignment within the range of the statute's cost and readiness parameters. Lockheed Martin's PBL proposal, submitted in June 2023 and updated in October 2023, was not within the cost or performance ranges to enable the Government to proceed to formal contract negotiation.

In close coordination with DoD and U.S. Military Service senior leadership, the F-35 JPO paused its path to a system-level PBL with Lockheed Martin. The F-35 Joint Program Office and Lockheed Martin agreed to extend the FY2023 annual recurring sustainment contract through March 2024, and the parties are working an additional extension through June 2024. The Government and Lockheed have a joint focus to ensure no breaks in contractual coverage for sustainment support, while also providing more time for the JPO and Lockheed Martin to plan and negotiate long-term contractual coverage. Our immediate priority is maintaining fleet support coverage as we work to update the air vehicle supply chain strategy to meet warfighter readiness requirements at a reasonable cost. Longer term, the F-35 enterprise will update the program's sustainment strategy, consistent with transition planning in the Department's response to Section 142 of the FY22 NDAA.

Conclusion

In closing, the Department recognizes and appreciates the continued support from Congress that has enabled tremendous progress by the government and industry teams to deliver and sustain the most advanced fighter weapon system to date. Most importantly, I remain fully committed to the critical work required to advance the F-35 program in conjunction with Congress, DoD stakeholders, and our industry partners. I appreciate the opportunity to have collaborative discussions with this Committee as we work together to strengthen the F-35 enterprise and continue providing safe, reliable, and capable aircraft for our warfighters and international coalition partners.

Dr. William A. LaPlante
Under Secretary of Defense for Acquisition and Sustainment

Senate-confirmed in April 2022, the Honorable Dr. William A. LaPlante serves as the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)). In this role, he is responsible to the Secretary of Defense for all matters pertaining to acquisition; contract administration; logistics and materiel readiness; installations and environment; operational energy; nuclear, chemical, and biological defense; the acquisition workforce; and the defense industrial base.

Prior to this appointment, Dr. LaPlante served as President and Chief Executive Officer of Draper Laboratory, a research and development company specializing in advanced technology solutions in national security, space exploration, health care, and energy. Previously, he was senior vice president and general manager at MITRE National Security, where he oversaw the operation of two federally funded research and development centers and the U.S. Department of Commerce's National Institute of Standards and Technology.

Dr. LaPlante served as the Senate-confirmed Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics from 2014 to 2017, where he aligned that Service's $43 billion acquisition enterprise budget with the Air Force vision and strategy. During his tenure, he forged a path forward on critical Air Force acquisition programs such as the B-21 long range strike bomber, while realizing nearly $6 billion in "should-cost" savings in other programs. Prior to this position, Dr. LaPlante spent 26 years at Johns Hopkins University Applied Physics Laboratory (APL), ultimately leading the Global Engagement Department where he was responsible for all of APL's work supporting offensive strike military capabilities. He also served as a member of the APL's Executive Council.

Dr. LaPlante has been a member of several scientific boards and commissions focused on maintaining national security, including the U.S. Strategic Command Senior Advisory Group, Naval Research Advisory Committee, and Defense Science Board. He joined other national experts as a commissioner on the congressionally-mandated Section 809 Panel, which performed a comprehensive review of Department of Defense acquisition policies and provided improvement recommendations, many of which became law.

Dr. LaPlante holds a doctorate in mechanical engineering from the Catholic University of America, a master's degree in applied physics from The Johns Hopkins University, and a bachelor's degree in engineering physics from the University of Illinois.

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STATEMENT OF

LIEUTENANT GENERAL MICHAEL SCHMIDT

PROGRAM EXECUTIVE OFFICER

F-35 LIGHTNING II PROGRAM

BEFORE THE

TACTICAL AIR AND LAND FORCES SUBCOMMITTEE OF THE

HOUSE ARMED SERVICES COMMITTEE

ON

F-35 ACQUISITION PROGRAM UPDATE

DECEMBER 12, 2023

NOT FOR PUBLICATION UNTIL RELEASED BY
THE HOUSE ARMED SERVICES COMMITTEE

Introduction

Chairman Wittman, Ranking Member Norcross, and distinguished Members of the subcommittee, thank you for the opportunity to provide an update on F-35 development and production plans and progress, as well as strategies to maximize readiness and reduce sustainment costs. I'm grateful that topics such as Tech Refresh 3 (TR-3) delivery, engine power and cooling modernization, test infrastructure, and sustainment are priorities for this subcommittee – and I assure you they are also top priorities of mine. Today, our Lighting Sustainment Center is delivering global support to U.S. Services, F-35 Partners, and Foreign Military Sales (FMS) customers, including unprecedented surge support to F-35 users in Israel. We are executing an F-35 War on Readiness, War on Cost, and War on Cyber to get after key program challenges. We are placing strategic focus on depot stand-up, organic warehousing and transportation, and modernization of our logistics information system. Meanwhile, organic pathfinder initiatives are driving cost-effectiveness as we delayer our F-35 supply chain. It's clear there is no shortage of innovation and progress being achieved across this Enterprise.

Our program-wide focus on TR-3 stability and Block 4 delivery aims to ensure this air system is ready and able to win tomorrow's advanced fight, if called upon. We are pursuing game-changing modeling and simulation efforts to minimize requirements for costly real-world flight test and training, we are combating challenges associated with concurrency to deliver necessary capabilities on relevant timelines in future lots, and we are closing in on Milestone C and a Full Rate Production Decision. I look forward to the opportunity to update you on progress and plans associated with these and other efforts today.

Program Progress

Since I last testified in March 2023, the F-35 Program has overcome significant challenges and made tremendous progress. In April 2023, the program awarded a Lot 17 option for 126 aircraft for the U.S. Services, Partners, and FMS customers. Just a few days later, the JPO awarded a Block 4 Contract, which strategically prioritizes development of fielded configurations and enables evaluation of capability maturity through predetermined decision points. In June, in coordination with Naval Air Systems Command, the JPO Training Systems & Simulation team developed and fielded the Effects Based Simulator, an innovative and affordable deployable training solution. In August, the JPO completed its Annual Cost Estimate (ACE). While in then-year dollars (including new inflation indices), the program's lifecycle cost estimate increased by $55B, in constant-year dollars the 2023 ACE represents a $45B decrease from the 2022 ACE. Despite economic and supply chain headwinds, this is evidence we are injecting affordability into this program. That same month, during a training event known as *Obsidian Iceberg*, a U.S. Marine Corps F-35B landed on California's Old Pacific Coast Highway during a planned test event demonstrating the platform's capability to operate in locations with limited runway. In September, the F-35 Enterprise completed Joint Simulation Environment (JSE) Runs for Score – a major objective on the path to a Full Rate Production decision. Later that month, multiple F-35 squadrons gathered in Georgia for the *William Tell 2023* Air Meet, demonstrating significant F-35 gun enhancements and F-35 integration capability with other air platforms in near-peer-like competition. In October, the U.S. Navy's 2nd operational F-35 squadron deployed aboard the USS Carl Vinson to conduct operations in the U.S. 3rd Fleet area of operations.

Progress during the past eight months also continues to demonstrate the value each Partner and FMS customer brings to the table. In May, the U.S. Air Force's 493rd Fighter Squadron from

the United Kingdom's RAF Lakenheath forward deployed to Norway's Ørland Air Base to participate in *Arctic Challenge 2023* alongside Norwegian, Dutch, and Italian F-35As supporting a two-week exercise throughout Scandinavia. That same month, Japan declared initial depot capability at its regional propulsion Maintenance Repair Overhaul and Upgrade facility, enhancing global depot maintenance capability. In August, Japanese F-35s arrived in Australia as part of a training exercise. Several weeks later, Australian F-35s travelled to Japan, bringing this multinational operation full circle. In September, Denmark received its first four F-35 aircraft in country. In October, U.S. F-35Bs from Naval Air Station Patuxent River conducted developmental test trials aboard the United Kingdom's HMS Prince of Wales, successfully expanding the F-35's shipboard operating envelope. Since early October, the F-35 Program has delivered surge support to Israel. Israeli users are achieving exceptional mission capability rates and the aircraft is proving resilient. We're learning a tremendous amount and will apply lessons learned to enhance fleet readiness across the globe.

Since March 2023, the F-35 Program has stood up capability at four new bases and on one new ship. To date, F-35 users have logged over 750,000 flight hours and 450,000 sorties across the globe. It's clear F-35 capability and international collaboration are increasing every day. Within ten years, there will be over 600 F-35s operating in the European theater alone, and fewer than 60 of them will be U.S. owned. The F-35 Partnership's shared commitment and mission brings game-changing value not only for coalition combat, but for our taxpayers as well. I'm tremendously proud of our multinational F-35 JPO team members who **D**eliver, **I**nnovate, and **G**row every day. Together, we're leaning into this *DIG In* mentality as we enable 5th Generation capability and pursue readiness excellence across the F-35 Fleet.

War on Readiness

In March 2023, I set a target of increasing the U.S. fleetwide F-35 mission capable rate by 10% (to 64%) by the end of March 2024. We've dubbed this effort the "War on Readiness." To achieve this, the F-35 JPO assembled a team dedicated to understanding and addressing complex challenges associated with top degraders, supply and maintenance challenges, and issues affecting long-term-down and out-of-reporting aircraft. My F-35 Executive Director and I chair War on Readiness meetings, and our F-35 Fleet Readiness team is led by an Air Force Major General, ensuring there is no question regarding this topic's importance and visibility within the F-35 Enterprise. The F-35 Executive Leadership Team is rolling up its sleeves to engage directly with suppliers as we ensure necessary focus is placed upon addressing top degraders and meeting supply chain requirements. War on Readiness stakeholders meet bi-weekly with participants spanning industry, F-35 users, and JPO personnel to "get tactical" in addressing specific sustainment challenges. I'm proud of the work this team is accomplishing, but there is much work ahead.

Today, our U.S. F-35 fleet mission capable rate averages 57.5% – up over 4% since I last testified. I am not yet satisfied with this progress, but I am confident this initiative is accelerating maturation of an ecosystem that supports the program's long-term sustainment goals. The War on Readiness is making headway in addressing top readiness degraders, which disproportionately reduce mission capability rates. Elimination of our top three degraders alone would increase U.S Fleet mission capability to 60.5%. In recent months, we've eliminated multiple degraders completely and significantly reduced many more; however, new top degraders have emerged. The War on Readiness has also enhanced the quality, granularity, and breadth of F-35 sustainment data, which enables greater readiness insight and drives decisions regarding the levers at our disposal. This data offers more context regarding the real-time availability of our F-35 Fleet.

As we continue to tackle our most pressing degraders, new challenges continue to emerge. However, most should be addressed well before they become "top degraders." We are prioritizing effective forecasting and root cause analysis to alleviate this in the future. To formalize and standardize these processes, the F-35 JPO established a Readiness Control Board to identify and resolve emerging degraders quickly, before they impact readiness. We are investing in processes and infrastructure today that will yield results for years to come. However, the warfighter does not have years to wait. Today, we can – and must – improve forecasting to stay ahead of future degraders before issues occur. We are leading initiatives to keep parts on-wing longer by improving reliability, maintaining an appropriate spares posture, and enhancing repair capability and velocity. The F-35 air system has proven its capability and supply chain resilience in recent months in Israel, and I remain confident in our global sustainment capability.

War on Cost

The F-35 JPO remains focused on enterprise affordability, and I remain personally committed to cost reduction across the acquisition lifecycle. In January 2023, I established an F-35 "War on Cost" to tackle affordability challenges in new and innovative ways. Like the War on Readiness, my F-35 Executive Director and I chair these meetings, and work alongside the team to identify and implement cost-saving solutions. The F-35 Affordability Directorate leads this initiative and is my primary conduit for ensuring cost control by addressing three focus areas: cost as a design and program requirement, cost estimating, and cost reduction.

In the 2023 ACE, the F-35 JPO captured an additional $13.6B (CY12$) in sustainment cost reductions over program's lifecycle, bringing the total captured savings to date to $33.7B (CY12$). This results from reliability and maintainability projects, propulsion component improvement

efforts, capability updates (including engine core upgrade), and workforce efficiencies driven by the National Autonomic Logistics Information System (ALIS) Support Center stand-up. The F-35 JPO has driven F-35A Cost Per Tail Per Year (CPTPY) down from $8.7M in 2014 to $6.4M in 2022 (CY12$) and the Cost Per Flight Hour from $87.3k to $36.1k (CY12$) over the same period. Meanwhile, we are reviewing support solutions to maximize economies of scale, identifying ways to keep parts on aircraft longer, exploring strategies to reduce hardware costs, and increasing simulator usage.

While sustainment initiatives are yielding progress, our War on Cost is also targeting development and production opportunities. We are getting creative and changing behaviors to mitigate cost growth, no matter the source. In the development space, time is money, and ensuring efficiency is essential to success. Opportunities in this space include lab optimization and development, security, operations, and test improvements. In terms of production, Unit Recurring Flyaway (URF) cost in CY12$ for all variants remains relatively stable, despite new capabilities introductions and supply chain headwinds. We are actively seeking ways to offset inflation pressures including streamlining contracting strategies, delayering supply chains, and maximizing production line efficiency. When it comes to incorporating affordability initiatives into the ACE, we are betting on ourselves, and will also hold ourselves accountable in the years ahead. I look forward to keeping you and your staff apprised of our progress.

Engine Power and Thermal Management Modernization

The Engine and Power Thermal Management System Modernization (EPM) pre-acquisition program is an air vehicle and engine development and integration program to support future Mission System capabilities while restoring engine life. It consists of the Engine Core

Upgrade (ECU) and the Power Thermal Management Upgrade (PTMU) and is progressing with support from the U.S. Services and Congress. EPM will provide increased cooling and electrical power generation required to support capabilities beyond Block 4 for all variants, while reducing lifecycle costs through engine life restoration. The JPO must rapidly staff the EPM team with expertise necessary to support this effort. We are relying on the U.S. Services to act quickly as we work together to meet these manpower requirements.

Based on the PB24 engine modernization decision, the JPO is continuing to develop and refine an EPM Acquisition Strategy that accounts for the necessary human capital and addresses test infrastructure and air vehicle integration risks while incorporating lessons learned from the program's initial development.

Depot Stand-Up

Organic depot stand-up remains critical to long-term air system affordability and availability. By executing its Global Support Solution, the F-35 Enterprise is establishing air vehicle, propulsion, and component repair facilities in the U.S., Europe, and Asia-Pacific regions. In FY22, the Lot 15-17 contract allocated significant funds towards air vehicle depot capacity establishment, demonstrating the Department's commitment to this strategy. The F-35 Program must sustain activated depots and accelerate new activations to keep up with the demands of a growing fleet. This investment will support the F-35 JPO in delivering organic depot repair capacity while deploying essential TR-3 and Block 4 capability to the fleet. From a propulsion perspective, U.S. organic and global depot capacity and activations are keeping up with fleet demands today, but there is still work to do on the air vehicle side.

In November 2023, the Ogden Air Logistics Complex declared repair capability for the Control Surfaces and Edges workload – the forty-fifth workload established across six organic U.S. depots. Before the end of calendar year 2023, we anticipate activation of three additional workloads including Electro-Mechanical Actuation at Fleet Readiness Center East, Integrated Core Processor at Warner Robins Air Logistics Complex, and Electro-Hydrostatic Actuation at Fleet Readiness Center Southwest. U.S. depots are executing 60% of activated workload component repairs today. The JPO is planning twelve activations in 2024, with remaining activations completing by 2028, for a total of 68 core workloads activated. Expanding our organic and industrial base capability is a key lever in achieving affordability and readiness objectives.

Organic Warehousing and Transportation

The F-35 JPO continues to promote maximum U.S. Service and International Partner involvement in all sustainment activities, not just in depot operations. In January 2021, the JPO entered into a Service Level Agreement with the Defense Logistics Agency (DLA) as the F-35 North American Regional Warehousing product support provider and with United States Transportation Command (USTC) and DLA as F-35 Global Transportation and Distribution product support providers. As a result, DLA and USTC now schedule and deliver Government-owned F-35 global spares material to and from international locations. We are on track to complete transition of more than 30,000 eligible air vehicle part numbers from Lockheed Martin warehouses to DLA warehouses by the end of 2023. In addition, 100% of propulsion items have already transitioned to DLA warehouses. Demilitarization and Disposal Services are included in this DLA agreement and are key Global Sustainment Strategy enablers as the program facilitates materiel management around the globe. Utilizing Government-operated core logistics capabilities is crucial

for ensuring prompt mobilization and response to emergency operations and this transition is essential to maximize sustainment affordability.

Future Air Vehicle Supply Chain Strategy

The JPO remains committed to ensuring contracts fairly and effectively motivate industry behavior to meet fleet readiness requirements. Historically, annualized sustainment contracts with F-35 prime contractors have not yielded sufficient availability and mission capability. In 2020, the F-35 JPO, Lockheed Martin, and the U.S. Services determined a five-year PBL contract would improve Non-Mission Capable – Supply (NMC-S) rates, supply chain response time, and gross issue effectiveness at lower or similar cost compared to existing contract methodologies. The FY22 National Defense Authorization Act prohibited entry into a supply chain PBL sustainment contract until DoD submits a report certifying that PBL will reduce cost or increase readiness.

The JPO and Lockheed Martin have faced challenges in PBL contract alignment within the range of the Government's cost and readiness parameters. Lockheed Martin's PBL proposal, submitted in June 2023 and updated in October 2023, is not within cost or performance ranges that enable the Government to proceed to formal contract negotiation. In close coordination with DoD and U.S. Service senior leadership, the F-35 JPO has paused its path to a system-level Supply Chain PBL with Lockheed Martin. The Government's priority is now focused on maintaining fleet support coverage and updating the air vehicle supply chain strategy to meet warfighter readiness requirements, at a reasonable cost.

ALIS-to-ODIN Transition

The F-35 JPO is evolving its legacy logistics information system, ALIS, into a modern system called the Operational Data Integrated Network (ODIN). ALIS-to-ODIN (A2O) is maturing software, hardware, data, and infrastructure with a focus on delivering incremental value to users along the way. In 2023, the program encountered technical complexities that delayed ALIS software releases. The program is working with industry to execute a strategy to mitigate near-term effects, while assessing longer-term A2O impact. The JPO is developing a final ALIS software release to add capabilities. This effort is also part of a broader initiative known as the *War on Cyber* which mitigates cyber obsolescence, requirements, testing, and operations challenges. In parallel, the JPO is developing ODIN foundational software to enable and simplify future application modernization. Our modernization strategy adopts a microservices architecture where software code is smaller and loosely coupled, and where software components can be deployed and scaled independently. This will enable faster and more frequent ODIN software updates to support user needs.

In 2023, the program successfully fielded unclassified ODIN hardware for new maritime and land-based site activations, and established contracts to replace fielded ALIS hardware with ODIN hardware. The JPO is on track to complete development, test, and certification of classified ODIN hardware elements to enable fielding beginning in 2024. Throughout this effort, the JPO is delayering its supply chain to drive acquisition agility and affordability. By obtaining technical data rights, the JPO enables direct Government procurement of hardware – accelerating procurements and reducing cost. Progress is continuing with data quality, transformation, and infrastructure enhancements. Specifically, the JPO is developing a Data Centralization Archive, which will improve unit hardware performance, provide easier access to data, and enhance fleet

analytics. The JPO designed an improved architecture and began development to "define our infrastructure as code," which allows us to publish software independent of underlying hardware and transition seamlessly into developmental and production environments in Government-owned clouds. Meanwhile, the National ALIS Support Center, continues to serve as a centralized source of remote support for system administrators. By reducing the required number of ALIS administrators, this facility contributes approximately $1B (and growing) to F-35 lifecycle savings.

Surge Sustainment Capability

Throughout its history, the F-35 Program has laid the groundwork for surge sustainment to ensure preparation for wartime activities. As we've seen in recent months, the F-35's global sustainment infrastructure, and the platform itself, are being tested through current conflict in Israel. Since the war began on 7 October, Government and industry personnel have worked together to meet emerging Israeli requirements. From operational and technical perspectives, our aircraft and global supply system are proving resilient. As we seek to drive sustainment affordability across the F-35 Enterprise, we are taking steps to ensure our surge sustainment capacity is not compromised. In alignment with the National Defense Strategy, and its objectives to ensure a resilient defense industrial base and foster integrated deterrence, the F-35 JPO participated in two combined OSD and Joint Staff F-35 sustainment table-top exercises to assess our sustainment strategy within a contested logistics environment. The JPO is applying lessons learned to maximize sustainment survivability, responsiveness, and flexibility.

F-35 Development Programs – Weapons, Tech Refresh 3 (TR-3), and Block 4

The F-35 Enterprise is simultaneously executing multiple development programs, which make the platform more lethal and survivable in the high-end fight. While the program has made progress in this domain, significant work remains. This year, The F-35 Program completed development testing and achieved design certification for U.S. Air Force F-35As to carry nuclear weapons fifteen months earlier than planned. In November, the F-35 Program completed integration and flight test for 2,000-pound GBU-31 Joint Direct Attack Munitions in just seventeen days. Lessons learned from this achievement are already accelerating other projects as the F-35 Program works to integrate additional weapons.

TR-3 remains the F-35 Program's top development priority. TR-3, and the associated Next-Generation Distributed Aperture System (DAS), realized significant risk over the past year, delaying forecasted Lot 15 production deliveries into calendar year 2024. While we are observing progress on TR-3, it's not happening quickly enough. Today, TR-3 hardware reliability exceeds the life limit required for aircraft production, and the Next Generation DAS meets the required 8,000 hours design. While hardware reliability represents significant progress, industry suppliers have faced challenges in meeting TR-3 and Next Generation DAS F-35 production demands. The program is working closely with industry partners to encourage necessary capital investments in TR-3 and Next Generation DAS infrastructure to increase production rates and recover schedule.

In recent months, the F-35 Program achieved important development milestones in real-world flight test. Since TR-3's first flight on 6 January 2023, the F-35 Program has flown over 140 sorties in support of TR-3 at Edwards Air Force Base (AFB) and Patuxent River Naval Air Station. In August, U.S. Air Force Pilots at Edwards AFB flew the first F-35 five-ship with TR-3 hardware and software to evaluate advanced sensor fusion. In October, the program released the first TR-3

software version to flight test that includes all TR-2 tactical functionality. On 14 November, Lockheed Martin pilots successfully flew the first production TR-3 configured F-35s in Fort Worth, Texas. The JPO modified seven test aircraft (one still pending Government acceptance) to TR-3 configuration and is pursuing an aggressive schedule to modify two additional aircraft.

TR-3 has experienced setbacks due to realized software development risk, aging development test aircraft, and insufficient lab capacity. Labs have not represented the operational environment well enough. Lockheed Martin and the F-35 JPO are implementing an Enterprise-wide approach to address these challenges. For example, the F-35 Program is using aircraft on the production line as "TR-3 labs" to reduce software development risk. This innovation prevented at least two months of TR-3 development schedule slip and represents significant cost avoidance.

As we look to the future, the F-35 Program's highest TR-3 priority is software performance improvement, with specific focus on aircraft start-up time and software stability in flight. While we are making progress, these software metrics are not yet adequate to field TR-3 software. Next Generation DAS integration with TR-3 software is also a significant priority as we work to deliver next-generation combat capability. Given schedule estimates to perfect TR-3 and the Next Generation DAS, we are working with the U.S. Services, F-35 partners, and FMS customers on a potential plan to truncate the initial TR-3 software release to deliver capable aircraft without full integration of all systems. This decision increases opportunities for pilot training, drives opportunities for maintainers to obtain hands-on experience, and reduces the duration that Lot 15 aircraft are parked awaiting software. Most importantly, this course of action enables the F-35 Program to pivot resources to the next software release, which incorporates the latest TR-2 combat capabilities into the TR-3 software baseline. Based on comprehensive discussions with the F-35 Joint Executive Steering Board (JESB) members, the U.S. Services and F-35 Partners notionally

support this approach, but we must have a stable, capable, and maintainable software load before making a final decision.

Like TR-3, Block 4 development is critical to advance F-35 air system capabilities for the high-end fight. Block 4 upgrades enhance electronic warfare, communication systems, and other mission systems capabilities for operations in contested spaces around the globe. Block 4 has experienced significant challenges associated with hardware design maturity and software integration timelines. Development and production concurrency is Block 4's most critical challenge, and we are dealing with its consequences today. The TR-3 experience reveals the consequences of accepting high risk in concurrency between development and production. The F-35 JPO, Lockheed Martin, and other industry partners have identified high risk concurrency in the F-35 Block 4 schedule, which would threaten to shut down aircraft production if development slips. We are focused on eliminating this concurrency and establishing realistic delivery schedules that U.S. services, F-35 Partners, and FMS customers can count on.

Several months ago, the F-35 Program awarded a Block 4 contract that puts significant rigor into concurrency analysis. The Block 4 contract establishes Capability Decision Points for an integrated, comprehensive review of the readiness of Block 4 hardware and software to be introduced into specific aircraft production lots. Capability Decision Points enable greater oversight and drive higher confidence in development schedules. Earlier this year, the Undersecretary of Defense for Acquisition and Sustainment directed an F-35 Block 4 development Technical Baseline Review. In recent months, an independent group of Navy and Air Force technical experts have been evaluating the Block 4 development schedule, hardware maturity, program risks, software tools, and industry and Government workforce skillsets. We are looking forward to the Technical Baseline Review's recommendations.

The JESB supports the F-35 JPO's initiatives to reduce concurrency and invest in development infrastructure to support modernization well into the future. The F-35 Program requires a future fleet of nine Flight Sciences Aircraft to complete Block 4 and to enable capacity for future F-35 modernization. Today, the F-35 Program possesses non-recurring engineering necessary to convert three F-35 production aircraft into Flight Sciences Aircraft and full funding in the Future Years Defense Program to complete the conversions. While this is a good start, the F-35 Program must convert six additional aircraft to meet program requirements. This action is dependent upon authority from Congress. The F-35 Program must make investments in Flight Sciences Aircraft and software labs at Lockheed Martin and throughout supplier locations to get the most operational capability out of the F-35 weapons system.

In addition to these efforts, F-35 Mission Systems software development efforts continue to seek more efficient and effective ways to develop and deliver capability to the warfighter. These lines of effort encompass Air System elements such as Operational Flight Programs; Full Mission Simulators and associated Threat Databases; ALIS, ODIN, and off-board mission support; and the JSF Reprogramming Enterprise (JRE) and Mission Data File (MDF) sets it creates. This unified software development approach improves development efficiency and enhances Enterprise-wide integration efforts.

Lot 18-19 Status and Plans

The F-35 production contract for Lot 18 and Lot 19 aircraft will deliver F-35s to U.S. Services, Partners, and FMS customers, increasing F-35 operational capacity around the world. International demand for F-35 aircraft is growing as evidenced by the addition of Poland and Finland, and with other allies soon to follow. There is a reason that nations across the globe

continue to competitively select F-35 to meet their national defense requirements. Through F-35 production contracts, the F-35 Program delivers the air vehicles our users require.

In October 2023, Lockheed Martin submitted a proposal for Lot 18 and Lot 19 production. The F-35 JPO and Lockheed are activity negotiating the Lot 18-19 contract and are targeting potential award on timelines faster than achieved in Lots 15-17. In recent F-35 productions lots, suppliers have experienced significant financial pressures under fixed price contracts in the wake of economic uncertainty. Inflation, increases in energy costs, and supplier base disruptions continue to affect cost. These realities have driven increases in Lot 18-19 proposal costs. Resolving this challenge requires partnership between Government and industry stakeholders as the team works towards awarding the Lot 18-19 production contract in Fiscal Year 2024. Beyond the Lot 18 and Lot 19 contract, we must also consider longer-term contract arrangements to stabilize the F-35 industrial base and control cost.

The F-35 Program intends to shift to a block-buy strategy for Lots 20-24 to establish greater stability within the F-35 supply base and reduce cost. Coupled with a known production rate over a longer defined period, Economic Order Quantity (EOQ) funding would enable Lockheed Martin and its subcontractors to make longer-term supply chain investments that reduce overall cost. EOQ has the potential to save up to $2B over Lots 20-24, encourage F-35 suppliers to make capital investments to further reduce cost, and avoid costly supply chain disruptions that occur under current shorter-term agreements. EOQ funding is critical to maintain stable production cost, and a stable supply base must be a high priority of all F-35 stakeholders.

Milestone C and Full-Rate Production

Completion of JSE Runs for Score in September 2023 cleared the path for the Department to set a date for a Milestone C and Full Rate Production decision in March 2024. Several key statutory and regulatory requirements remain, such as the Director, Operational Test and Evaluation (DOT&E) Report on F-35 Initial Operational Test & Evaluation (IOT&E); the Operational Test Agency's Report on OT&E results; and Defense Acquisition Executive signature of a revised F-35 Acquisition Strategy. The DoD is completing final joint Service and independent cost estimates, which will ensure a realistic program cost baseline as we formally move into Full Rate Production. When achieved, a formal Full Rate Production decision will reduce and eliminate several costly administrative programmatic processes and drive supplier confidence to invest in long-term production and supply chain efficiencies.

Addressing Government Audit Recommendations

As we dive into these and other complex and important topics today, I appreciate the opportunity to testify alongside my colleague from the GAO, Mr. Jon Ludwigson. The F-35 JPO remains an open and committed partner to the GAO's oversight mission, and we are currently supporting five unique audits across two different GAO mission teams – as well as six audits from the Department of Defense Office of Inspector General (DoD IG) and Air Force Audit Agency (AFAA) – which encompass the entirety of the F-35 acquisition lifecycle.

The JPO works actively to implement and close GAO recommendations, as well as recommendations received from other audit agencies. In addition to these active audits, there are sixty-two issued recommendations (eleven pending closure) from GAO, DoDIG, and AFAA that are being implemented across the F-35 Enterprise. While independent program oversight is

beneficial, these reports do drive significant manpower requirements within the F-35 Enterprise. Within the past six months, the GAO has issued new reviews covering development, sustainment strategy, and property accountability. Here in the JPO, implementation activities have already begun. My team is working diligently to implement these recommendations and will continue to maintain transparency and communication with our GAO colleagues.

Human Capital

People are our number one resource. We must invest in appropriately staffing the F-35 Program (both Government and Industry) with talent necessary to continuously develop, produce, and sustain the F-35 Air System. We must incentivize, recruit, retain, and professionally grow our people to meet the challenges in front of us. Earlier this year, the Air Force Life Cycle Management Center (AFLCMC) and Naval Air Systems Command (NAVAIR) analyzed the JPO's workforce demands and sizing. This analysis highlighted several staffing concerns. The F-35 Program is in a challenging phase as we develop, produce, and sustain three aircraft variants concurrently. AFLCMC and NAVAIR are helping us fill existing vacancies, but I am concerned that program priorities and customer demands are not matched with commensurate human resources to support the F-35 Enterprise as the fleet and demand continue to grow. I'm appreciative of the U.S. Services attention to this matter.

Conclusion

Since I last testified before this committee in March 2023, the world has changed, but our focus on affordable and timely fleet-wide readiness and capability remains the same. Our Enterprise is being tested in new ways through real-world conflicts and is proving capable, ready,

reliable, and resilient. However, much work remains ahead of us. By executing an F-35 War on Readiness, War on Cost, and War on Cyber we are elevating the visibility of our most pressing challenges. Actions taken today to accelerate depot stand-up, organic warehousing and transportation, engine power and cooling modernization, streamlined contracting strategies, logistics information system modernization, and enhanced use of technical data rights will increase F-35 availability and drive down sustainment cost. Innovative software development and testing methodologies will continue to accelerate capability delivery. Meanwhile, a formal Full Rate Production decision will drive supplier confidence for decades to come, and allow us to focus on the future rather than the past. I'm proud of all our team is accomplishing and know we will continue to progress in the months and years ahead. Here in the F-35 JPO, our people are our most important asset – and none of this is achievable without their support and commitment. As always – we'll continue to apply our F-35 *DIG In* mentality as our workforce **D**elivers, **I**nnovates, and **G**rows together. Thank you once again for the opportunity to discuss our progress, challenges, and opportunities. This subcommittee's support and oversight are essential to our success.

Lieutenant General Michael J. Schmidt

Lt. Gen. Michael J. Schmidt is the Program Executive Officer and Director for the F-35 Lightning II Program. In this capacity, he leads the F-35 Joint Program Office in the life-cycle program management of the F-35A, F-35B, and F-35C, the fifth-generation strike fighter of choice for the Air Force, Navy, Marine Corps, seven international partners, and seven current Foreign Military Sales customers.

Lt. Gen. Schmidt entered the Air Force in 1991 after graduating from Iowa State University as an Industrial Engineer and ROTC distinguished graduate. He served in numerous engineering, program management, and leadership positions. He worked as a Lockheed Martin program manager via the Education with Industry program. He served as Aide-de-Camp to the Commander of Air Force Materiel Command, both an Air Force Legislative and Appropriations Liaison, the F-35 Program Element Monitor, an advisor to the Afghan National Army, and commanded the 696th Armament Systems Squadron. Lt. Gen. Schmidt then served as Deputy for Tactical Aircraft Systems in the Office of the Secretary of Defense and as Senior Materiel Leader for Contractor Logistics Support Division at Oklahoma City Air Logistics Center. He also served as Program Executive Officer for Fixed Wing Programs at U.S. Special Operations Command; Program Executive Officer for Intelligence, Surveillance, Reconnaissance and Special Operations Forces at Air Force Materiel Command; Program Executive Officer for Fighters and Bombers; and, most recently, as Program Executive Officer for Command, Control, Communications, Intelligence, and Networks. He is a graduate of the Air Force Legislative Fellows Program and the National War College.

EDUCATION

1990 Bachelor of Science, Industrial Engineering, Iowa State University, Ames
1993 U.S. Army Air Assault School, Fort Rucker, Ala.
1995 Master of Business Administration, Finance, with distinction, Bentley College, Waltham, Mass.
1997 Squadron Officer School, Maxwell Air Force Base, Ala.
2001 Advanced Program Managers Course, Defense Systems Management College, Fort Belvoir, Va.
2003 Certificate in Legislative Studies, Georgetown University, Washington, D.C.
2003 Legislative Fellow, Capitol Hill, Washington, D.C.
2008 Master of National Security Strategy, National War College, Fort Lesley J. McNair, Washington, D.C.
2011 Executive Program Managers Course, Defense Acquisition University, Fort Belvoir, Va.
2012 U.S. Air Force Leadership Enhancement Program, Center for Creative Leadership, Greensboro, N.C.
2016 Senior Acquisition Management Course, Defense Acquisition University, Fort Belvoir, Va.

ASSIGNMENTS

July 1991–April 1992, Deputy Program Manager, Joint Tactical Information Distribution System Navy Integration, JTIDS Joint Program Office, Hanscom Air Force Base, Mass.
May 1992–March 1994, JTIDS Production Program Manager, JTIDS Joint Program Office, Hanscom AFB, Mass.
April 1994–August 1995, E-8C Aircraft Production Program Manager, Joint Strategic Target Attack Radar System (Joint STARS) Joint Program Office, Hanscom AFB, Mass.
September 1995–June 1996, Fire Control Systems Program Manager (Education with Industry), Lockheed Martin Electronics and Missiles, Orlando, Fla.
July 1996–July 1997, F-22 Legislation and Oversight Program Manager, F-22 System Program Office, Wright- Patterson AFB, Ohio
August 1997–May 1999, F-22 Edges and Empennage IPT Lead, F-22 System Program Office, Wright-Patterson AFB, Ohio
June 1999–May 2000, Commander's Action Team Lead, Directorate of Requirements, Headquarters Air Force Materiel Command, Wright Patterson AFB, Ohio

June 2000–August 2001, Aide-de-Camp to the Commander, Headquarters AFMC, Wright-Patterson AFB, Ohio
September 2001–September 2002, Chief, Congressional Relations, Office of Air Force Legislative Liaison, the Pentagon, Arlington, Va.
October 2002–July 2003, Air Force Legislative Fellow, Capitol Hill, Washington, D.C.
August 2003–June 2005, Joint Strike Fighter (F-35) Lead Program Element Monitor, the Pentagon, Arlington, Va.
July 2005–July 2007, Commander, 696th Armament Systems Squadron (AIM-120D), Eglin AFB, Fla.
(September 2006–January 2007, Program Analysis Team Chief, CJ-8, Combined Security Transition Command-Afghanistan, Kabul, Afghanistan)
August 2007–June 2008, Student, National War College, Fort Lesley J. McNair, Washington, D.C.
July 2008–June 2010, Deputy for Tactical Aircraft Systems, Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics, Program Systems Acquisition, Air Warfare, the Pentagon, Arlington, Va.
July 2010–May 2011, Chief, Contractor Logistics Support Sustainment Division, Oklahoma City Air Logistics Center, Tinker AFB, Okla.
May 2011–July 2014, Program Executive Officer for Fixed Wing Programs, U.S. Special Operations Command, MacDill AFB, Fla.
July 2014–April 2016, Program Executive Officer for Intelligence, Surveillance, Reconnaissance and Special Operations Forces, Air Force Life Cycle Management Center, AFMC, Wright-Patterson AFB, Ohio
April 2016–April 2018, Program Executive Officer for Fighters and Bombers, AFLCMC, AFMC, Wright-Patterson AFB, Ohio
April 2018–July 2022, Program Executive Officer for Command, Control, Communications, Intelligence and Networks, AFLCMC, AFMC, Hanscom AFB, Mass.
July 2022–present, Program Executive Officer, F-35 Lightning II Joint Program Office, Arlington, Va.

SUMMARY OF JOINT ASSIGNMENTS
September 2006–January 2007, Program Analysis Team Chief, CJ-8, Combined Security Transition Command- Afghanistan, Kabul, Afghanistan, as a lieutenant colonel
July 2008–June 2010, Deputy for Tactical Aircraft Systems, Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics, Program Systems Acquisition, Air Warfare, the Pentagon, Arlington, Va., as a lieutenant colonel and a colonel
May 2011–July 2014, Program Executive Officer for Fixed Wing Programs, U.S. Special Operations Command, MacDill Air Force Base, Fla., as a colonel
July 2022–present, Program Executive Officer, F-35 Lightning II Joint Program Office, Arlington, Va., as a lieutenant general

MAJOR AWARDS AND DECORATIONS
Distinguished Service Medal
Defense Superior Service Medal with oak leaf cluster
Legion of Merit
Defense Meritorious Service Medal with oak leaf cluster
Meritorious Service Medal with three oak leaf clusters
Joint Service Commendation Medal with oak leaf cluster
Joint Service Achievement Medal
Air Force Achievement Medal
Afghanistan Campaign Medal

EFFECTIVE DATES OF PROMOTION
Second Lieutenant Oct. 8, 1990
First Lieutenant Oct. 8, 1992
Captain Oct. 8, 1994
Major Nov. 1, 2001
Lieutenant Colonel May 1, 2005
Colonel Sept. 1, 2009
Brigadier General Jan. 1, 2016
Major General July 31, 2019
Lieutenant General July 5, 2022

United States Government Accountability Office

Testimony

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

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F-35 JOINT STRIKE FIGHTER

More Actions Needed to Explain Cost Growth and Support Engine Modernization Decision

Statement of Jon Ludwigson, Director, Contracting and National Security Acquisitions

GAO-24-107177

GAO Highlights

Highlights of GAO-24-107177, a testimony before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

Why GAO Did This Study

The F-35 Lightning II Joint Strike Fighter program remains DOD's most expensive weapon system program. It is estimated that it will cost over $1.7 trillion to buy, operate, and sustain these aircraft.

The F-35 program manages a family of strike fighter aircraft that integrates stealth technology with advanced sensors and computer networking capabilities. DOD plans to acquire 2,470 F-35s to replace several other aircraft used by the Air Force, Navy, and Marine Corps. As of December 2023, the program has delivered over 900 aircraft to the U.S. services, allied partners, and foreign military sales customers.

DOD is 5 years into a development effort to modernize the F-35 aircraft's capabilities and is considering options for modernizing the F-35's engine.

This testimony discusses acquisition-related risks in the F-35 modernization efforts. It is largely based on GAO's May 2023 report (GAO-23-106047) on F-35 acquisition.

What GAO Recommends

In May 2023, GAO made seven recommendations to DOD aimed at improving Block 4 cost reporting and engine and thermal management modernization efforts. DOD concurred with three, partially concurred with three, and did not concur with one recommendation that the program set engine modernization requirements before awarding a contract. GAO previously made a matter to Congress to require Block 4 reporting until its completion. GAO continues to believe that DOD should fully implement these recommendations.

View GAO-24-107177. For more information, contact Jon Ludwigson at (202) 512-4841 or ludwigsonj@gao.gov.

December 12, 2023

F-35 JOINT STRIKE FIGHTER

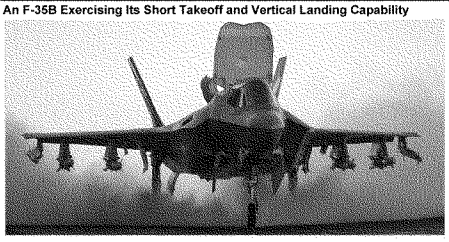
More Actions Needed to Explain Cost Growth and Support Engine Modernization Decision

What GAO Found

The Department of Defense's (DOD) effort to modernize the F-35's capabilities, an effort known as Block 4, continues to experience cost and schedule growth. Block 4 was originally defined as 66 capabilities and estimated to cost $10.6 billion, with development expected to be completed in fiscal year 2026. In May 2023, GAO reported that Block 4 costs had grown to $16.5 billion and the effort was now estimated to be completed in 2029. Additionally, DOD has added new capabilities to Block 4 nearly every year, so Block 4 is now composed of 80 capabilities. DOD's report to Congress on the Block 4 effort does not distinguish higher-than-expected costs for previously planned Block 4 capabilities from growth due to adding capabilities. Consequently, Congress does not have a clear picture of the reason for the growing F-35 modernization costs.

The Block 4 effort has also continued to experience developmental delays for important technology updates. For example, the F-35 program has yet to install Technology Refresh 3 (TR-3)—the $1.64 billion suite of upgraded hardware and software technologies critical to enabling many future Block 4 capabilities—on production aircraft. The services will not accept aircraft until TR-3 is installed.

An F-35B Exercising Its Short Takeoff and Vertical Landing Capability



Source: © Lockheed Martin. | GAO-24-107177

The program has announced plans to upgrade the F-35's engine and is exploring options to modernize the power and thermal management system that is used to cool aircraft subsystems that generate heat. The current cooling system is overtasked, requiring the engine to operate beyond its design parameters. The extra heat is increasing the wear on the engine, reducing the engine's life, and adding a projected $38 billion in maintenance costs over the life of the aircraft.

The program has assessed some engine and cooling improvement options but the military services have not fully defined future aircraft cooling requirements. By defining these requirements and obtaining this and other key information, DOD and the services would be more informed about performance, cost, and technical implications. Furthermore, because the original development program is scheduled to transition to sustainment and would be subject to less oversight, GAO has recommended that DOD manage the engine and thermal management modernization as a separate program, with its own distinct cost, schedule, and performance baselines.

Chairman Wittman, Ranking Member Norcross, and Members of the Subcommittee:

Thank you for the opportunity to discuss our work on the F-35 Lightning II Joint Strike Fighter. The F-35 program is a family of fifth-generation strike fighter aircraft that integrates low-observable (stealth) technology with advanced sensors and computer networking capabilities. The F-35 will be used by the Department of Defense (DOD), as well as seven international partners, to perform a wide range of missions.[1] DOD aims to procure 2,470 F-35s to replace several other aircraft used by the Air Force, Navy, and Marine Corps. To date, the program has delivered over 900 aircraft to the U.S. services, international partners, and foreign military sales customers. The program completed development of the F-35's original baseline capabilities in 2018 and is nearing the end of operational testing to evaluate whether the aircraft is operationally effective, suitable, and survivable. The program, however, is also more than a decade delayed and $183 billion over its original plans.

DOD is now in the fifth year of a $16.5 billion modernization effort—known as Block 4—to upgrade the F-35's hardware and software systems. DOD intends for Block 4 to help the aircraft address new threats that have emerged since DOD established the aircraft's original requirements in 2000. These Block 4 capabilities are requiring more power and cooling than anticipated, which has led the program to begin planning to modernize the already overworked F-35 engine.

This statement discusses (1) DOD's progress in developing, testing, and delivering Block 4 capabilities and risks that remain, and (2) DOD's approach to assessing the options for modernizing the F-35 engine and power thermal management system. The statement is based on our report on F-35 modernization issued earlier this year as well as prior related reports.[2] For those reports, in general, we analyzed data provided by the contractors, the program office, and others in DOD, and conducted interviews with DOD officials and contractor representatives. Each of the

[1]Seven partner nations—Australia, Canada, Denmark, Italy, Netherlands, Norway, and the United Kingdom—contribute to F-35 development, production, and sustainment. In addition, the program currently has nine foreign military sales customers: Belgium, Finland, Germany, Israel, Japan, Korea, Poland, Singapore, and Switzerland. According to program officials, multiple additional countries are at various stages of consideration for foreign military sales.

[2]GAO, *F-35 Joint Strike Fighter: More Actions Needed to Explain Cost Growth and Support Engine Modernization Decision*, GAO-23-106047 (Washington, D.C.: May 30, 2023), and *F-35 Joint Strike Fighter: Continued Oversight Needed as Program Plans to Begin Development of New Capabilities*, GAO-16-390 (Washington, D.C.: Apr. 14, 2016).

reports provides further information on its specific objectives, scope, and methodology. In addition, we summarized information from our prior reports, including relevant recommendations and the actions DOD took to address them, where appropriate in this statement.

The work on which this statement is based was 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.

Modernization Effort Faces Delays and Limited Transparency into Its Continued Cost Growth

The F-35 program, now 5 years into its Block 4 modernization efforts, continues to experience developmental delays to important technology updates. As Block 4 content and costs continue to grow, the program's cost reporting mechanisms have not provided a full accounting of the sources of the increases.

Modernization Capabilities Continue to Be Delivered Late

As we reported in May 2023, the F-35 program's schedule for installing Technology Refresh 3 (TR-3)—the $1.64 billion suite of upgraded hardware and software technologies that will enable many future Block 4 capabilities—on production aircraft was at risk for further delays.[3] The program moved ahead with the decision to begin installing TR-3 components in Lot 15 production aircraft in February 2023 to help TR-3 installation stay on schedule, even though it had less time to ensure the related software was ready for production. As a result, we reported that TR-3 software fixes were ongoing, but that the program had less time to resolve them to achieve its schedule goals. Program officials, however, stated that DOD will not accept any TR-3 enabled aircraft until those fixes are completed.

The program also continued to experience late Block 4 capability deliveries due to software development delays and testing challenges, which create risk for future delays. For example, the limited availability of aircraft to test Block 4 software limits the program's testing capacity. As of May 2023, the program had seven test fleet aircraft, with four devoted to TR-3 testing and three able to test Block 4 capabilities. The program is aware of this testing limitation and plans to incorporate additional test aircraft for a total of 14 flight test aircraft for testing Block 4 capabilities.

[3]GAO-23-106047.

However, officials told us that schedule risk remains due to competing testing priorities, even with future aircraft additions to the test fleet.

Capability deliveries have also been a problem throughout the Block 4 program. For example, for the January 2022 software release, Lockheed Martin delivered two of the five planned Block 4 capabilities on time, with the other three capabilities delayed. Similarly, of the six capabilities that were delayed in 2021, three had not been delivered as of March 2023, according to program officials.

Evolving Content of the Modernization Program Obscures Reasons for Cost Growth

In May 2023, we reported that F-35 Block 4 and TR-3 modernization costs continue to grow. The program originally defined the Block 4 modernization effort in 2016 as 66 capabilities. The original baseline cost of the effort was $10.6 billion. As of May 2023, the F-35 program estimated that Block 4 development costs had increased to $16.5 billion.[4] Program officials attributed recent cost growth to the inclusion of new capabilities into the content of Block 4. Additionally, we found that TR-3 development costs grew by $30 million since August 2021.

The program has continued to change the content of Block 4, which has also affected the overall schedule, expanding it by 3 years. Since originally establishing the program with the goal of delivering 66 capabilities by 2026, the program has added new capabilities into the content of Block 4 nearly every year, while also removing others. As of May 2023, the program expected Block 4 to be composed of 80 capabilities and extended the completion date through fiscal year 2029, 3 years later than it originally planned.

As the content of Block 4 has grown beyond the originally planned capabilities, the cost estimation reporting mechanisms used by the program have not provided visibility into modernization cost growth versus increased cost due to adding new capabilities. In May 2023, we found that the program's three cost-reporting mechanisms for tracking Block 4 cost growth do not address our best practices for cost estimating because they do not explain cost variances experienced with developing capabilities.[5] Specifically, none of the mechanisms report on cost

[4]GAO-23-106047.

[5]GAO-23-106047. The Block 4 cost estimate does not document, explain, or review any variances between planned costs and actual costs. In addition, the program's annual Block 4 report to Congress does not compare modernization costs against original estimates, or document, review, or explain any variances between planned and actual capability costs. Lastly, the program's frequent changes to the Block 4 baseline reduce the effectiveness of Earned Value Management as a tool for assessing Block 4 cost performance and does not document, review, or explain any variances between estimated and actual capability costs.

differences between original estimates and the actual costs for developing capabilities. Without adequate visibility into modernization cost growth over time in a program with regularly changing content, the amount of cost growth attributable to development of the original capabilities versus growth due to added capabilities is not clear.

To address this issue, in May 2023, we recommended that DOD ensure the F-35 program office report to Congress on cost differences between original estimates and actual costs for a defined group of modernization capabilities over time.[6] DOD concurred with this recommendation and stated that it would evaluate different methods of grouping capabilities to support annual reporting of cost differences between the original estimates and actual costs.

Underscoring these challenges is that DOD has managed the complex Block 4 effort as part of the F-35 baseline program, which has made monitoring progress and oversight challenging. The F-35 baseline program is planning to enter full-rate production and transition to sustainment in March 2024.[7] At that point, the F-35 program, and the Block 4 effort that is managed within this program, will no longer be subject to certain laws and policies related to oversight development programs. For example, some of the oversight tools—such as cost, schedule, and performance baselines—that are established by programs that follow DOD's major capability acquisition pathway would not be required for Block 4.[8] As we previously noted, the Block 4 effort is expected to continue through at least 2029 and has already experienced cost increases and schedule delays.

In April 2016, we recommended that the program manage Block 4 modernization as a separate program from the F-35 baseline program, in part, to provide more visibility and to hold the program accountable for

[6]GAO-23-106047.

[7]We have also reported on F-35 sustainment challenges, including delays setting up military service depots (i.e., facilities to complete the most complex repairs), inadequate equipment to keep aircraft operational, and maintenance and supply delays affecting aircraft readiness. These challenges have in part led to the F-35 fleet mission capable rate—the percentage of time the aircraft can perform one of its tasked missions—being far below program goals. For example, F-35 fleet mission capable rate was about 55 percent in March 2023. See GAO, *F-35 Aircraft: DOD and the Military Services Need to Reassess the Future Sustainment Strategy*, GAO-23-105341 (Washington, D.C.: Sept. 21, 2023).

[8]10 U.S.C. § 4214(a)(1) ("The Secretary of a military department shall establish a baseline description for each major defense acquisition program and for each designated major subprogram under the program") and DOD Instruction 5000.85, Major Capability Acquisition (Aug. 6, 2020) (Change 1, Effective Nov. 4, 2021).

meeting cost, schedule, and performance goals.[9] DOD did not concur with our recommendation and continues to manage Block 4 as part of the F-35 baseline program. Congress subsequently required reporting on Block 4, which met the intent of our recommendation.[10] However, that reporting requirement ended in March 2023.[11] In May 2020, we made a matter for congressional consideration that Congress extend these reporting requirements until all Block 4 capabilities are fielded.[12] The matter is currently pending consideration by Congress.

Program Lacked Key Details to Support Engine and Thermal Management Modernization Decision

In May 2023, we reported that the F-35 program's analysis of options for modernizing the engine and thermal management system to reduce sustainment costs, improve engine life, and enable future F-35 capabilities did not contain key details.[13] For example, we reported that it had not fully defined the power and cooling requirements the engine and related components will need to support capabilities beyond those planned through 2035. Furthermore, the program office had not fully assessed the costs and some of the technical risks of the different engine and thermal management system upgrade options. Finally, we found that the efforts to modernize the engine and cooling system needed additional oversight.

Current Aircraft Cooling System Demands Exceed Its Original Design

In May 2023, we reported that the demands of the power and thermal management system (PTMS) that cools the aircraft's subsystems exceed the system's original design.[14] The PTMS, a system designed by a Lockheed Martin subcontractor, uses air pressure from the engine to provide cooling to aircraft subsystems that generate heat, such as the radar, to ensure they do not overheat and fail. It is a complex subsystem that includes the equipment necessary to provide aircraft main engine start, emergency power, cockpit conditioning, equipment cooling, and some electrical power.

Because the original estimates of the need for cooling proved to be incorrect, the PTMS uses more air pressure from the engine to cool subsystems than originally specified in the requirements, which is

[9]GAO-16-390.

[10]Pub. L. No. 114-328, § 224(d).

[11]Pub. L. No. 114-328, § 224(d).

[12]GAO, *F-35 Joint Strike Fighter: Actions Needed to Address Manufacturing and Modernization Risks*, GAO-20-339 (Washington, D.C.: May 12, 2020).

[13]GAO-23-106047.

[14]GAO-23-106047.

reducing the life of the engine and increasing costs. These cooling problems will only get worse as the program adds new capabilities to the aircraft. Modernization capabilities—including Block 4 capabilities already installed and future ones planned through 2035—require even more cooling capacity and air pressure than the PTMS and the engine can support, respectively. In total, the program has already added $38 billion to the program's life-cycle cost estimate because of these cooling challenges, largely due to the increased wear and tear on the engine.

The program determined that it must upgrade the PTMS by 2029 to enable capabilities planned through 2035 and upgrade the engine to reduce life-cycle costs.

F-35 Program Did Not Fully Assess Modernization Risks, Costs, or Requirements

In May 2023, we reported that the F-35 program evaluated different options for modernizing, or upgrading, the PTMS and the engine to address the need for additional cooling capacity, restore engine life, and reduce life-cycle costs.[15] The program office completed what it refers to as the Business Case Analysis in March 2023. According to program officials, they intended for the analysis to provide the services with information to help them make engine and PTMS modernization decisions. They evaluated three preselected options for improving power and cooling by upgrading the PTMS as well as modernizing or replacing the engine:

- the current F135 engine with an upgraded PTMS,
- an upgraded F135 engine with an upgraded PTMS, and
- a fully redesigned engine with an upgraded PTMS.

For each category above, the program also evaluated different upgrades to the PTMS.[16] Two of these upgrade options enhance the existing PTMS to varying degrees and one option is a totally redesigned PTMS. Each engine and PTMS combination presents different trade-offs based on levels of commonality, cooling capacity, costs, schedules, and other factors. Officials explained that some future capabilities will also place increased demands on other systems, such as the electrical power system, and may require an upgrade to the fuel thermal management

[15]GAO-23-106047.

[16]The analysis compared 20 engine and PTMS combinations. However, not all were feasible options due to the modernization timelines.

system, another system that fuels the engine and removes excess heat from subsystems.[17]

We found that the program's assessment did not meet our definition of a business case analysis and the program did not complete an analysis of alternatives.[18] As a result, we compared the program's analysis with general acquisition leading practices, such as those from our Cost Estimating and Assessment Guide and Technology Readiness Assessment Guide.[19]

In doing so, we found analytical gaps in the program's comparative analysis—in areas such as unaddressed technical risks and cost estimating—meaning that the military services' decisions were not informed by this key information.

- **Technical risks**. The program did not fully assess the technical risks associated with the modernization of the engine, PTMS, and other related systems. The program's comparative analysis did not include an assessment of the technology readiness for the various engine and thermal management modernization options or for the combined engine and PTMS options integrated as a system.[20] Furthermore, officials said that some of the modernization options' technologies were immature. According to program officials, there was a detailed understanding of the maturity level of each engine option, but not for all modernization aspects such as the PTMS. Program officials told us that most subcomponents of engine modernization are what they consider to be mature. However, the subcomponents of PTMS

[17]According to program officials, if the fuel is too hot, it will not be used effectively to cool engine components.

[18]The analysis of alternatives—normally conducted during the Materiel Solution Analysis phase for major defense acquisition programs—is a key input to the Capability Development Document, and supports the materiel solution decision at milestone A. An analysis of alternatives may be conducted at comparable points for other Adaptive Acquisition Framework pathways as appropriate. See Department of Defense, Office of Secretary of Defense, Cost Assessment and Program Evaluation, *Analysis of Alternatives Cost Guide* (Jan. 12, 2022).

[19]GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020); and *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects* [Reissued with revisions on Feb. 11, 2020.], GAO-20-48G (Washington, D.C.: Jan. 7, 2020).

[20]Technology readiness assessments evaluate the technical maturity of a technology at a specific point in time for inclusion into a larger system. They serve as the basis for realistic discussions on how to address potential risks as programs move from early research and technology development to system development and beyond.

modifications are much less mature. If these technologies are not matured by the start of development, the program risks moving forward with an unstable design that can cause cost increases and schedule delays.

- **Life-cycle cost estimating**. The program's analysis did not capture all the costs of each modernization pathway. While program officials said that they considered the cost estimates for the engine upgrade options to be complete, the program had not developed cost estimates for the PTMS upgrade options. Additionally, while the program's cost estimates included the costs to integrate each engine option onto the aircraft, the additional integration costs associated with increasing the cooling capacity of the PTMS were not considered. We previously found that when integration costs and risks are not understood, programs risk incurring additional costs.[21]
- **Independent cost estimates.** According to program officials, they requested that the Office of the Secretary of Defense for Cost Assessment and Program Evaluation conduct an independent cost estimate that was due in the spring of 2023. However, the F-35 program office had not finished assessing all costs to inform this estimate at the time of our May 2023 report. The program also did not have cost estimates for numerous aspects of thermal management modernization, including breakdowns of the PTMS upgrade options. Without an independent cost estimate encompassing all engine and related systems' modernization costs, decision makers lack insight into the true potential costs.

Finally, we found that the military services had not established requirements for engine and thermal management modernization to guide decisions on which PTMS option to select. According to program officials, the military services will define their own requirements, or the future capabilities needed from the aircraft, which will dictate the amount of power and cooling the engine and PTMS, respectively, will need to support. We found that while the program generally knew the cooling capacity it would need to support known capabilities through 2035, program officials stated that the military services had not validated those capabilities as performance requirements, so they are notional. Until the military services do so, the program is limited in determining what additional power and cooling is needed to support capabilities through 2035. Furthermore, it is unclear how far into the future any PTMS and

[21]GAO-20-48G.

engine upgrades will be able to support the F-35, which the program expects to operate well into the 2070s.

Prior to the issuance of our report, in March 2023, DOD officials announced that they would pursue an upgrade to the current engine but did not identify what upgrades they intend to make to the PTMS. As part of the President's budget for fiscal year 2024, the Air Force requested about $255 million for development and design contracts to upgrade the current engine but did not indicate what the total upgrade effort would cost. Program officials acknowledged that they were moving forward, although there were many unknowns. However, they noted that they had accelerated the process so the military departments could more quickly select a modernization option because of the need to upgrade the PTMS by 2029.

In May 2023, we made five recommendations aimed at improving the program's insights into engine and power thermal management technology risks, costs, and requirements.[22]

- DOD concurred with two of our recommendations to evaluate technology readiness levels and to report on the full life-cycle costs for engine and power thermal management.
- DOD partially concurred with our recommendation to mature all critical technologies and systems prior to starting product development. It stated that it will mature technologies to the greatest extent possible, but will use a risk management process for less mature technologies to ensure they continue to mature during development.
- DOD also partially concurred with our recommendation that the F-35 program obtain an independent cost estimate for all engine and power thermal management modernization options. Officials stated that the Director of Cost Assessment and Program Evaluation conducted an independent cost estimate and comparative assessment of all propulsion solutions, but that this effort did not include an assessment of power thermal management system options.

We continue to believe that fully implementing our recommendations would provide DOD with a comprehensive understanding of F-35 engine and power thermal management technology risks, costs, and requirements.

DOD did not concur with our recommendation that the Under Secretary of Defense for Acquisition and Sustainment should ensure the military

[22]GAO-23-106047.

services set engine and power thermal management modernization requirements. DOD stated that setting military service requirements is not within the Under Secretary of Defense for Acquisition and Sustainment's authority and that requirements are developed, approved, coordinated, and validated through a specific DOD governance process. DOD officials explained that as approved requirements are updated, the F-35 program will reevaluate its analysis as appropriate. We recognized that it is the military services' responsibility to define their requirements. We also recognized that the F-35 program operates under the Office of the Under Secretary of Defense for Acquisition and Sustainment oversight. As a result, we revised our recommendation to assert that the Office of the Under Secretary of Defense for Acquisition and Sustainment, as the oversight authority for the program, direct the F-35 program office to reevaluate its comparative analysis. We recommended that this reevaluation be completed after the military services define their power and cooling requirements, and before proceeding with development of the engine and thermal management modernization effort, as appropriate.

Engine and Cooling System Modernization Efforts Need Further Oversight

In May 2023, we found that managing the engine and thermal management modernization efforts as part of the existing F-35 program would limit opportunities for oversight of this costly and complex effort.[23] At that time, F-35 program officials told us that they intended to manage engine and thermal management modernization under the existing acquisition program. Therefore, we recommended that the Under Secretary of Defense for Acquisition and Sustainment manage F-35 engine and thermal management modernization as a separate program, with its own distinct cost, schedule, and performance baselines. DOD partially concurred with our recommendation, citing that program officials were still uncertain about how they will manage engine and thermal management modernization efforts. As a result, we also made a matter for congressional consideration that Congress should consider directing the Secretary of Defense to ensure that the engine and thermal management modernization effort is initiated as a separate program, which could include designating this as a major subprogram. Congress has not yet taken action on our recommendation.[24]

In conclusion, the F-35 remains critical to DOD's defense strategy and to its warfighters. The successful modernization of the aircraft and its

[23]GAO-23-106047.

[24]H.R. 2670, a Bill for the National Defense Authorization Act for Fiscal Year 2024, included a provision that would require the designation of all efforts to modernize and upgrade the existing propulsion, power, and thermal management systems of the F-35 aircraft as a major subprogram of the F-35 acquisition program.

systems will play a key role in keeping the F-35 relevant for decades to come. However, with Block 4 underway and engine and thermal management modernization on the horizon, DOD, the military services, and Congress are at a critical juncture.

Block 4 has proven to be complex, costly, and difficult to oversee. The changing content of the modernization of aircraft systems and the program's approach to reporting costs have made it hard to discern the cause of the cost and schedule growth. Enhancing opportunities for oversight, by implementing our recommendations, could help DOD and Congress with this difficult undertaking.

Similarly, the program stands poised to begin the engine and PTMS modernization effort and could face similar challenges. This effort is also complex, costly, and critical to delivering enhanced capabilities to the F-35 users in the U.S. military services and our partners and allies around the world. By taking certain steps, as we recommended, DOD would be better equipped to make fully informed decisions and Congress would have enhanced opportunities for oversight.

After decades of development, the F-35 program is nearing completion of the baseline program and transitioning efforts to sustainment, which could lead to less formal acquisition oversight for the Block 4 effort. Taking steps now to ensure that the Block 4 and engine and PTMS efforts develop and update information to facilitate acquisition oversight—such as baseline cost and schedule estimates and performance goals—would provide a more structured way for DOD and Congress to track the progress of these important efforts.

Chairman Wittman, Ranking Member Norcross, and Members of the Subcommittee, this completes my prepared statement. I would be pleased to respond to any questions you may have at this time. We look forward to continuing to work with Congress as we continue to monitor and report on the progress of the F-35 program.

GAO Contact and Staff Acknowledgments

If you or your staff have any questions about this testimony, please contact Jon Ludwigson, Director, Contracting and National Security Acquisitions, at (202) 512-4841 or ludwigsonj@gao.gov. Contact points for our Office 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 Justin Jaynes (Assistant Director), Jillena Stevens (Analyst-in-Charge), Edward Harmon, Leigh Ann Haydon, Scott Hepler, Christine Pecora, and Curtis Birch Synnott. Other staff who made key contributions to the reports cited in the testimony are identified in the source products.

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Congressional Relations	A. Nicole Clowers, Managing Director, ClowersA@gao.gov, (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548
Public Affairs	Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800 U.S. Government Accountability Office, 441 G Street NW, Room 7149 Washington, DC 20548
Strategic Planning and External Liaison	Stephen J. Sanford, Managing Director, spel@gao.gov, (202) 512-4707 U.S. Government Accountability Office, 441 G Street NW, Room 7814, Washington, DC 20548

Jon Ludwigson

Mr. Ludwigson is a Director in the Contracting and National Security Acquisitions (CNSA) team and has worked for the United States Government Accountability Office (GAO) for over 20 years. His work with CNSA currently spans a variety of acquisition programs including DOD space systems, DOD strategic nuclear systems including NC3 and GBSD, missile defense, as well as several large individual acquisition programs including the F-35 Joint Strike Fighter, CH-53K, and KC-46. In addition, Mr. Ludwigson has led teams examining advanced technologies and weapons system development including hypersonic weapons systems, artificial intelligence, directed energy, and alternative position, navigation and timing. Prior to joining CNSA, Mr. Ludwigson led numerous examinations of science and technology, energy market development, and regulatory oversight relating to a wide range of energy sources and uses. During his time at GAO he has contributed to GAO's duplication, fragmentation and potential cost savings reports and the high-risk reports. Mr. Ludwigson received numerous accolades in recognition of his contributions to GAO and Congress.

Mr. Ludwigson holds a master's degree in public policy from Georgetown University and a bachelor's degree in business administration from the University of Colorado at Boulder. He has completed additional coursework at American University. He works out of GAO's office in Denver, Colorado.

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

DECEMBER 12, 2023

QUESTIONS SUBMITTED BY MR. COURTNEY

Mr. COURTNEY. As we discuss other upgrades needed for the F–35, can you confirm that ECU is being designed for any PTMS configuration to allow for the current schedule to stay on target?

Dr. LAPLANTE and General SCHMIDT. Yes, the ECU is being designed to integrate with all F–35 PTMS configuration concepts currently being considered.

Mr. COURTNEY. With the RFI released for new PTMS requirements, when do you intend to integrate a new PTMS to support the aicraft?

Dr. LAPLANTE and General SCHMIDT. The F–35 acquisition program intends to begin the development of an upgraded Power Thermal Management System (PTMS) in FY24, with system qualification by 2032 and production line cut-in beginning in 2033. Schedule milestones will be refined as the PTMS acquisition solution matures.

Mr. COURTNEY. Can you explain the PTMU modernization plan and timing?

Dr. LAPLANTE and General SCHMIDT. The JPO's near-term priority is to fully validate that all PTMU technical requirements can be met with a materiel solution, which also supports direction included in the FY24 NDAA, SEC. 226. F–35 PROPULSION AND THERMAL MANAGEMENT MODERNIZATION PROGRAM. The concept development contract is planned to commence this summer and will begin competitive PTMU design activities.

Mr. COURTNEY. What is the current PTMS cooling capacity requirement for Block 4? Has the definition changed? And what is the maximum PTMS capacity need over the lifetime of the platform?

Dr. LAPLANTE and General SCHMIDT. The F–35 Lightning II Joint Program Office will provide a CUI response directly to the House Armed Services Committee.