DEPARTMENT OF DEFENSE APPROPRIATIONS FOR FISCAL YEAR 2014

WEDNESDAY, JUNE 19, 2013

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 9:36 a.m., in room SD–192, Dirksen Senate Office Building, Hon. Richard J. Durbin (chairman) presiding.

Present: Senators Durbin, Reed, Cochran, Shelby, Collins, Murkowski, Coats, and Blunt.

DEPARTMENT OF DEFENSE

STATEMENT OF HON. FRANK KENDALL, UNDER SECRETARY FOR ACQUISITION, TECHNOLOGY AND LOGISTICS

OPENING STATEMENT OF SENATOR RICHARD J. DURBIN

Senator DURBIN. Thank you all for joining us this morning.

The subcommittee meets to receive testimony on the fiscal year 2014 budget, the request for the Joint Strike Fighter (JSF) program, to review its cost, schedule, performance, given that it is the largest acquisition program in the history of our Nation.

To provide some context, since its inception, the Department has invested $44 billion to develop these aircraft. For fiscal year 2014 alone, the President's budget request for the Joint Strike Fighter program includes $8.7 billion to continue development of test and procure 29 aircraft, operate and sustain the growing fleet, and begin a formal modification program.

For today's hearing, there will be two panels. On the first panel, I will welcome Under Secretary of Defense for Acquisition, Technology and Logistics, the Honorable Frank Kendall. Thank you for coming. Chief of Naval Operations, Admiral Jonathan Greenert. Admiral, thank you for being here. Chief of Staff of the Air Force, General Mark Welsh. General, thank you. Assistant Commandant of the Marine Corps, General John Paxton. General, thank you. Program Executive Officer for the Joint Strike Fighter program, Lieutenant General Christopher Bogdan. Thank you.

On the second panel, we are going to hear from the Director of Operational Test and Evaluation, the Honorable Michael Gilmore; Director, Government Accountability Office Acquisition and Sourcing Management Team, Michael Sullivan; and Senior Fellow and Director of Research, Brookings Foreign Policy Program, Mi-

chael O'Hanlon. Gentlemen, thank you for being here and providing your testimony.

I have been concerned about the defense acquisition programs that obviously cost taxpayers billions of dollars more than what the Department and Congress originally signed up for. The Joint Strike Fighter program has had more than its share of problems over the last decade. Frankly, its history reads like a textbook on how not to run a major acquisition effort.

For instance, the Government turned over complete oversight responsibility to the prime contractor on a cost reimbursement contract, resulting in questionable design decisions, some cost overruns and schedule delays. And the extreme overlap between development and production, also known as concurrency, guaranteed the unit costs of the aircraft would be considerably higher than the $69 million per copy we originally planned.

That said, after many challenging years of development, I am told that the program is starting to turn the corner in terms of cost and schedule. The most recent selected acquisition report shows the aircraft unit cost decreasing slightly by 4.2 percent. Moreover, projected concurrency costs to modify production aircraft have decreased by 47 percent, and durability testing is showing the aircraft's structure is reacting within normal limits.

Now, I look forward to hearing testimony addressing these achievements later today, as well as a better understanding of how we reached this point in the acquisition process. I want to hear what steps are being taken to ensure that we learn from this experience and not repeat mistakes.

Given the difficult budget challenges facing our Nation, this hearing must also address the remaining development risks, the entire cost of the program, the relevance to the future war fight, and whether any other options are being considered for a less costly future mix of tactical fighter aircraft.

Each of you will have an opportunity to provide an opening statement, as well as to respond to questions, and I ask that you keep your opening statements brief so we can have more questions. And your full written statement, of course, will be part of the record.

I now turn it over to Senator Cochran for opening remarks.

STATEMENT OF SENATOR THAD COCHRAN

Senator COCHRAN. Mr. Chairman, I am pleased to join you in welcoming these distinguished witnesses to our hearing to review the F–35 Joint Strike Fighter program and the funds needed to provide for tactical aircraft.

This hearing should help us understand the threats to our safety and security and the defenses we need to defend against those threats.

We look forward to hearing your testimony and appreciate your assistance to our committee.

Thank you.

Senator DURBIN. Thanks, Senator Cochran.

Our first witness is Under Secretary of Defense for Acquisition, Technology and Logistics, the Honorable Frank Kendall. Frank, please proceed.

SUMMARY STATEMENT OF HON. FRANK KENDALL

Mr. KENDALL. Thank you, Mr. Chairman.

I ask that our written testimony be admitted to the record, please.

Chairman Durbin, Ranking Member Cochran, members of the subcommittee, I am delighted to have the opportunity to discuss the F–35 Joint Strike Fighter program with you today. Obviously, this is a critical program for the Department and our Nation. Air superiority and the ability to project power from the air are central to the way our armed forces fight. Other nations are developing capabilities that threaten our technological superiority in the air, and we cannot afford to be complacent about the decisive advantage we have enjoyed since World War II.

I will let my colleagues from the Air Force, Navy, and Marine Corps say more about the operational importance of the F–35, and I will focus on the acquisition aspects of the program.

My experience with the F–35 dates back about 3 years to the spring of 2010. The Department's and my focus has been on the efforts to control cost on the program and to achieve a more stable design so that we could increase the production rate to more economical quantities. Indications at this time are that these efforts are succeeding, but we still have a lot of work left to do.

We are now about 90 percent of the way through the development program and 40 percent of the way through the flight test program. Since the program was rebaselined, following the 2010 Nunn-McCurdy cost breach, the program has been executing with modest schedule slips.

Looking ahead, there is still risk in the schedule, particularly with the final block of software called Build 3–F. There is also the potential for surprise in the remaining test program, including flight testing and fatigue life structural testing.

Our intention is to complete the development effort within the planned cost and schedule. However, we may need to make some adjustments as events unfold. On the whole, however, the F–35 design today is much more stable than it was 2 or 3 years ago.

In 2011, I concluded that given the design issues we were seeing at that time and the uncertainty about how soon they would be resolved, that we were not ready to increase the production rate on the program. The F–35 is one of the most concurrent programs I have ever seen, meaning that there was a high degree of overlap between the development phase and the production phase of the program. Mr. Chairman, I understand that this is of high interest to you and I would be happy to address this subject in more detail in response to your questions.

In our 2013 budget request, we kept the production rate flat for the next 2 years. I seriously considered stopping production at that time, but concluded that the cost and disruption that would result would be considerable and that the better course was to delay the previously planned increase in production rate until the test program had progressed to the point where we would have more confidence in design.

This fall, I will be reviewing the program to determine whether or not we should plan to increase the production rate significantly

in 2015, as is currently planned. At this point, I am cautiously optimistic that we will be able to do so.

With regard to cost, we are most of the way through development and intend to execute the balance of the ongoing development effort within the available funds. Since 2010, production costs have been stable and are coming down, as you mentioned, roughly consistent with our estimates. We have been tightening the terms of production contracts beginning with Lot 4 in 2010, which is our first fixed-price incentive contract. In Lot 5, we tightened the terms further and lowered cost despite the fact that we did not increase the production rate. For the first time in Lot 5, Lockheed was required to share in the cost associated with design changes due to concurrency. Lots 6 and 7 are currently in negotiation, and in these lots and all future lots, Lockheed will bear all the risks of overruns. At this point, we have a solid understanding of the production costs and believe that they are under control.

Sustainment costs represent our greatest opportunity to reduce lifecycle cost of the F–35 going forward, and we are now focused on finding ways to introduce competition and to take creative steps to lower those costs as well.

PREPARED STATEMENT

The bottom line is that since 2010, we have been making steady progress to complete development, stabilize the design, and control costs. We have a lot of work remaining, and we should not be surprised if bad news does occur. We have still a long way to go in the test program. But as I said, I am cautiously optimistic that we will be able to increase production to more economical rates beginning in 2015 as planned.

Thank you, Mr. Chairman.

[The statement follows:]

PREPARED STATEMENT OF HON. FRANK KENDALL AND LIEUTENANT GENERAL CHRISTOPHER C. BOGDAN

Chairman Durbin, Vice Chairman Cochran, and distinguished members of the subcommittee: Thank you for the opportunity to address this subcommittee regarding the F–35 Joint Strike Fighter.

The F–35 is the Department of Defense's largest and most important acquisition program. Its success is of fundamental importance to our national security. The JSF will form the backbone of U.S. air combat superiority for generations to come. It will replace legacy tactical fighter of the Air Force, Marine Corps and the Navy. The F–35 will provide a dominant, multirole, fifth-generation aircraft capable of projecting U.S. power and deterring potential adversaries across the full spectrum of combat operations. For our international partners and foreign military sales customers, the JSF will become a linchpin for future coalition operations, will help to close crucial capability gaps, and will enhance the strength of our security alliances. Military technology does not stand still, and maintaining technological superiority our service men and women have relied upon effectively for decades depends on the successful fielding of the F–35.

The multirole F–35 is the centerpiece of the Department of Defense's future air dominance and precision attack capabilities. The F–35's 5th generation attributes, including integrated advanced technology sensors, networking, and signature controls, are critical for maintaining U.S. air supremacy and ensuring our ability to operate against modern and emerging threats. The emergence of competitor 5th generation aircraft within the next decade; coupled with the proliferation of sophisticated electronic warfare capabilities and modern integrated air defense systems increasingly threaten our current 4th generation aircraft. The F–35 is designed to control the air and to penetrate heavily defended environments in order to deliver a wide-range of precision munitions. Shared development and international produc-

tion will bring the added benefit of increased allied interoperability and cost-sharing across the Services and partner nations. The President's fiscal year 2014 budget request includes a total of $8.3 billion for continued system development ($1.8 billion) and procurement ($6.5 billion) of an additional 29 F–35 aircraft. To ensure the F–35 maintains its effectiveness against continually evolving threats, this request also includes resources to deliver advanced weapons and sensors to the F–35 fleet in the years following Initial Operational Capability for our Services. The Department also endeavored to protect the development of the F–35 Program this year as it adjusted its budget to execute the mandates of sequestration. The Department has requested a reprogramming of $75 million to keep the development program on schedule and we urge the subcommittee's support for this request. Ensuring the success of the F–35 development program and achieving a stable design that will permit increased and more economical production rates have been among my top priorities. I would also ask this subcommittee to help us maintain funding stability in the F–35 Program as you review the fiscal year 2014 President's budget request.

WHERE THE PROGRAM HAS BEEN

Three years ago, the program experienced a critical unit cost breaches according to the Nunn McCurdy statute. My predecessor, now Deputy Secretary of Defense Ash Carter, rescinded the Milestone B and Acquisition Program Baseline. The Nunn McCurdy breach resulted from overly optimistic perceptions of development risk and an overly aggressive, concurrent acquisition strategy. The critical review and re-baselining process included an examination of all aspects of the program and led to significant changes in how the F–35 program is managed and executed. After elevating the Program Executive Officer to a three-star flag officer billet and bringing in Vice Admiral Dave Venlet from the Naval Air Systems Command to be the Program Executive Officer, the Department executed a detailed Technical Baseline Review to reassess the time and resources required to complete development prior to resetting the Baseline and certifying the program. To address the technical risks identified by that review, the Department added 2 years and $4.6 billion to the development and test programs. We also made significant changes to our technical and contractual relationships with Lockheed Martin, the prime contractor. To ensure Lockheed Martin shared equitably in program risks and to incentivize cost reduction, we began the transition from cost-plus production contracts to fixed price-type contracts beginning with a fixed-price incentive-fee contract for Lot 4. In Lot 5, the 2011 Lot, we continued this process, tightening contract terms and obtaining a cost sharing agreement with Lockheed Martin for concurrency risk—the costs associated with implementing design changes to fix problems identified in testing on aircraft that had already been manufactured. We are currently negotiating fixed price-type contracts for production Lots 6 and 7, under which the contractor will be assuming the risk for any cost overruns. With me today is the current Program Executive Officer, Lt. Gen. Chris Bogdan, who is focused on continuing to execute these changes and deliver this critical warfighting capability to the U.S. Services and our international partners. Also here today is Sean Stackley, Assistant Secretary of the Navy for Research, Development and Acquisition and Dr. William LaPlante, Principal Deputy Assistant Secretary of the Air Force for Acquisition and Management. All of us are fully dedicated to the success of this program.

PROGRAM ACCOMPLISHMENTS IN THE LAST YEAR

Flight test is progressing close to plan and is about 40 percent complete. To date the F–35 Program has flown more than 3,000 flights totaling more than 5,000 flight hours and is largely tracking to our re-baselined plan. The first in-flight weapons releases were conducted from both the Air Force's F–35A conventional take-off and landing variant and the Marine Corps' F–35B short take-off/vertical landing version and the program also began testing the most dynamically challenging portion of flight envelope testing. Flight testing of the aircraft's maximum design speed, maximum altitude and high angle of attack flight characteristics, has been successful to date. On June 5, 2013, the integrated test team at Edwards Air Force Base conducted the first powered launch of an AIM–120 Advanced Medium-Range Air-to-Air Missile from an F–35A. Dynamic Load Testing models of the F–35A and F–35B have completed their first lifetime (8,000 hours) of structural fatigue testing, with the F–35C scheduled to complete in July. After tearing down the aircraft, analyzing the results, and making any necessary modifications, each variant will move on to a second lifetime of testing over the coming year. The program also completed a U.S. Air Force operational evaluation that cleared the way to begin pilot and maintenance training at Eglin Air Force Base (AFB). The Marine Corps and Air Force now have thirty-nine (39) F–35's deployed to operational and training squadrons at four

locations and have completed over 1,500 sorties totaling 2,000 flight hours. The program has completed initial training for the transition of nearly fifty (50) pilots and over seven hundred (700) maintainers. The Marine Corps activated the first F–35B squadron at Marine Corps Air Station (MCAS) Yuma, Arizona and now has six aircraft flying. None of these aircraft are fully operational of course; that cannot occur until operational software completes development and test and is fielded. The Services also recently informed the Congress of their plans for establishing Initial Operational Capability (IOC), indicating their confidence in the program's ability to deliver capabilities on schedule. Concurrency costs are coming down faster than program estimates, and production costs are coming down as well. The price of producing F–35s continues to decrease for each successive lot placed on contract; Lot 5 aircraft averaged 4 percent less than Lot 4's, as did the price for Pratt & Whitney's engines. We expect such reductions to continue.

INTERNATIONAL PARTNERSHIP

The F–35 program continues to be the Department of Defense's largest cooperative development and production program, and with eight original Partner countries all continuing their participation under Memorandums of Understanding for System Development and Demonstration (SDD) and for Production, Sustainment and Follow-on Development (PSFD). The eight partner countries are the United Kingdom, Italy, The Netherlands, Turkey, Canada, Australia, Denmark, and Norway. I recently met with my international counterparts at our annual Chief Executive Officer's Conference and I can assure you that the partnership remains strong and committed to the program. Over the last few years, individual partner nations have modified their procurement plans to reflect the program's progress and the available funding in their defense budgets, in a manner similar to the changes in our own procurement plans. However, at this time each considers the F–35 a key to their national defense and remains committed to the program. Turkey deferred the two jets they had ordered in LRIP 7 (2012), deciding to revisit their production decision in time to join LRIP 9 (long lead—2014; on contract in 2015). The Netherlands first two aircraft are being readied for delivery this year to train Dutch pilots to participate in operational testing. The Netherlands Ministry of Defense is fully committed to the F–35, awaiting conclusion of parliamentary budget debates this summer to determine the timing for the next Dutch aircraft order. Lastly, Canada continues to fulfill the requirements in its mandated CF–18 replacement process with the next update due to Parliament the fall. The process is not anticipated to complete with this update.

In addition to development and production with our international partners, there is robust activity in the Foreign Military Sales (FMS) arena. Delivery of Israel's first of nineteen (19) F–35A aircraft is scheduled to begin in 2016, with current plans for seventy-five (75) Israeli F–35's. Japan signed a Letter of Offer Acceptance (LOA) for four F–35A variant aircraft in June 2012 to be delivered from the Lockheed Martin assembly line in 2016. Thirty-eight (38) follow-on aircraft will be produced in a Final Assembly and Check-out Facility (FACO) built in Japan, with deliveries beginning in 2017, for a total of forty-two (42) aircraft. Japan's Ministry of Defense continues to plan for additional production to replace their aging fighter fleet; and a decision on the replacement aircraft is expected by 2017. Last June the F–35 team provided a proposal to the Republic of Korea, which is also competing for the acquisition of its future fighter. We expect Korea's decision by the end of this month. Should the F–35 be selected, deliveries would commence in 2017. The Singapore Air Force is currently working with the F–35 program through a Studies and Analysis FMS case leading to a potential request for acquisition later this year.

WHERE WE ARE NOW

The F–35 program continues to make steady progress. I believe we have a realistic plan in place. We are seeing progress close to plan but challenges and risks remain. We still have a long way to go in the flight test program, with over 50 percent of the flight test remaining, and have a good deal of development to complete, particularly software and weapons integration.

While the program did experience significant schedule and cost growth prior to the 2010 Nunn-McCurdy cost breach, the Department's actions and our experience over the last 3 years reflect that the program is on a more stable footing. Our focus now is on completing development, which will permit ramping up to increased economies of scale in production, and on getting support costs down.

COST, SCHEDULE AND PERFORMANCE

The Department is focused on executing the development program with discipline to ensure the program delivers the planned for capabilities within the time and funding that has been budgeted.

Unit Recurring Flyaway (URF) costs are on track to meet the affordability targets that I established during the MS B recertification in 2012. The transition to fixed price production contracts is helping with this positive trend, but to meet our cost goals the Department must ramp up the production profile. In 2012, I flattened production because of excessive concurrency risk and concern about the stability of the design. The situation today has improved to the point that I am cautiously optimistic that we will be able to increase production in 2015 as planned, provided development and test progress continues to show improvement and costs risks associated with concurrency continue to decline.

DEVELOPMENT STATUS

Over the past 2 years the Program Office has implemented significant changes in how system software is developed, lab tested, flight tested, measured and controlled. These changes are showing positive effects, and we are moderately confident that the program will successfully release the Block 2B and 3I capability as planned in 2015 and 2016. Block 2B is our initial combat capability, which the U.S. Marine Corps plans to use to declare their IOC. Block 3I will have the same operational capabilities as Block 2B, but includes a hardware upgrade of the aircraft's computers. The Air Force plans to declare IOC with the Block 2B/3I capabilities by December 2016. However, there is more risk to the delivery of Block 3F, required for Navy IOC and the Services' full warfighting capability, by late 2017. The F–35 Program Office is conducting a Block 3 Critical Design Review early this summer. The results of this review, coupled with a solid 6 months of flight testing on our 2B software, will allow the Department to determine the likelihood of meeting its Block 3F commitments on time. I expect to have more definition regarding Block 3F capability at the end of the summer, but we do see risk in the Block 3F schedule at this time.

While software development and integration is the highest risk the program faces as we complete development, there are other risks we are tracking that warrant management attention. Among these are the Helmet Mounted Display System (HMDS), the Arresting Hook System (AHS) for the F–35C (carrier variant), and the Autonomic Logistic Information System (ALIS). The HMDS is a major technological advance for pilot situational awareness but it has presented design challenges. HMDS issues faced by the program over the past year were "green glow," or insufficient helmet display contrast; latency of the displayed information; "jitter," or lack of stability of the displayed symbology as the aircraft maneuvers; night vision acuity; and alignment of the displayed symbology. Last year the program made significant progress against these challenges using dedicated HMDS flight testing to identify and analyze acceptable HMDS performance. As a result of testing, the program has successfully mitigated the effects of four of these HDMS issues. More work is planned this summer to ensure that the night vision camera is effective for Marine Corps operations. All of these systems still pose moderate risk, but the program has well-planned and resourced mitigation plans in place for each. I would categorize these as typical of challenges associated with a complex weapon system development program, but design and production concurrency have rendered them more acute in the F–35's case.

It is important to note the impact our budget uncertainty has had on the program, specifically in the test program. The devastation caused by sequestration and the future furlough of our civilian workforce are real. Although these are not typical challenges, they are our reality and are increasingly difficult to recover from. For example, we estimate a minimum impact to our testing schedule of a 1 month slip due to the furlough of Government test personnel. We continue to assess the effects downrange from furlough to our activities on this and other programs, as this is new territory for us in terms of understanding the full impacts.

PRODUCTION STATUS

Overall, production performance is tracking to the post-strike Lockheed Martin baseline and the aircraft production quality is improving. As of June 10, 2013, the program has delivered a total of fifty-six (56) aircraft—twenty-five (25) for testing and thirty-one (31) for operations and training.

In the fall of 2012, the F–35 Program Office was alerted to a case where non-compliant specialty metals were used in the manufacturing of the F–35 Radar. The

metals in question are in small high performance magnets that are embedded in the lowest levels of the F–35 supply chain. The noncompliance does not refer to the quality of these materials but to their country of origin. Following a thorough review, and after the required congressional notification, I determined that a National Security Waiver was appropriate to allow acceptance of aircraft containing these noncompliant high performance magnets. There was no risk associated with the use of the materials and the time required to re-qualify a compliant high performance magnet would have resulted in major delay to the production and fielding of the aircraft. Subsequent to the discovery and disclosure of this noncompliance, a complete assessment of the supply chain bill of materials was completed and two other instances where noncompliant specialty metals were being used in the manufacturing of the F–35 Radar and Target Assemblies were discovered. I both amended my earlier National Security Waiver and issued a new National Security Waiver to cover these instances of noncompliance in order to ensure that the production and testing timeline for this critical program would not be negatively impacted until compliant parts could be qualified and obtained. I can assure you that the Department and I take this matter extremely seriously. I have personally met with the prime contractor to discuss its corrective action plans and have tasked the Defense Contract Management Agency to review the reasons behind the noncompliance on the target assemblies. In addition, the program office has insisted that the prime contractor institute aggressive and thorough measures to identify any additional instances and correct its specialty metal compliance process.

CONCURRENCY COSTS

As I mentioned, structural fatigue testing is proceeding according to plan and one of the biggest concurrency risks—that of a significant structural redesign—is decreasing accordingly. The quantity and significance of test findings to date have been consistent with or better than what we have seen on past fighter programs.

Predicted concurrency costs are coming down with the execution of flight testing. Additionally, the projected concurrency costs per aircraft are being revised downward due to a number of initiatives. In the summer of 2012, the F–35 Joint Program Office (JPO) and Lockheed Martin (LM) created a joint JPO–LM Concurrency Management Team. Their first tasks were to identify the key drivers of concurrency costs, develop a discrete bottoms-up cost estimate, and work collaboratively to mitigate expected concurrency impacts. The new cost model reflects a detailed engineering approach informed by the remaining F–35 qualification, flight test, and ground test events. The F–35 program has taken measures to improve management of concurrency risk and minimize the costs of delivering warfighting capability to the Services by reducing the time required to implement changes to the production line, where these modifications are cheapest, and ensure that fewer aircraft need post-production retrofits. These included introducing incentives to the Lot 5 and beyond production contracts so that Lockheed Martin absorbed a reasonable share of the risk and cost of discovering and implementing concurrency changes during production.

SUSTAINMENT COSTS

The operation and sustainment (O&S) costs estimate reported in this year's Selected Acquisition Report (SAR) to Congress is unchanged from the independent cost estimate the Director of the Cost Assessment and Program Evaluation office (D, CAPE) provided to support the Defense Acquisition Board's 2012 Milestone B Nunn-McCurdy recertification review. It will be updated for the fall 2013 Interim Program Review DAB, based in part on the program's cost data gained from operations at Eglin AFB and MCAS Yuma.

The SAR reflects O&S costs that total $617 billion in constant year 2012 dollars or $1,113 billion in then-year dollars; the then-year estimate highlights the inflationary impacts of operating those aircraft beyond the year 2065. The cost per flight hour (CPFH) reflected in the SAR is also the unchanged D, CAPE estimate. I established CPFH affordability targets during the MS B recertification, and we are working to achieve reductions that will bring the program in below these targets to ensure the F–35 is affordable as we transition to the operations and sustainment phase.

The Department, Services, and F–35 Program Office have undertaken numerous initiatives to explore ways to reduce total O&S costs. At this point, the O&S costs represent the best remaining opportunity to reduce program costs. These initiatives include:

—Conducting a Sustainment Business Case Analysis using independent reviewers.

—Injecting competition in sustainment areas to include managing the global supply chain, producing support equipment, operating our training centers and administering ALIS in each of our bases and squadrons.
—Instituting a robust Reliability and Maintainability program to systematically identify parts and systems on the aircraft today that require repairs too frequently.
—Standing up the organic depots to improve the quality, throughput, and turnaround times for parts repairs.

While we are being aggressive in our efforts to reduce overall O&S costs, our current estimates are just that—estimates. My confidence in our cost estimates will improve when we have actual costs based on sustaining broad operational employment and can benefit from the learning and experience of our warfighters.

FUTURE OF THE TACTICAL FIGHTER INDUSTRIAL BASE

The Department is concerned about the future of the United States' high performance tactical aircraft industrial base. We are on the path to having one active fighter production facility in the next few years, but even more disconcerting is the gap between development programs for the F–35 and the next generation of high performance aircraft. Approximately a year ago, the Defense Advanced Research Projects Agency was tasked by the USD(AT&L) to begin the "Air Dominance Initiative," a program envisioned as leading to competitive prototyping programs for the next generation of air dominance systems technologies beginning in 2016. In the current austere budget climate it will be difficult to find resources to maintain and advance our competitive technologies for high performance tactical aircraft, but it is important that we do so. Programs such as the Unmanned Carrier Launched Air System can fill part, but not all, of this gap.

CONCLUSION

The Department has a realistic baseline in place and we are seeing steady progress in the program. The Department remains committed to the F–35 as the core of our U.S. combat air superiority and precision strike capabilities for generations to come. The capabilities of the F–35 are necessary to our continued technological superiority on the battlefield. Over the past few years, the Department has put in place the right fundamentals and realistic plans using sound systems engineering processes, and we are monitoring and tracking performance using detailed metrics. Overall, there is much work still ahead of us and there is still the possibility that we will be surprised during the balance of the development and test program, but at this time we believe we have put the program on a much more stable footing then it had prior to the Nunn McCurdy breach in 2010.

Thank you again for this opportunity to discuss the F–35 Joint Strike Fighter Program. We look forward to answering any questions you have.

Senator DURBIN. Thank you, sir.

Chief of Naval Operations, Admiral Greenert.

STATEMENT OF ADMIRAL JONATHAN W. GREENERT, CHIEF OF NAVAL OPERATIONS, UNITED STATES NAVY

Admiral GREENERT. Thank you, Chairman Durbin, Vice Chairman Cochran. Thanks for the invitation to discuss the future of naval aviation here this morning.

Today's topic, for me, the F–35C, is really a key part of our future. It provides a unique and essential set of capabilities for our air wing and for our carrier strike group and effectively for the fleet, and it will dramatically enhance the near-term and the future air wing capability immediately upon its integration.

Now, as we prepare to integrate this aircraft, we are focused on three things: One, to ensure that the F–35C delivers on the requirements that we validated that we need; two, to make sure that integrating the F–35 Charlie into our air wing is effective and that it conforms to the carrier—it has to fit into the air wing; and third, to understand the concepts required for affordable operations and sustainment.

Now, with regard to capability, we need the stealth. We need their advanced electronic warfare (EW) sensors, the weapons, and perhaps more importantly, the command and control capability that this aircraft brings. With its stealth and its EW capability, it effectively enables us to be closer to the threat. You can fuse targets. That means as you detect targets, you can bring them together, determine what is what, what is the threat, and build a common operational picture, and you can engage first. And perhaps just as important, the F–35 Charlie is designed to share this operational picture with other F–35s, other tactical aircraft, including our Super Hornet and the other aircraft in the air wing, other ships, other platforms via our tactical data links. So it really is a force multiplier in addition to be an incredibly capable aircraft.

With regard to integrating the F–35C into the carrier and into the air wings, our top challenge is to reconcile that we need to get done before our IOCR. We need to get the software program, the Block 3F capability, certified. It brings us weapons, the EW systems that I just mentioned, and an aircraft that meets the operational envelope certification. We need an arresting hook that is durable, reliable, and precise. And we need the helmet monitor display system which is being worked right now with some deficiencies. We need that certified. And as I mentioned before, to integrate, we need it to be carrier compatible, if you will, and that at-sea evaluation will start next year.

Based on the Joint Program Office projections, we are on track for this with some risk, particularly in the software certification.

Now, with regard to understanding and addressing our operations and sustainment, we have a lot of work to do, but I think we have adequate time to prepare to integrate the F–35. We are conducting a business case analysis on the level of repair effort, the logistics, the maintenance schemes that we will use, and we have tri-service meetings. That means I meet with my service chief counterparts quarterly, and we meet with the Joint Program Office quarterly to go over these sorts of things.

The CONOPS—we will need a concept of operations to have been established to settle what the flying hour cost is going to be. In other words, what are my flying habits for this type of aircraft? Simulation, which is very advanced, versus training versus proficiency flying. I need to determine what is the best estimate for the cost to fly this aircraft and we will work through that. We have a mandate that Mr. Kendall has given us. And right now, we look and project we will meet this mandate, but this is something we have to focus on—we, the fleet.

PREPARED STATEMENT

Our sustainment challenges are to be able to maintain this aircraft in a maritime environment, saltwater, moving ship and a carrier, human environment. It is hot. It is dusty. And how do we maintain this aircraft in that hangar bay? We need to be able to repair the aircraft in my view, and that requires the right parts and the correct scheme. And we need trained sailors to do that. And if we are going to repair it, then we need logistics, and we got to have an affordable logistics train and one that is responsive.

So to me, Mr. Chairman, the F–35C is designed to provide the capability we need, and I look forward to working with this committee, with the Congress, and with the Program Office to bring it into the fleet at an affordable rate. Thank you.

[The statement follows:]

PREPARED STATEMENT OF ADMIRAL JONATHAN W. GREENERT

Chairman Durbin, Vice Chairman Cochran, distinguished members of the subcommittee, thank you for the opportunity to testify today on the carrier variant of the F–35 Joint Strike Fighter (F–35C).

The F–35C will replace our F/A–18C Hornet fleet starting at the end of this decade and provide essential and unique capabilities that complement the rest of our carrier air wing (CVW). Our focus areas, from today until the time F–35C enters the fleet, remain: Ensuring the F–35C delivers the capability we need and expect, integrating F–35C into our CVWs, and understanding and addressing the requirements to sustain the aircraft and its payloads.

THE CAPABILITY WE NEED AND EXPECT FROM THE F–35C

The capability the F–35C is expected to deliver is needed to provide Navy a strike-fighter with the stealth, sensing and command and control capabilities for our future CVW to do two important missions: assure access and project power. These missions require our aircraft be able to overcome, by stealth, jamming or threat system destruction, surface-to-air missiles, air-air missiles, tactical aircraft and sensors. These threats and their components will continue to advance and (likely) proliferate within the next decade—and may be employed individually or collectively as part of more capable air defense ships or integrated air defense systems. Our CVWs will need the F–35C's contributions to assure access and project power in the future.

The F–35C is expected to operate closer to threats than the F/A–18 E/F Super Hornet because the F–35C has a lower radar signature and an improved capability to detect, avoid and jam enemy radars. The F–35C is designed to be able to use this access and its more sophisticated and comprehensive suite of sensors to conduct "first day" attacks and to establish an operational picture of the battlespace.

Equally important, the F–35C is designed to share its operational picture with other aircraft—particularly the F/A–18 E/F—to enable them to conduct strike and anti-air attacks with stand-off weapons. The F–35C is expected to be able to integrate various active and passive sensors from multiple aircraft (including F/A–18, E–2D Hawkeye, and EA–18G Growler) into the F–35C's operational picture. This process automatically formulates "weapons-quality" tracks for each target that can then be shared with other aircraft and ships, enabling them to engage the target.

INTEGRATING F–35C INTO OUR CARRIER AIR WINGS

At a minimum, the F–35C will need to initially deliver equivalent capabilities to the F/A–18C it replaces in order for F–35C to integrate into the CVW. These capabilities are the ability to operate on and from the aircraft carrier and the ability to detect and engage aircraft, ground targets and surface maritime targets. These capabilities will be incorporated into F–35 as part of Block 3F, which makes this software program and associated equipment (Block) necessary for F–35C to be integrated into the CVW.

I am monitoring two other items needed to integrate F–35C into the CVW: Redesign and testing of the Arresting Hook System (AHS) and correction of problems with the Helmet Mounted Display System (HMDS). Based on Joint Program Office (JPO) projections, the AHS will be corrected within a year, while the HMDS will be addressed in the F–35A and F–35B, before the Navy's F–35C is fielded. Based on JPO-projected development timelines, testing milestones and carrier suitability evaluations, the Navy has established February 2019 as our threshold (minimum expected) Initial Operational Capability (IOC) date, with an objective date of August 2018.

UNDERSTANDING AND ADDRESSING SUSTAINMENT REQUIREMENTS

The timeframe between now and threshold IOC affords the Navy adequate time to prepare to integrate F–35 into the fleet. In addition to integrating F–35C's warfighting capabilities into the CVW, the system's maintenance and sustainment processes must be compatible with our existing infrastructure—and the F–35C presents unique maintenance and logistics challenges. For example, sustaining the Low

Observable (LO) signature of the aircraft will be a new challenge to Navy maintainers. It is expected that there will be a learning curve in order to properly maintain this critical feature in the relatively harsh at-sea environment. Another challenge is the movement and transfer of replacement (spare) engines onto a deployed aircraft carrier, at sea around the world. Current fixed-wing, helicopter, and ship-to-ship at-sea transfer methods are not capable of moving the "Power Module," the largest module of the F135 engine; it is too big. We are exploring different options to resolve these at-sea challenges prior to IOC, and our first F–35C operational deployment.

There are additional challenges, from Navy's perspective, associated with the builder's maintenance concept for F–35C. The demands of CVW operation in an expeditionary environment have taught us we need to be able to do maintenance, and some repairs, at sea. Our Sailors accomplish many of the maintenance requirements for all of our CVW aircraft at intermediate ("I-level") maintenance facilities inherent aboard the aircraft carrier at sea. Currently, the F–35C program is not designed to incorporate I-level maintenance. The Joint Program Office (JPO) has been requested to arrange for, and review, a Level of Repair Analysis (LORA), which will be independently assessed by a third-party, to study the business case of incorporating I-level infrastructure into the F–35 program. This Tri-Service study will examine avenues to optimize current processes and maintenance investments which could save money, enable more repairs of F–35C to be conducted at sea and increase the operational availability. The results of this study will be available for all Services to consider. We are also examining whether the F–35C's requirements for data "reachback" to support logistics orders and maintenance planning are suitable for the forward maritime operating environment. Each of these aspects of F–35C sustainment (logistics, repair and maintenance) impacts the cost to sustain the F–35C, and we are working to understand them fully to identify opportunities to reduce sustainment cost.

CONCLUSION

The Navy needs the capability of the F–35C and remains committed to it as an essential component of our future CVW. However, we have some challenges to work through to ensure it delivers the capability we need and expect, integrate F–35C into our CVWs, and understand the requirements to sustain F–35C. The JPO plans are designed to address these challenges in the timeframe between now and when Navy intends to field the F–35C.

Thank you again for the opportunity to appear before the committee and I look forward to your questions.

Senator DURBIN. Thanks, Admiral.

The Chief of Staff of the Air Force, General Mark Welsh.

STATEMENT OF GENERAL MARK A. WELSH, III, CHIEF OF STAFF, UNITED STATES AIR FORCE

General WELSH. Thank you, Mr. Chairman, Vice Chairman Cochran, members of the committee. We appreciate the opportunity to be here this morning to discuss the importance of the Joint Strike Fighter to our Nation's security, in my view, and also any other tactical aircraft programs you would like to address.

Since April 1953, the United States has deployed roughly 7 million American servicemembers to combat and contingency operations around the world, and thousands of them have died there, but not a single one has been killed by enemy aircraft. The air superiority that this Nation has enjoyed for those 60 years is not an accident and gaining it and maintaining it is not easy. It requires trained, proficient, and ready airmen, and it requires credible, capable, and technologically superior aircraft.

Air superiority is critical to our Nation's security, as Mr. Kendall mentioned a moment ago. It is a fundamental pillar of not just air power but a prerequisite to the American way of modern joint warfare, and without it, our Nation's ground and maritime forces would have to radically change how they go to war.

I believe the F–35 is essential to ensuring we can provide that air superiority in the future. Potential adversaries are acquiring fighters on a par with or better than our legacy fourth generation fleet. They are developing sophisticated early warning radar systems and employing better surface-to-air missile systems, and this is at a time when our fighter fleet numbers about 2,000 aircraft and averages a little over 23 years of age, the smallest and the oldest in the Air Force's history. America needs the F–35 to stay a step ahead, to make sure that the future fight is an away game and to minimize the risk to our ground forces when conflict inevitably does occur. Its interoperability among the Services and partner nations, its survivability against the advance integrated air defense systems, and its ability to hold any target at risk make the F–35 the only real viable option that I see to form the backbone of our future fighter fleet.

PREPARED STATEMENT

Over the past 2 years, the program has shown steady progress, and now it needs stability. I am proud to lead the airmen who power the most capable air force on the planet and they need the right tools, as you know and have helped them get, to guarantee global vigilance, reach, and power for America. The F–35 is one of those tools.

And I look forward to our discussion.

[The statement follows:]

PREPARED STATEMENT OF GENERAL MARK A. WELSH, III

Chairman Durbin, Ranking Member Cochran, and distinguished members of the subcommittee, thank you for the opportunity to discuss the Joint Strike Fighter (JSF) and the future of tactical aircraft. Thank you also for your support of our Airmen who are currently engaged around the world executing our five core missions of air and space superiority, intelligence, surveillance, and reconnaissance, rapid global mobility, global strike, and command and control to provide *Global Vigilance, Global Reach*, and *Global Power* for our Nation.

In January 2012, the Secretary of Defense issued new defense strategic guidance (DSG)—*Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*—which serves as a foundational document both to articulate national security interests, and to guide America's military posture and procurement. To support this guidance, the F–35A, along with the KC–46 tanker and the long range strike bomber, remain the Air Force's top three acquisition programs. The F–35A will form the backbone of our tactical aircraft fleet for many years, and will replace our aging fighters with a dominant, multirole, fifth-generation aircraft, capable of projecting power, deterring potential adversaries, and winning future wars alongside similarly-equipped allies and partners.

AIR SUPERIORITY AND GLOBAL STRIKE

The F–35A directly impacts two of our five core missions—air superiority and global strike. While complementing the F–22's world-class air superiority capabilities, the F–35A is designed to penetrate integrated air defense systems (IADS) and deliver a wide range of precision air-to-ground and air-to-air munitions against air defense targets. These suppression and destruction of enemy air defense (SEAD/DEAD) missions are a prerequisite to gaining air superiority. Air superiority provides freedom of action for the entire joint force. In fact, April 15, 1953, was the last time an American servicemember on the ground was killed by an enemy aircraft. The air superiority that America has enjoyed for over 60 years is not an accident, and gaining and maintaining it is not easy. It requires a credible, capable fleet of aircraft employing cutting edge technology to counter emergent threats, as well as a trained, proficient, and ready force of Airmen to fly them. As an Air Force, we are proud of the decades of consistent delivery of air superiority that we have been able to provide the Nation, and we believe it is our duty and obligation to continue

and preserve that core mission. Without air superiority, the joint team would have to radically change how it goes to war, with U.S. and allied operational success subject to much greater risk.

In terms of global strike, the F–35A will also pay dividends as we re-focus our attention to the possibility of military operations in contested environments. Our fighters and bombers have enjoyed relative freedom from attack in Iraq and Afghanistan, but as increasingly sophisticated and capable global anti-access/area-denial threats continue to proliferate, the ability of our fourth-generation fighters to penetrate contested airspace will wane. Much like the initial days of the first Gulf War, when only the F–117 possessed the capability to strike downtown Baghdad, the F–35A's survivability and lethality in highly contested environments will help deter and defeat potential adversaries anywhere on the planet, holding any target at risk, today and tomorrow.

THREATS

Over the last 22 years, our military has fought four major regional conflicts—Kuwait, Bosnia, Afghanistan, and Iraq, with the smaller-scale enforcement of United Nations Security Council Resolution 1973 over Libya concluding just 18 months ago. However, our security challenges persist across the globe from transnational terrorism in Africa, to regional instability in the Middle East, to a nuclear-armed North Korea. Our technological advantage is threatened by the worldwide proliferation of advanced air defense systems such as the Russian-built S–300 which has garnered recent headlines in Syria. Moreover, countries are developing fighters on par or better than our legacy, fourth-generation fleet. For example, China and Russia are currently testing fifth-generation fighters, with China recently flying two new advanced stealth fighters—the J–20 and J–31. These world-wide technological advancements are occurring at time when our fighter fleet numbers about 2,000 aircraft and averages 23 years old, the smallest and oldest in our history.

CAPABILITIES

While the Air Force's current fleet of fighters has excelled in recent conflicts, the JSF is a necessity for future, high-end engagement, providing increased survivability and lethality. Fifth-generation survivability attributes include improved all-aspect stealth, advanced electronic warfare systems, and fused mission systems that provide unmatched battlespace awareness. It also includes the necessary tactical air characteristics of maneuverability and speed. In terms of lethality, the F–35A offers unprecedented data fusion and situational awareness with powerful radars, sensors, and other high performance capabilities that allow the successful prosecution of advanced ground and air threats in any environment, to include the dense high-threat environments characterized by double digit surface-to-air-missiles (SAMs) and multilayered IADS. Our current fighters have been modernized to incorporate some of the latest component technologies, but they are at the limits of both modernization and service life. We cannot modernize the fourth-generation fleet to the level of survivability and lethality necessary to operate and prevail in highly contested environments. Recapitalization of the tactical fighter fleet through the JSF program best positions America's military to meet the security challenges of today and tomorrow, and to fulfill America's defense posture as expressed by the Defense Strategic Guidance.

Future military operations will require partnership with international partners and allies. The JSF's interoperability offers another unique capability that will enable America's military and Air Force to fight alongside our coalition partners seamlessly in the future. In addition to shared equipment and costs,[1] the JSF's interoperability will lead to common tactics, techniques, and procedures, mutual understanding of employment, and unprecedented degrees of shared situational awareness. Such integration will greatly enhance our ability to operate, survive, and succeed in future joint and coalition environments. By employing the same world-class equipment with similar procedures and tactics, we will be able to fully realize the synergistic effects of fifth-generation joint and coalition warfare.

CURRENT STATUS

The fiscal year 2014 budget request includes $4.5 billion for continued development and procurement of 19 F–35A conventional take-off and landing (CTOL) aircraft. Aggressive risk management and refined system engineering analysis contributed to an approximate 30 percent reduction in concurrency cost estimates since

[1] International partners have provided over $4.5 billion for JSF development.

2011, and the program has made significant strides overcoming technical challenges and software development delays.

The Air Force has received 22 production aircraft, and these early production deliveries have allowed us to begin the necessary ramp-up for future operational tests, and to build our initial cadre of pilot and maintenance instructors. To date, the program has completed over 1,400 CTOL test flights, comprising 46 percent of planned test points, and testing the JSF to its full envelope—700 knots, over 50,000 feet, over 50 degrees angle of attack, and multiple successful weapon separation tests to include the first AIM–120 live launch. We also completed the first life-durability test on the F–35A, a key milestone that reduces concurrency cost risk to future low-rate initial production (LRIP) lots.

During calendar year 2012, the JSF program conducted a successful operational utility evaluation and started pilot training at Eglin Air Force Base. We currently have 23 trained USAF pilots and 437 trained maintainers at Eglin. We expect the first aircraft delivery to Luke AFB—the first F–35A pilot training center—in February 2014, and to our first partner there, Australia, in the summer of 2014. We will also stand up the CTOL depot at Hill AFB this summer, and deliver their first aircraft in October of 2013.

Building on the progress made so far and the steps we take today are crucial in our efforts to declare F–35A initial operational capability (IOC). After last year's program re-baseline, the joint Services were tasked to provide Congress our updated IOC criteria and timeline estimates. Currently, the Air Force plans to declare IOC in December 2016 with a combat-ready squadron of 12 F–35As. The Air Force will declare F–35A IOC when Airmen are trained and equipped to conduct basic close air support, interdiction, and limited SEAD/DEAD operations in a contested environment. The follow-on 3F software package will add even more capability into the Air Force air superiority core mission by enabling multiship suppression and destruction of enemy air defenses, as well as enhanced air-to-air and air-to-ground modes. The 3F software suite is expected in 2017 and should be included in LRIP lot nine production aircraft.

SEQUESTRATION

We recognize that in the current fiscal environment, we must adapt to expected resource constraints. The JSF program has seen significant improvement in recent years, but the blunt effects of sequestration threaten to disrupt that progress. Sequestration significantly impacts every one of our investment programs, including the F–35A. Although unit costs for the F–35A have been trending down due to relative program stability, sequestration-induced disruptions to the program could, over time, potentially cost more taxpayer dollars to rectify program inefficiencies, raise unit costs, and delay delivery of validated capability. In fiscal year 2013, we planned to procure 19 F–35A aircraft. As a result of sequestration, we may have to reduce the procurement quantity by at least three and potentially as many as five aircraft.

CONCLUSION

The JSF is critical to our national security. This platform will form the backbone of our tactical aircraft fleet for many years to come, and will reinvigorate our aging fleet with a dominant, multirole, fifth-generation fighter. The JSF will feature prominently in future joint and coalition operations—flying with both U.S. and allied markings—projecting power, deterring potential adversaries, and winning future wars.

Although sequestration jeopardizes the stability of the program as we struggle to simultaneously regain readiness and recapitalize the Air Force's fighter and tanker fleets, we are committed to build upon the many significant milestones the JSF program has achieved in recent years. We have made great strides to reduce expenses across the life of the program, but we need Congress to pass a defense appropriations measure for fiscal year 2014 so that we can plan for the future. The JSF represents an investment in the air superiority of our Nation. It will assure that when America sends her sons and daughters to fight, they will fight with the protection of American airpower overhead . . . just as their brothers, sisters, parents, and grandparents have done in every conflict since April 15, 1953.

Senator DURBIN. Thank you very much, General.

Assistant Commandant of the Marine Corps, General John Paxton.

STATEMENT OF GENERAL JOHN M. PAXTON, JR., ASSISTANT COMMANDANT, UNITED STATES MARINE CORPS

General PAXTON. Chairman Durbin, Vice Chairman Cochran, distinguished members of the committee, thank you for the opportunity to discuss the Joint Strike Fighter and its role in the future of both the Marine Corps and our overall tactical aviation.

As the Marine Corps modernizes its aviation fleet, the continued development and the fielding of the F–35 Joint Strike Fighter remains a top priority. The capabilities offered in this jet are unequaled by anything in the world today. Within the B version of this single platform, we obtained the most lethal fighter characteristics, supersonic speed, low observable radar evading stealth, extreme agility, and the unmatched ability to collect, fuse, and disseminate information.

The F–35B's short take-off and vertical landing (STOVL) triples the number of airfields worldwide that the aircraft can utilize, and combined with the F–35C carrier variant, it gives the Nation double the number of capital ships that are capable of operating a fifth generation multirole fighter. In today's growing environment of anti-access and area of denial technology, the ability of many more State and non-State actors on the world stage to reach out and potentially touch surface targets thousands of miles out to sea necessitates that America consider and plan to have sufficient assets like these available to combat these threats.

Our ability to tactically base fixed wing aircraft in the hip pocket of our ground forces has long been instrumental to our many successes on the battlefield, from the birth of our marine aviation through today. The F–35B is the tactical aircraft that we need to support our Marine Air Ground Task Force from now into the middle of this century. The F–35C is the tactical aircraft that we need to enhance our participation in the Navy air's carrier air wings and their degree of power projection from the sea.

The F–35 will replace three models, three type model series, of aircraft that the Marine Corps currently operates. It will replace all of our F/A–18 multirole fighters, our AV–8B attack aircraft, and our EA–6B electronic aircraft. The F–35 is more than just a new fighter. By replacing so many different capabilities in our arsenal, it represents an entirely new way of doing business including, as the CNO said a minute ago, tactical command and control.

PREPARED STATEMENT

I thank each of you for your time, your interest, and your support of our Nation and our military.

I request that my written testimony be accepted for the record and look forward to your questions.

We are committed to always providing the Nation a force, today's force for today's crisis today, and the JSF is key to our ability to do that.

Thank you very much.

[The statement follows:]

PREPARED STATEMENT OF GENERAL JOHN M. PAXTON, JR.

Chairman Durbin, Ranking Member Cochran, and distinguished members of the subcommittee, thank you for the opportunity to discuss the Joint Strike Fighter (JSF) and the future of Marine Corps tactical aircraft.

As the Marine Corps modernizes its aviation assets, the continued development and fielding of the F–35 Joint Strike Fighter (JSF) remains a top priority. The F–35 will supplant the Marine Corps' aging Tactical Aviation (TACAIR) fleet by replacing F/A–18 Hornets, AV–8B Harriers, and EA–6B Prowlers. The incorporation of the F–35 aircraft into the Marine Air Ground Task Force (MAGTF) will provide a dominant, multirole, fifth-generation platform capable of full spectrum combat operations in support of naval and joint forces. We are well into this transition plan and failure to maintain both JSF production rates and legacy aircraft service life extension programs will impact operational readiness and aircraft availability.

While today's U.S. military force is highly adept, new challenges are emerging from nations and non-State actors employing increasingly sophisticated anti-access/area-denial (A2/AD) strategies. The proliferation of A2/AD technology enables them to reach out and potentially touch surface targets thousands of miles out to sea. This necessitates America to consider and plan to have sufficient assets available to combat these threats. While designed to meet an advanced threat through low observable lethality and survivability, the F–35 JSF will also bring enhanced intelligence, surveillance, and reconnaissance (ISR) capabilities to the battlefield. The aircraft's ability to develop, process, and display information to the pilot and disseminate it to tactical, operational, and strategic levels is what makes the F–35 truly unique and a critical node for the MAGTF across the entire range of military operations. As the Nation's expeditionary force in readiness, the Marine Corps must be prepared and able to operate in an A2/AD environment from the sea and ashore to project influence and power at a time and place of the Combatant Commander's choosing. USMC F–35s will be a critical enabler of this capability.

The short take-off and vertical landing (STOVL) F–35B will provide the MAGTF with flexible, expeditionary basing options required to maintain the advantage in the future fight. Expeditionary basing includes operating from amphibious ships and from remote locations ashore where few airfields are available for conventional aircraft. Our requirement for expeditionary tactical aviation has been demonstrated repeatedly from the expeditionary airfields and agile jeep carriers of World War II, to austere forward basing in Iraq and Afghanistan. Today this concept has proven viable for operations in support of the "new normal"—a posture that requires an enhanced baseline of security at U.S. diplomatic facilities and an increased vigilance marking the cascading and deleterious effects of civil uprisings such as those that occurred in Libya and Yemen. In short, the Marine Corps' ability to tactically base fixed wing aircraft has been instrumental to our success on the battlefield and on the world stage.

At sea, the F–35 can operate from both aircraft carriers and amphibious shipping. The ability to employ the F–35B from 11 big-deck amphibious ships doubles the number of "aircraft carriers" from which the United States can employ a fifth-generation capability. The F–35B also generates launch and recovery flexibility beyond U.S. Navy ships by being cross deck compatible with all international conventional and STOVL capable aircraft carriers.

While operating ashore, the F–35B is not constrained to major airfields of 8,000 feet or more. The ability to operate from short, less than 3,000 foot runways provides a more than three-fold increase in the number of airfields worldwide that STOVL aircraft can utilize. Additionally, STOVL aircraft can operate from expeditionary airfields constructed from airfield matting or established on nonairfield infrastructure such as highways or large parking lots; a capability repeatedly demonstrated during Operation Iraqi Freedom and Operation Enduring Freedom.

The Marine Corps' acquisition of the F–35C variant will continue and enhance its current participation in United States Navy carrier air wings. Carrier air wing capabilities of the future will be bolstered by the F–35C's survivability and lethality against anti-access threats that include advanced surface to air and anti-ship missile systems. In the face of emerging threats, a carrier air wing's ability to project power will rely heavily on the ability to detect, track and prosecute targets while at the same time avoiding detection. Marine Corps F–35C squadrons as part of United States Navy carrier air wings will be an essential element of this power projection capability from the sea.

The F–35 will provide a dominating counter to a broad spectrum of current and future threats while ensuring success on the battlefield that cannot be addressed by current legacy aircraft. Continued funding and support from Congress for the F–35 JSF program is of utmost importance for the Marine Corps and our Nation.

On behalf of the Marines and Sailors who provide this Nation with its versatile, reliable, middleweight force in readiness, I thank Congress for your constant interest in and recognition of our challenges. Your continued support is requested to ensure the Marines Corps can proceed with the fielding of this aircraft, an aircraft that for the first time in aviation history combines the most lethal fighter characteristics—supersonic speed, radar-evading stealth, extreme agility, a short takeoff/vertical landing capability, and the unmatched capability to collect, fuse and disseminate information—all in a fifth-generation platform. The capabilities offered in this jet are unequaled by anything in the world today. It is a capability critically needed by our Nation and your Marine Corps and a capability whose day is rapidly dawning.

Senator DURBIN. Thanks, General, and your statement will be made part of the record, without objection.

Lieutenant General Bogdan.

STATEMENT OF LIEUTENANT GENERAL CHRISTOPHER C. BOGDAN, UNITED STATES AIR FORCE, JOINT STRIKE FIGHTER PROGRAM EXECUTIVE OFFICER

General BOGDAN. Mr. Chairman, Ranking Member Cochran, and distinguished members of the subcommittee, thank you for the opportunity to discuss the F–35 program with you today. I will be brief so we can get on to the Q&As.

The F–35 program is not the same program it was a number of years ago. We have significantly restructured the program over the past few years and created a much more realistic baseline to the program. We have also adequately resourced the program to meet our commitments in terms of manpower, technical expertise, time, and money.

Relative to the program's schedule, we are executing with minor delays today but are mainly on track to that schedule we put in place in 2010. I am confident we will meet the commitments from Block 2B and 3I which will allow the U.S. Marine Corps to declare initial operational capability (IOC) in 2015, which will allow the Air Force to declare IOC in 2016, and meet the commitments of our initial partners in terms of delivering their planes to them.

I am less certain about our final capability 3F being delivered at the end of 2017, and we can discuss that further in the Q&As.

Affordability is my number one concern and my number one priority on the program. Relative to development, we have taken a mindset that we have no more time and no more money in the development phase of the program, meaning that within the resources we are given, we are committed to finishing the program on time and within budget.

Relative to production costs, the cost of the airplane and the cost of the engine are coming down lot after lot. I am currently negotiating Lot 6 and 7 with Lockheed Martin and Pratt & Whitney, and I expect that trend to continue many years into the future, that the prices will continue to come down.

Relative to operations and sustainment costs, today the Program Office is taking aggressive action on many fronts to lower the lifecycle costs of this airplane, and I would be more than happy to detail those during the Q&A. What we need to do is ensure that our partners and the Services have an affordable weapons system in the future, and the Program Office takes this on very seriously.

Technically, I believe the design of the aircraft is sound, and we have solutions to all the technical problems we see in front of us

today. That does not mean that in the future we will not have other challenges and other discoveries, but I believe we have the capability and the capacity to overcome those.

And finally, I have been at the helm of the program for about 6 months, and my promise to you and the enterprise is I will continue to lead this program with transparency, accountability, and discipline.

Thank you and I look forward to your questions.

Senator DURBIN. Thanks, General.

And we will do 5-minute rounds of questions here. We have, obviously, a great interest within the committee.

Let us concede a few points that have been made by everyone. First, America wants to have air superiority—period—over any possible enemy. Secondly, we owe it to the men and women who are fighting to defend this country to give them the very best that they can rely on to protect their own lives and to perform their missions capably and successfully. Third, we have a responsibility to the taxpayers in achieving that goal to make sure we do not waste their money in the process of developing an aircraft that meets those criteria.

Now, over 10 years ago, we had a competition for this aircraft. I believe the notion behind the Joint Strike Fighter was to finally try to harmonize the needs of our military within the Services based on a similar or likeminded platform that we were designing.

The question we have to ask ourselves today is what have we learned over the last 10 years plus in terms of the development of this aircraft. Mr. Kendall, you were pretty blunt at one point. You stated your disagreement with the decision that allowed the JSF to begin production before the first test flight even occurred. You called it "acquisition malpractice." The decision made by your predecessors resulted in the severe concurrency that the program continues to experience today, almost 12 years later.

As the Under Secretary of Defense for Acquisition, you are responsible for establishing the Department's acquisition rules and regulations. What have we learned? What would you do to limit concurrency in not only programs under your purview today but future programs that we might consider?

CONCURRENCY

Mr. KENDALL. Thank you, Mr. Chairman. I was going to bring up that quote if you did not. It is the one that I think I most often associated with.

When I first saw the schedule for the F–35, I was surprised. I had not seen a program with that degree of concurrency in my past experience. I talked to some of the people who were involved——

Senator DURBIN. Excuse me a second. Can you step back a second and define "concurrency" in terms that the layman would understand for the record?

Mr. KENDALL. It is not unusual in any development program, as you come towards the latter phases of the development program, to start the production process. The key to doing that successfully is that you have design stability, that you do not expect to find anything in the test program, the balance of the test program, or any additional software development that you may be doing that

will substantially change the design and change the manufacturing process, change the tooling, force you to go back and modify some of the product you have already made.

The reason to do that, of course, is that you want to get the product into the field as soon as you can. And there are some efficiencies associated with making that transition earlier. Sometimes it is threat-driven. Sometimes there is a lot of urgency about getting the capability out because of the threat. So it is a judgment call as to how much overlap you have between the development phase of the program, particularly the testing phase, and the actual start of production.

Historically for something like a new aircraft, a sophisticated, new, cutting-edge design, we would be a year or two into test flight before we started production. We did a much more aggressive approach on the F–35. And my understanding is that people felt at the time that the modeling and simulation, that our design tools were much more sophisticated, and that we would not see a lot of problems and find them through the test program. That was wishful thinking, frankly. It kind of flies in the face of all of our prior experience.

I am going to read to you from the guidance. You asked me about policy. I brought with me the draft policy that is in staffing right now, and it specifically addresses concurrency. I will tell you what it says.

In most programs for hardware-intensive products, there will be some degree of concurrency between initial production and the completion of developmental testing, and perhaps some design and development work, particularly completion of software, that will be scheduled to occur after the production decision is made. Concurrency between development and production can reduce the lead time to field the system, but it also can increase the risk of design changes and costly retrofits after production has started.

Program planners and decision authorities should determine the acceptable or desirable degree of concurrency based on a range of factors. In general, however, there should be a reasonable expectation based on developmental testing of full-scale prototypes that the design is stable and will not be subject to significant changes following the decision to enter production. At milestone B, which is our development decision point, the specific "typically event-based" criteria for initiating production or fielding at milestone C, the production decision point, will be determined and included in the decision memorandum that is published at that time.

So we want an event-based decision to enter production based on actual demonstration through developmental testing, primarily that the product is mature enough that we can go into production with reasonable risk. That is the criteria.

Again, I think in the case of the F–35, there was a combination of factors. Part of it, frankly, was that the money was sitting there in the budget for production and people had a sense of momentum about getting production started because the money was sitting there. I resisted making that kind of decision in my position. We should not be driven by the fact that there happens to be some money sitting in the budget.

CONTRACTOR INCENTIVES

Senator DURBIN. So let me ask you. One is a theory and approach to acquisition and the other is the incentive that we created. And you have just identified it. There was money sitting there to produce, and there was the yearning urge to acquire that taxpayers' dollar maybe too quickly, which does not sound to me like a sound decision, and I think what you identified is your own personal decision not to fall into that trap.

I would like to ask you when it comes to something that is characterized as UCA—I will try to pronounce this—undefinitized contractual action, a contractor performing work under a UCA is not incentivized to control cost because all of the actual cost incurred while under a UCA get rolled into the final negotiating costs recovered by the Government. That sounds like a similar situation where we are creating an incentive to produce, not to produce in a timely fashion or in the best fashion, but in a fashion that spends the money that we have appropriated.

What would be your comment on that?

Mr. KENDALL. Chairman, I have given other testimony where I have talked about the pressures in our system, the incentives to be optimistic, to take risk. And it runs throughout our whole system. And anyone who has ever held a position like mine has, to some degree, had to kind of resist those pressures.

If you look at the desire of the operational community to have the best possible capability—so there is a tendency to have optimism in terms of the requirements and what we can accomplish. Industry is interested in selling. So they tend to be optimistic about what can be produced, what kind of capability can be built. When budgeteers put together their budgets, they tend to be optimistic about how much you can get for the money because they want to get as much as possible into the budget. When people bid on projects, they tend to be optimistic because they want to win the business, and the way to bid a little more aggressively and hope that you can execute. It ripples all the way through our system. Essentially one of the things we have to do to keep our risk under control, frankly, is to kind of push back against that.

Now, you mentioned UCAs. UCAs, undefinitized contract actions, are essentially situations where we have not completely defined the job to be done, and we have not reached a complete agreement with the contractor about exactly what that job will be and what it will cost us. So we start contract activities with the idea that after we have started, we will go back and we will clean it up. We will complete the definition of the contract. We will definitize, if you will, the contract action.

UNDEFINITIZED CONTRACTUAL ACTIONS

The data is pretty clear on this. In development in particular, that leads to problems. It leads to difficulties further downstream. If you look at the history of our programs and our cost overruns—and I am going to be publishing some data on this—UCAs in development consistently result in cost and schedule overruns later. And it is because, frankly, the job has not been well enough defined on

the Government part, the contractor is not ready to build it, there is still openness for optimism that has not been refined yet.

The other problem with the UCA is that you give up a lot of your negotiation leverage once you sign that contract. And I resist them. There are rare occasions when we can do them.

Now, interestingly, the data on production contracts that are started with an undefinitized contract action is not nearly as negative. The problem is primarily on the development side of the house. So as a general matter, we resist doing them. There are rare occasions where we really need to get the work started. If we are doing something that is an urgent operational requirement, for example, it makes more sense to get the work started. People are going to be dying if you do not get that product out, and you want to get it out quickly and you take some risk and you may spend some more money as a result of that. But you get the product out quicker because of it.

Senator DURBIN. Based on your testimony, it sounds like the enemy is optimism, and I do not know that we want to be pessimistic when we get into this.

Mr. KENDALL. We want to be realistic and pragmatic, Mr. Chairman.

Senator DURBIN. Realistic. Thank you.

Senator Cochran.

Senator COCHRAN. Mr. Chairman, we appreciate very much having the cooperation of this distinguished panel of witnesses. I have a few questions.

General Welsh, the major challenge before us in this year is trying to avoid budget decisions that compromise our capabilities that are needed by the U.S. and our allies to look down the road 10 to 15 years to assess the threats that will exist then and then making decisions now that help meet those needs and capabilities.

How do you apply that theory to actual practice? Are we making progress in meeting the challenge?

ASSESSING FUTURE MILITARY THREATS

General WELSH. Vice Chairman, the biggest problem we have that Mr. Kendall mentioned is optimism, and I think he is exactly right, by the way. When you are looking at the military threat of the future, we also tend to be pessimistic so we assume the future threat is 10 feet tall, all-capable, all-knowing, and almost impossible to defeat. And so we need absolutely the best things money can buy and massive quantities to be able to fight that war. So we have to fight that tendency when we look at the future threat.

In the Air Force, we have looked very closely at the future threat to assess whether it is for conducting the air superiority mission or it is doing a global strike mission or it is supporting ground activity, close air support or indirect strike. As we look at that threat, no matter how you examine it, when fifth generation aircraft become available to our adversaries, when advanced SAM systems like the S–300 become available to our adversaries, when they are able to integrate and train with those systems, the difference between fourth generation and fifth generation fighters becomes starkly clear. And the reality is, without talking about how many you need, just on a pure capability perspective, if a fourth genera-

tion fighter meets a fifth generation fighter, the fourth generation fighter may be more efficient, but it will be dead. It really is that simple.

And so we need to determine when do we need this high-end capability, how much of it do we need, and then how do we mix it with a fourth generation capability that we will have in our fleet for years. We are going to have a mix of aircraft for a long time, and some missions will be better suited to the legacy fleet that will have a little bit lower operating cost and some will be better suited to the high-end fleet that will have to fight the highly contested, determined foe in a full-spectrum fight. You have to have the fifth generation capability to succeed in the air fight. And that is after a pretty comprehensive analysis of the threat that we intend to face.

Senator COCHRAN. Given the expectation of increased F–35 costs and inevitable production delays, is it still true or is it time to start looking at investment in alternatives, as well as continued commitment to the F–35 program?

F–35 PRODUCTION COSTS

General WELSH. Sir, I will give you a brief answer and then see if Mr. Kendall or General Bogdan would like to comment on the actual production costs. My view is that the Program Office and the company, the contractors, understand what it takes to build this airplane now. I believe we have those costs pretty well captured.

The big costs that we are most focused on now are the operation and sustainment costs over time. What does it cost to manage this fleet, to operate this fleet, to repair the fleet, to supply the fleet? The Program Office is leading a number of initiatives supported by all the Services represented here who are working very hard to try and drive those costs down, and I believe General Bogdan can give you some good examples of early success in that effort. But this has to be an ongoing, continuous effort.

One of the benefits we have and kind of a strange side benefit of the concurrency problem the Chairman described is that we actually have actual numbers now maybe earlier in the program than we would otherwise. So we are starting to replace projected costs with actual costs, and as we continue to fly more hours, we will have a better feel for what it really costs to maintain this airplane. But that is clearly the focus.

That will drive us to consider mixed fleets for a long time into the future. All of us will continue to have them for a while, and the investment strategies in the future have to consider options for continuing down that vein.

Senator COCHRAN. Thank you, Mr. Chairman.

Senator DURBIN. Thanks, Senator Cochran.

Senator Reed.

Senator REED. Well, thank you, Mr. Chairman.

Let me first commend Secretary Kendall for his decisive intervention in the program, and also for his candor in warning us that we still have some real serious challenges ahead. We are not there yet.

REWORK COST

Let me ask a specific question about the rework cost. You have noted that the cost per unit seems to be coming down. Does that exclude or include rework cost?

Mr. KENDALL. Yes, sir. The cost of production, the basic production, is coming down roughly with the curve that we expected it to come down on.

The cost of retrofit, of concurrency changes is also coming in—about 25 percent I believe—less than our predictions had indicated. So we are making progress on that as well.

I mentioned that in Lot 5 we started sharing those concurrency costs with Lockheed. They started absorbing some of that risk. And we did that for two reasons. One was to focus their attention on this more and in part to get the concurrency changes into the design as quickly as possible. And we have made some pretty substantial progress on that as well. So at this point in time, we are reasonably encouraged.

Now, of course, as we go through the test program, we are discovering more and more of the things that have to be fixed, and we do see that list of things that have to be changed. So as time goes on, we hope that that will come down and we have projection that suggests that within the next few years that will be well under control.

Chris, do you want to add to that?

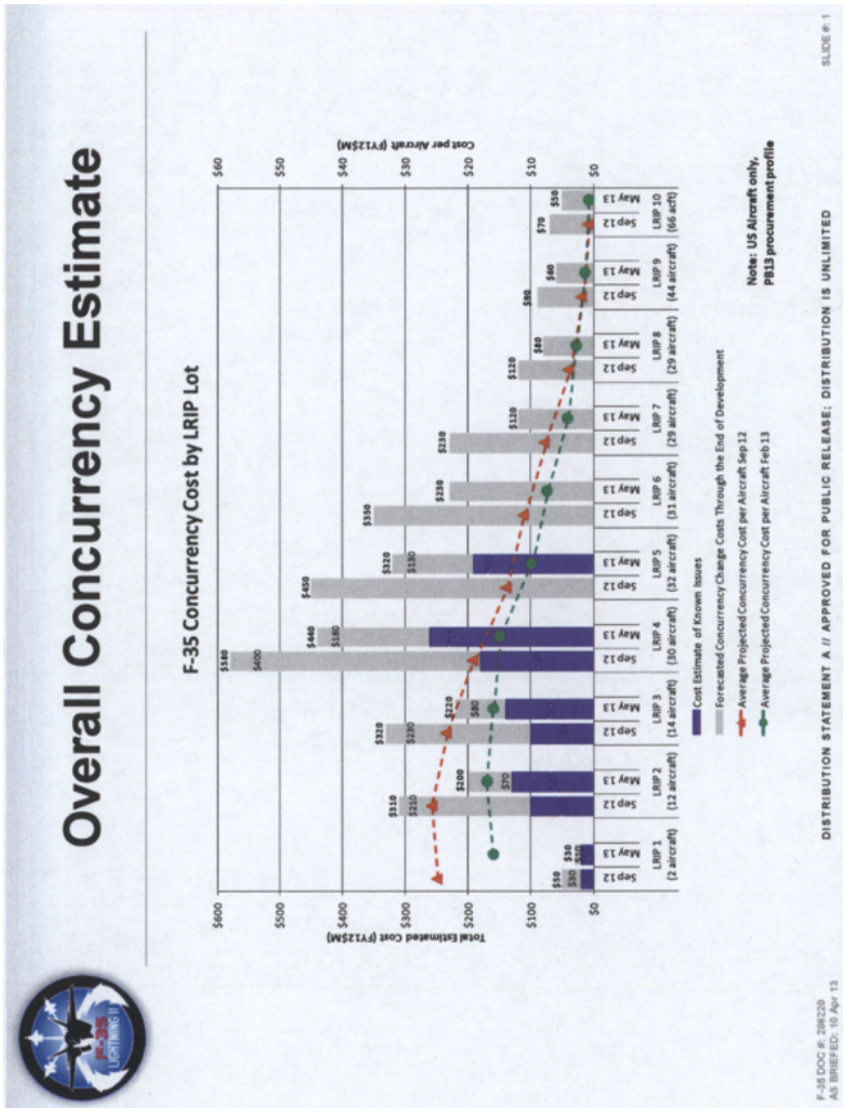
General BOGDAN. Yes, sir. When I talk about the price of the airplane coming down and I talk about the unit fly-away cost or the URF of the airplane, it does indeed include the calculations and the dollars for concurrency, retrofitting airplanes that came off the production line that were not corrected, as well as putting those fixes back into the production line. So our curves and our cost models include an estimate for that concurrency, sir.

Senator REED. So you are estimating, going forward, that the rework trend is down, and given potential issues with software, you do not anticipate at this point that that curve will bend back up and you will have another problem.

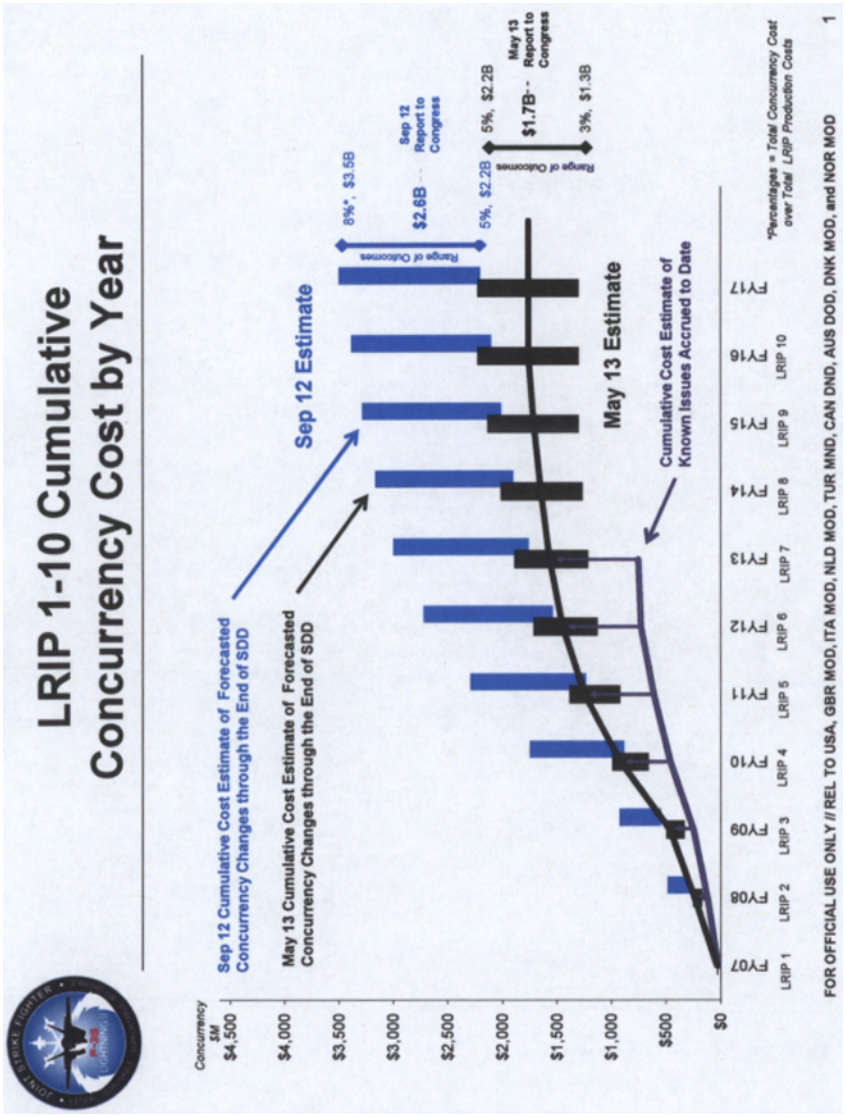
General BOGDAN. Sir, the small good news there is both our estimates have come down about 25 percent, looking to the future on how many fixes we are going to have to make to the airplanes, and the actual cost of making those retrofit fixes and getting the fixes back into the production line are also down about 25 percent. So if you take both of those together, our initial estimates of concurrency cost back 3 or 4 or 5 years ago are probably on the order of about 50 percent lower now in both the estimating and the actual costs. And I can provide the committee that information to show you that.

[The information follows:]

The "Second Report to Congress on F–35 Concurrency Costs: House Report 112–331, Conference Report to Accompany H.R. 2055," dated May 2013, contains the chart below and shows that estimates of concurrency costs have been reduced approximately 32 percent between the fiscal year 2012 and the fiscal year 2013 estimate.



The original estimates for concurrency were identified as approximately 5–8 percent of the overall production costs through System Development and Demonstration completion. Since that initial estimate, more precise estimating techniques, along with an overall reduction in the number of problems driving concurrency changes than had originally been expected, have put the current cost of concurrency to 3–5 percent of the overall production costs as indicated by the chart below.



Senator REED. Thank you.

FIRM REQUIREMENTS

Secretary Kendall, one final question to you. One way we manage cost of the weapons systems is changing requirements. Do you anticipate or is that being discussed in terms of managing this cost going forward, given limited budgets?

Mr. KENDALL. Senator Reed, the requirements—we have 35—I think are firm at this point. One thing we will have to do is respond to advances in the threats as they occur. So there is some follow-on development planned already, and we have asked for some funds for that to start some of the early design work to respond to threats that are just emerging. This is not a world in which things stand still. The threat constantly evolves, and we have to stay ahead of it.

I want to go back and just mention a couple things on the possibility of increased cost going forward.

As we go through the test program, we are retiring risk, but the areas where we would be most concerned are in some kind of a major structural failure. We have done roughly one lifetime of fatigue testing on the aircraft. So we have two more of those to go. As we go through that, the likelihood of a major structural failure that would cause a significant redesign goes down, but it is not zero yet.

The same is true of the aerodynamic performance. If there were some aerodynamic performance major problem that would emerge as we explore the extremes of the flight envelope, that might cause a significant problem and some redesign work. So far, we do not see a high likelihood of either of those things, but they are still possibilities.

CYBER THREATS

Senator REED. Let me ask a final question and this goes to an issue that you are looking ahead to emerging threats. Are you confident that you have the systems in place to prevent the cyber aspects of the aircraft from being compromised and confident that at this point they are not?

Mr. KENDALL. I am reasonably confident—and Chris should answer this as well—that our classified information is well protected. I am not at all confident that our unclassified information is as well protected. Now, it is unclassified because it is not as sensitive or important, but I am concerned in general with the loss of design information that is at the unclassified sensitive level, and I am going to be putting some policies in place to try to make stronger sanctions, if you will, or stronger consequences for our contractors who do not protect that information well enough. Part of that is being stolen right now, and it is a major problem for us.

Senator REED. And does that increase the vulnerability of the aircraft right now that we can anticipate?

Mr. KENDALL. What it does is reduce the cost and lead time of our adversaries to doing their own designs. So it gives away a substantial advantage. So it is not as much a specific vulnerability. It is the amount of time and effort they are going to have to put in to getting their next design and staying with us.

Now, as you are probably well aware, at least two nations are well into developing fifth generation aircraft right now. So that is a concern.

Senator REED. Thank you, Mr. Chairman.

Senator DURBIN. Thanks, Senator Reed.

Senator Shelby.

Senator SHELBY. Thank you, Mr. Chairman.

I thank all of you for your service.

General Welsh, as I sit up here with this subcommittee, a part of the Appropriations Committee, a big part, we have to make sound money decisions. Most of us, I believe, believe air superiority is very important, as you referenced earlier. We have had that a long time, since the Second World War.

My thought about the whole plane: One, is the aircraft—is the concept sound? Will it work? Have you worked out the technical glitches, most of them? Most planes and most weapons systems will have technical glitches, some more than others. And ultimately, this committee has got to balance the need to how much we can afford.

I believe myself that we should be on the cutting edge of technology. We should be smart in what we do and how we do it. I believe, from what I know—and we are not in a closed hearing, but this plane has got a lot of stuff, potential which you cannot talk about here today.

But what and how do we bring the cost down? Economies of scale. We know that. The more you produce of something, we got to do this. That is going to be one of the money decisions we have to make. One, do we need this plane? I think we do. Second, can we afford this plane and how do we afford it?

AFFORDABILITY OF THE F–35

Do you want to talk about that a minute?

General WELSH. Thank you, Senator.

I agree we need the airplane. Can we afford the airplane is the question facing not just the committee but us as well.

Senator SHELBY. The American people.

General WELSH. Yes, sir.

Senator SHELBY. Can we afford not to do it?

General WELSH. Well, I do not think so because there is no other option right now.

What we are asked to do is pretty well defined by our national guidance and by our Defense Strategic Guidance. And based on that requirement that is handed to our Services in the air domain, this airplane is something that we need to meet the mission we have been assigned. If the mission changed dramatically, if there was no intent to be worried about threats from other technology that develops in the future, if there was not a requirement for the United States of America to be able to protect its national interest against those threats, we would not need the airplane. But that is not the case.

And so everything we are focused on right now is making sure this airplane is operationally feasible. The Program Office works that every single day. They focus on the cost of development, the

production, and the sustainment over time and how do we drive those costs down. The Services help them in that effort.

From the Services' perspective, we are both helping with a developmental and operational test and we are actually training air crews now. In the Air Force, we have 22 airplanes. Some of those are at Eglin Air Force Base, Florida flying right now. Of those aircraft, we have trained 23 new pilots on the F–35 over this year. We have flown about 2,200–2,300 sorties and about 3,500 flying hours now. The airplane works. The pilots will tell you it is a "great jet" that the avionics are—here is a quote from the squadron commander at Eglin—"light years ahead of legacy fighters in our military." And so they believe this program is moving forward.

They are still frustrated by some of the things that keep them from fully utilizing the aircraft, but a lot of that is the function of the concurrency that Mr. Kendall described. They cannot fly within 25 miles of lightning. They cannot fly in the weather yet. That is going to require software development that is due and is on track to be delivered. By the time we reach our initial operational capability at the end of 2016 for the Air Force, those problems will be in the past.

Senator SHELBY. Will this plane, as far as you see, have any peer in the world?

General WELSH. The F–22 will be a peer, but that will be the only one.

AFFORDABILITY

Senator SHELBY. Secretary Kendall, you have to make decisions on acquisition, and that gets into the affordability. Do you want to speak to the affordability again? Economy of scale—I understand that. And the cost you have brought down. I understand that.

Mr. KENDALL. One of the initiatives that Dr. Carter, when he was Under Secretary, and I started was to put affordability caps on all of our programs as they come through the process. And the idea of that is to ensure that our reach does not exceed our grasp. And what we require programs to do now is to do an analysis of likely future budgets that would be expected and to look at the portfolio of products that the new product would be in and to determine a reasonable amount of money that could be spent on the product. And from that, we derive a cost cap for the production, unit production cost, and for sustainment costs for the program. Now, obviously, F–35 was many years into development before we started this policy. We are doing that now routinely.

As far as the F–35 itself is concerned, it is an affordable program. It is affordable in part because of its priority. It is our number one priority conventional warfare program, and we will find a way to afford it. I mean, 10, 20, 30, 40 years down the road, there may be a question about how many we actually end up and how large our force structure is, but I do not think there is any question at this point in time that we need the program, that we can afford it within our budget, and that we need to get production up to a rate that is more economical as soon as we can.

Senator SHELBY. Are you still concerned about any of the technical glitches dealing with the Services, the Navy, the Marines, and Air Force?

TECHNICAL ISSUES

Mr. KENDALL. As General Bogdan mentioned, there are a number of technical issues that will be resolved. The tail hook was mentioned by Admiral Greenert. That will be in testing shortly in the next few months. The helmet is still being worked on. At this point in time, I would say the helmet was kind of on the edge of acceptable. It needs to be better. The software that was mentioned—we need to get that. Software is largely a matter of time and money, but some of the 3F capabilities are very important to the acceptable performance of this aircraft, and we need to get them even though we can IOC potentially without them. So there are a number of things that have to be done. Lightning strike was mentioned as another one we are working on.

These are all things that we are working our way through in the development program and resolving over time. We have made a lot of progress in the last couple of years, and I do not see anything at this point in time that is going to keep us from getting the airplane to where we need it to be.

Senator SHELBY. Thank you, Mr. Chairman.

Senator DURBIN. Thank you, Senator Shelby.

Senator Collins.

Senator COLLINS. Thank you, Mr. Chairman.

Secretary Kendall, from its inception the F–35 was designed to be an international program, and indeed, we have formal, binding agreements with several of our allies such as Great Britain, Australia. I believe the Israelis have agreed to purchase some F–35s. Could you comment on what value it brings to have international partners involved in this program from the beginning, and also, what cost savings to the American taxpayers are produced by these international agreements?

INTERNATIONAL PARTNERS

Mr. KENDALL. Thank you, Senator Collins.

There are several aspects of having the international involvement that are beneficial. First is obviously their direct contribution to the development cost. Our eight original partners have all made some contribution to development.

There are obviously economies of scale associated with higher production rates. Right now, we expect several hundred aircraft to be bought by our partners, and this makes a difference of—of course, I do not know the exact number, but it is 10 to 15 percent, I think, in unit cost.

General BOGDAN. Almost 20 percent.

Mr. KENDALL. Almost 20 percent difference in unit cost.

Now, interestingly, we just had our annual meeting with all of our partners, all of my counterparts, and reviewed the program with them. They are all encouraged by the progress on the program. They are all still in the program, which I think says something. Canada is still considering its decision, and I think the Netherlands has not made a final decision. And even though, because of budget constraints and other things, some of them have reduced their numbers, they all see the value in the F–35 and are all, at this point in time, still in the program.

In addition, we are starting some foreign military sales.

So there is something of a consensus that this is the future of tactical aviation internationally.

Senator COLLINS. Thank you.

General Welsh, this morning you described the F–35 as a fifth generation aircraft, and we hear that term all the time from you and from other military officials and experts. I know that one of the characteristics that you are referring to is the aircraft's stealth capabilities.

You share a responsibility to build a force that can operate effectively in an anti-access environment. We know that Russia and China are developing advanced stealth fighters. We know that some of our potential adversaries have advanced integrated air defense systems as well.

To the extent that you can in open session, could you describe more fully for this committee what exactly it means that the F–35 is a fifth generation fighter and how that technology helps us counter emerging threats?

General WELSH. Thanks, Senator. That is a fantastic question actually.

I would put it this way. The emerging threat essentially means it is more integrated, it has longer range, and it connects quicker to things like sensors and things that can shoot you down if you are flying in an airplane and prevent you from completing your mission or getting access to a target. What the fifth generation capability does with a combination of the stealth signature that makes it more difficult for radars or different types to track you, with electronic protection, self-contained electronic attack capability against those radars with the ability to move quickly through a threat environment, with the ability to maneuver to evade enemy threats that are launched at you. It significantly breaks kill chains, if that makes sense. So a kill chain, from the time they first see you and pass off your data on your airplane to a system that is going to try and intercept you, whether it is an air system or it is a ground system—that kill chain is required to be completely intact for someone to keep you from preventing your mission.

Fifth generation technology allows you to break that kill chain at multiple places and allows you to operate in an environment you could not operate in a fourth generation aircraft because the kill chain would not be disrupted that way. That is what it does for you whether you are competing against a single airplane or you are competing against a system on the ground. It allows us to operate in places we could not before and complete the mission we have been assigned.

Senator COLLINS. Thank you. That is very helpful.

Thank you, Mr. Chairman.

Senator DURBIN. Thanks, Senator Collins.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

And good morning, gentlemen. Thank you for being here this morning. Thank you for your service.

General Welsh, as you might expect, my comments or questions today will deal largely with Eielson and the role that future

OCONUS (outside the continental United States) basing of the F–35 might play in Eielson's future.

For the benefit of my colleagues here on the subcommittee, back in February 2012, General Welsh's predecessor announced that the Air Force planned to transfer an F–16 squadron from Eielson down to Elmendorf Air Force Base. It would downsize Eielson by the order of about two-thirds of its Active Duty personnel and all done by 2015. The Air Force has informed us that they intend to make a decision this fall following completion of an environmental impact statement (EIS) and a strategic analysis.

This would have a devastating impact on the economy of the Fairbanks and the interior region. The direct and indirect job loss is estimated at over 3,000 individuals. Unemployment would rise from where we are now at 6.2 percent to an unacceptable level of 8.9 percent, lay off teachers, close schools, a tough, tough situation. Of course, we are not in a base realignment and closure (BRAC) environment. I have described this as a back door BRAC.

And it probably comes as no surprise that I, along with the other members of the Alaska delegation, have requested that the Air Force be prohibited from implementing its proposal for Eielson in 2014.

Back in 2008, the Air Force announced to the Fairbanks community in writing the start of an environmental scoping process for possible basing of the F–35 there at Eielson, and then in 2009, we came to learn that the scoping process never occurred but we were promised at that time that Eielson was either at or near the top of the list of possible OCONUS basing of the F–35. So we were then told that there was going to be an announcement that would be made shortly on OCONUS bases. That never came.

Can you tell me, General Welsh, what thoughts, if any, the Air Force has on the desirability of Eielson as an F–35 basing location, what kind of timeframe you are looking at for OCONUS F–35 basing, and then also whether or not the Air Force's immediate decision on downsizing Eielson will be affected by possible F–35 basing at some point in the future?

OCONUS F–35 BASING

General WELSH. Yes, Senator. The Secretary and I just reviewed earlier this week the proposed criteria for our overseas CONUS base selection process for the F–35. There is a little more work to be done on that to make sure we have the criteria firmly established and clearly coordinated with U.S. Pacific Command, U.S. European Command, and Pacific Air Forces (PACAF) and United States Air Force in Europe (USAFE). That process is ongoing. I would suspect by the end of this month those criteria will be firmly established and we will start to evaluate all of the potential bases in both Europe and the Pacific.

In the Pacific, Eielson is one of the bases. As you know, Alaska—it will be part of the Pacific basing for overseas basing for the Pacific. Eielson is one of the bases on the list to be examined. And so we will take a look at every base relative to these criteria and sometime this fall—my guess is late October—we will produce a preferred and a reasonable alternative listing that will be fully briefed to the Congress.

I will tell you this, Senator. I am looking forward to my visit to Eielson here in about a month or month and a half to meet with the community there and hear their concerns directly. And as you mentioned, we are completing the environmental impact statement and we are still on the same timeline to make a recommendation to the Secretary this fall.

Senator MURKOWSKI. Let me ask then about the EIS. Some of the particular criticism that I have heard, which you should be prepared for when you go up north—I understand that the Air Force is simultaneously proceeding to complete the EIS and the strategic analysis. The public will have an opportunity, apparently, to comment on the EIS draft but not on the strategic analysis. And I am not quite sure why it is set up that way. It does not seem to make sense to me. An EIS is designed to inform the decisionmakers on the range of alternatives to a proposed action. So it seems logical to me that you would have the strategic analysis precede the EIS and then inform from there.

So I guess the question to you would be whether or not you could leave this draft EIS comment period open until the strategic analysis is done and also to invite comments then on the strategic analysis as well, whether or not you would consider that.

General WELSH. Senator, the path ahead that the Secretary laid out for us was for us to take a look at the EIS. The strategic analysis I believe you are referring to is the one that will be conducted by the Pacific Air Force's Commander, General Carlisle and his team. And when he has completed that analysis—and it is an operational analysis. It is an assessment of the inputs from the EIS. It is to look at costing. It is to look at all the things you and I both hope are in the discussion. And then he will come forward to the Secretary with a recommendation. I am not sure keeping that available for public comment, as he completes his recommendation, would be helpful to his process. I think public comment has been pretty clear in the EIS, and that is going to be factored in to everything he says. You, of course, will see the results of any analysis he does.

Senator MURKOWSKI. And I just might add that the concerns that I am hearing from those who weighed in and gave that public comment is that they do not feel that they have been heard on it. So it will be something that you will hear when you go up north. So it may be something that you and your folks might want to give an extra look at, and I would appreciate that. I look forward to your visit.

Thank you, Mr. Chairman.

Senator DURBIN. Thank you, Senator Murkowski.

LARGE ACQUISITION PROGRAMS

Let me ask you this, Mr. Kendall. I have listened to your earlier testimony, and I am trying to draw some analogies which may or may not be accurate in my mind. In the financial industry, we have this phrase "too big to fail." And I am wondering if this project is so large in scope that it was too big to cancel, that it had to continue apace because of international partners, fifth generation demands. Have we reached a point, when it comes to acquisitions in the future, that we have to take this into consideration?

Mr. KENDALL. Mr. Chairman, I do not think any program in the Department is too big to fail just as a matter of principle.

As a practical matter for the F–35, we are not at a place where we would consider stopping the program. I think General Welsh mentioned that. We are most of the way through development. The costs, I think, are under control, at least for production. We are trying to bring the costs of sustainment down. There is no question that the threat is driving us towards the next generation of aircraft. Our fourth generation aircraft are not going to be survivable on the future battlefields. To start over, to go back 10–20 years and to invest $20 billion or $30 billion in development of another aircraft and replacement of the F–35 just does not make any sense.

SUSTAINMENT

Senator DURBIN. So let me go to the one particular that you mentioned: Sustainment. It is my understanding that the cost of flying the Air Force variant of the F–35 is 28 percent greater than sustaining the F–16. And a report that came out in 2012, the JSF Selected Acquisition Report, estimates the cost to sustain the fleet of JSF's over a 30-year life is $1.1 trillion, which equates over a 30-year period of time to $36 billion a year, which is a substantial sum of money by our calculations, by anyone's calculations.

It is my understanding that one of the best ways to reduce sustainment costs is to address them very early in the program, and it appears that did not happen as it should have in this program. So what actions are we taking now to deal with these anticipated sustainment costs?

Mr. KENDALL. Chairman, I would just point out to you that is, I believe, an inflated number over about 50 years. So it covers a lot of time and a lot of inflated costs. It is still a very big number and we need to do everything we can to drive it down. There is a long list of things. I think in our written testimony we go through some of those.

But the keys include looking very creatively at the things we do in sustainment to see if there are more efficient ways to do them and also bringing in competition. We are not going to leave this sole source in the hands of one provider. We are going to go out and bring in competition and use that to drive the costs down.

We also have an initiative in the Department to use what is called performance-based logistics. It is a business approach where people essentially provide a level of reliability to us and get incentives to do that and provide it to us at lower and lower cost.

So there are a number of things that can be done. I am going to let General Bogdan answer. He has got a long list of things that we are doing.

Admiral Venlet, who was General Bogdan's predecessor, has also attacked this problem. So we are not just starting on this. You can, I think, argue that we started this too late. We should have done it a little bit earlier, but we are certainly giving it our full attention now.

Senator DURBIN. General Bogdan.

General BOGDAN. Sir, there are primarily three areas that I am taking action on right now to try and reduce the costs.

The first area, as Mr. Kendall said, was there are different portions of the sustainment lifecycle of the airplane that we, over the next few years, will compete. For example, support equipment on this program is well known. We know where the support equipment needs to come from. We know what it is designed like. There is no reason in the world why I need to buy the support equipment for this airplane from a single supplier who actually just goes out and contracts with many other suppliers to buy that. So we will compete that type of thing.

Another example is on the global supply chain. We will have airplanes all over the world in the next 10 or 15 years. There is no reason to believe that a prime contractor whose niche is building and manufacturing airplanes could be or should be a world-class global supply chain expert. There are other companies out there that can do that, and we will explore those kinds of options. So competition is one piece.

There is a second piece that we are working on very aggressively. That is what we call our reliability and maintainability program. Until a few years ago, this was an airplane on paper. We did not have airplanes flying. Today we have over 7,000 hours under our belt and over 5,000 sorties. The information that I am gaining from flying those airplanes today is invaluable. I can show you a list of the 50 top parts on the airplane that are breaking more readily than we thought they would. I can show you the 50 parts on the airplane that are taking longer to repair than they should. By systematically looking at a reliability and maintainability program where we attack those problems by either redesigning the parts or finding a second supplier or finding a way to better repair those parts organically, say, by standing up your depots, you can begin to attack the reliability and maintainability of the program. We could not do that a number of years ago because we did not have any real data. We have a lot of that data now. So we are doing that.

The third piece is that $1.1 trillion estimate that you talked about has an awful lot of assumptions in it that those three gentlemen at the other end of the table have a lot to do with in terms of how many hours does each pilot need to fly relative to getting training in a simulator. How many maintainers do I really need on the flight line to launch this airplane?

Those kinds of assumptions, which we put in place many, many years ago, that came up with this $1.1 trillion number are now being relooked at because we know more about the airplane. And with their advice and with their assumptions, we will go back in and now relook at the CONOPS, or the concept of operations, for maintaining and sustaining the airplane and adjust those numbers. I personally think you will see over the next few years those numbers coming down, sir.

Senator DURBIN. Thank you very much.

Senator Cochran, any follow-up?

Senator COCHRAN. Mr. Chairman, I have one follow-up question.

F–35 OPERATIONS AND MAINTENANCE COSTS

General Paxton, the Commandant of the Marine Corps, General Amos, has indicated the Marines expect to save up to $1 billion per

year in operations and maintenance cost by having one type of tactical aircraft in inventory, and that billions of dollars have already been saved over the last decade by not recapitalizing the Marine Corps with fourth generation aircraft and waiting to recapitalize with the F–35.

Given increased F–35 costs and production delays, is this still true, or is it time to start looking at alternatives, as well as continued commitment to the F–35 program?

General PAXTON. Thank you, Senator Cochran.

I believe the basic premise of the Commandant's previous statement and then when you connect it to the comments that General Bogdan and Mr. Kendall just made—the basic premise of cost and affordability is true. It is coming down, and as we actually have more flight hours and more sorties and more reliability of the data, we have a better ability to predict the actual fly-away costs, as well as the cost per flight hour for the aircraft.

I come at this a little differently as opposed to the gentlemen at the other end of the table who are either technicians or aviators. I am a grunt. I am an infantry guy. So when I look at the program and the viability and the value of the program, sir, I go back to the basic premise that we have three type model series that we are going to do away with, the F/A–18, the EA–6B, and the AV–8B. So there is an inherent cost savings in necking down the type model series.

In addition, as we get more reliability, as General Bogdan said, and we get actual facts from those hours and sorties, we have the capability of collapsing a little bit the maintenance that is done at the depot level, at the intermediate level, and at the organizational level. We actually have marines out there right now turning wrenches on things that we did not expect to happen this early in the program because we have been able to identify where some of those mean times between failure are and what they can actually do.

So I believe as the program gets more mature, a comment that General Welsh made earlier about the value of stability in the program—it is not an issue of too big to fail, sir. It is an issue of stability and using stability to create an advantage and turn risk into opportunity because I am confident we can bring the costs down on this. And then the bathtub that we are in where we have aging fourth generation legacy aircraft—we will be out of there, and then we will be into a fifth generation aircraft that we can optimize and use around the world in many more places to do many more things.

Thank you, Senator.

Senator COCHRAN. Thank you very much.

Senator DURBIN. Senator Shelby.

TECHNICAL CHALLENGES

Senator SHELBY. I want to go back, if I could, Secretary Kendall, to the technical challenges because General Bogdan alluded to some of them just a minute ago.

What are, say, the top three technical challenges? Is it software, as it develops and will help you expand your envelope and so forth? Is it metal fatigue or problems with metal production, you know,

the failure of that? What is it? I am sure all of them have not been satisfied, but I feel technically they will.

Mr. KENDALL. I will give you my three and General Bogdan may have——

Senator SHELBY. Is that important——

Mr. KENDALL. It is. We have a list of things, obviously, that we are attacking.

The top three on my list would, first of all, be software and getting the software completed. The Block 3F capability is critical to the airplane. So we need to get that done. We will have to make some decisions as we get further along. We are about to do a critical design review for that software, and we will be looking at it very closely this fall.

The second thing on my list is the helmet. The cockpit of the airplane was designed around the concept of that helmet and the ability of the pilot to look through the structure of the airplane and to have all the things he needs in front of him in the visor of that helmet to operate effectively. There are a number of issues there that we have been working. As I mentioned earlier, we are kind of at the edge of acceptable, but we are not where we would like to be to get out of that. So that would be second.

The third thing is the thing that came up a moment ago. It is reliability. We are not where we need to be on reliability right now. And I think we can do better on that. We are lagging behind our own goals by a significant margin right now in terms of the reliability that we are actually seeing on the airplane. We need to improve that.

So those would be my top three, and I will let Chris add anything.

Senator SHELBY. General.

General BOGDAN. Sir, I would tell you software, software, software.

But realistically Mr. Kendall got it right. Software is number one on the list, and he talked about that.

Senator SHELBY. But the software, if I could—and correct me if I am wrong—expanding software, you know, software that people are thinking up and putting together, that would help you expand the envelope of the capability of this plane, would it not?

General BOGDAN. Absolutely, sir.

Senator SHELBY. It is key. Go ahead.

General BOGDAN. First of all, just to give you some perspective, the airplane itself has 10 million lines of software code in it. That is about five times more than any other airplane we have ever developed. And that is just on the airplane. The off-board systems, the maintenance system, the mission planning system, has another 10 million lines of code on it. So this is virtually a flying computer.

If you do not get the software right on this program, all of those things that General Welsh and the CNO and the Vice Commandant of the Marine Corps talked about are not going to work right. We have many sensors on the airplane and they all have to talk to each other to provide the pilot with the situational awareness he needs to go into those very high-threat environments. If you do not get the software talking right to those sensors, you will have a problem.

The good news there is over the last 2 years, we have made significant progress in the way we develop, test, and field software on this program. I am cautiously optimistic that in the future what we have learned over the last 2 years can be applied to the future, but that does not mean that we are out of the woods yet because the hardest part of the software development on this program still lies ahead of us in our Block 3, and that is where we attempt to take all the information from one's own airplane from another F–35 flying next to you and all the other sensors that we have in our arsenal and put that all together to give that pilot a picture.

Senator SHELBY. Do you believe you can do it?

General BOGDAN. I do, sir. And the reason why I believe that is—and I am cautiously optimistic—is because a lot of the foundation of what we need to do in 2016 and 2017 we are flight testing today. And it is working. It is not working perfectly, but there are no things that I look at in the future relative to software that I do not think we can overcome to be quite honest with you.

A couple years ago, I am not sure we could have said that on the program partly because we had not flight tested much of it. But we have 40 percent of the flight testing done now, and we are starting to learn a lot more.

One of the other things that Mr. Kendall did not mention that is always on my mind is the maintenance system on this airplane is a huge information technology system. We call it Acquisition Logistics Information System (ALIS). And what it does is it combines both the maintenance of the airplane, the supply chain for parts on the airplane, and the training for the maintainers and the pilots, and puts it all together. That system has great promise, but that system like any other complicated information system with software has got serious problems.

What we did over the last year, instead of keeping that logistics/maintenance system in that part of the development program organizationally, we pulled it back underneath our engineering team. So they are dedicating the same kind of software work that we use on the airplane to the maintenance system. I believe over the next 2 years—and you can hold me accountable for this—we will see great improvement in the ALIS system.

Senator SHELBY. General Welsh, do you have anything to add to that?

General WELSH. Senator, I am pretty confident because while it is not the same thing and it is not nearly as complex as doing it on the actual airplane, we have integrated this concept in the simulator, which has been working well for training for some time. Now, there are not as many lines of software code in the simulator, but the data integration concept works tremendously well. One pilot described it to me as if you are flying around in a 200-mile bubble of information. That is the concept behind the airplane. That is why the helmet is so important because that is how it is relayed to the pilot. Everything as a young fighter pilot, I grew up flying around thinking, "Boy, I sure wish I knew X; X is now available to somebody flying the F–35." It is displayed for you in a very easy-to-understand concept. The biggest problem for the pilots is figuring out how do you manage the info. That is what they are focusing their training on.

Senator SHELBY. Thank you, Mr. Chairman.

Senator DURBIN. Thanks, Senator Shelby. It was a good question and it, I think, puts in perspective what we are talking about here. Who could have imagined 12 years ago, when somebody said let us do a Joint Strike Fighter, what the evolving threat would be that we face today and will face in the future and what the evolving technology would be? We could not have dreamed we would be carrying these around in our pocket. Maybe they could have but I would not have. And we are dealing with that.

And it takes a sense of optimism, Mr. Secretary. I do not think that is a negative in every aspect. I think it is positive when it comes to our view as Americans facing challenges, meeting them head on, and conquering them. And despite some setbacks here, we are on the path now to the development of a plane that is going to make America safer.

Thank you for your testimony today. We are going to have the second panel come on now, and I will come by and say goodbye to you and thank you for your testimony.

Director of Operational Test and Evaluation, Michael Gilmore; from the GAO, Michael Sullivan; and from Brookings, Michael O'Hanlon will be the next panel.

We are going to welcome the second panel here once we get nametags switched. There we go.

Our first witness on the second panel is Director, Operational Test and Evaluation, the Honorable Michael Gilmore. Dr. Gilmore, please proceed. Your written statement will be part of the record and please proceed with your oral testimony.

STATEMENT OF HON. DR. J. MICHAEL GILMORE, DIRECTOR, OPERATIONAL TEST AND EVALUATION

Dr. GILMORE. All right. Thank you, Mr. Chairman, Senator Cochran, Senator Shelby.

I agree with the statements that were made by a number of the previous panel members that the program now is on a much sounder basis than it was back in 2009 preceding the Nunn-McCurdy review and the restructuring and the technical baseline review that actually extended—all those activities extended into 2011. They put the program on a much firmer basis by taking a hard-nosed look, a rigorous look at past program performance. And I am not talking about ancient programs; I am talking about programs like the F–22—what it took to make those planes operational; what were realistic assumptions about what kind of testing actually needed to be done; and what kind of, they are called, test points needed to be flown; what could modeling and simulation really tell you versus what you needed to have the aircraft itself tell you; how many aircraft did you actually need to do testing.

So we added a significant number of aircraft to conduct the test program. We added a substantial number of test points, not relying on modeling and simulation or unrealistic assumptions about so-called test efficiencies, which the Program Office, unfortunately, is beginning to talk about again.

And I also agree with the statements that were made by Lieutenant General Bogdan and Mr. Kendall that there are many important challenges that remain. In particular, the Block 3F software,

which is going to provide the most important combat capabilities, has yet to be flight tested. An earlier version of it is just beginning development.

What is the history of flight testing that software up to this point? Well, as I looked at the most recent data from the Program Office in preparation for this hearing, as of the end of May of this year, not all of the Block 1 test points had been completed. They were supposed to have been completed some time ago.

The Block 2A software flight test program was supposed to complete in February 2013 according to the integrated master schedule's version 7 that the Program Office is funded to. That did not occur. That flight testing did not finish at the end of February. And my estimate is that it could extend anywhere from January 2014 to August 2014.

Block 2B in integrated master schedule 7, was supposed to finish flight testing in May 2014. My current estimate, based on the pressures that I see building in the program, is that it will finish around December 2014.

Now, admittedly, these are not the multiple-year disconnects with reality that existed prior to 2009. These are 6 to 12 months in schedule slippage relative to the integrated master schedule to which the program is funded. So that is obviously an improvement. But it does demonstrate that as many of the previous panel members said, this is an extremely complex undertaking, and it is very difficult to project with any certainty, although we are doing a much better job of it than we had been, how long it will take to finish all of these complex developments and demonstrate through testing that they actually work.

Some of the previous panel members talked about 90 percent of the development being complete. Well, that depends upon how you define development. To me, the development is not complete until the military capabilities have actually been demonstrated through testing to work. Many of the panel members talked about development of the software being complete when it is actually available for the first time to be loaded into the aircraft. And what we are finding is that we discover a number of problems, many problems that require what is called regression testing and other testing to sort through and fix once we actually start the flight test program.

I would note that the PEO, Lieutenant General Bogdan, noted that the Block 2B software program is just a few weeks out of step with his current schedule. And that is true, but his current schedule is based upon a rebaselining that the program did back in November 2012 that added 31 weeks to the development program for the Block 2B software and subtracted 31 weeks from the flight test program. Now, that is a concern to me because what that means is the flight test program is undergoing an accordion like squeeze, and I am afraid that it may mean that some unrealistic assumptions are being made about flight test efficiencies.

And so I hope that that decision to increase the 31 weeks needed for development of the software, which was prudent based on what we have been seeing, but to then subtract 31 weeks from the flight test program so that the endpoint, the fleet release of the 2B software, stays there in 2015 consistent with needs for operational testing and IOC in the Marine Corps—I hope that is not a har-

binger of decisions that were made early in the last decade which yielded the need for the restructuring.

Finally, you mentioned a concern about how do we reduce risk, what lessons should we learn. Mr. Kendall mentioned that we needed much more rigorous developmental testing and that we should wait longer before we begin production. I mean, production in this program started before there was any flight testing at all, which was unprecedented in the history of aircraft development programs. And so that is about as concurrent as you can get. That is pretty much 100 percent concurrency. Obviously, that is a bad thing.

PREPARED STATEMENT

We need to have more rigorous developmental testing. We need to let that developmental testing proceed before we make production decisions. But let me also say that my experience with early operational assessments where we take versions of aircraft, tanks, other military equipment before a production decision is made, before a decision to go to low-rate initial production, put it in the hands of soldiers, sailors, airmen, and marines, let them tell us what the problems are that they see at that point, even though when we start low-rate initial production, we still have a ways to go in terms of developing all of the final capabilities, let the actual people who are going to have to use this equipment and rely on it tell us what the problems are that need to be urgently fixed before we ramp up to full-rate production.

Under law, we do the initial operational test just prior to full-rate production, but I see great value to doing these operational assessments prior to a decision to begin that low-rate initial production.

So I thank you and I look forward to your questions.

[The statement follows:]

PREPARED STATEMENT OF HON. DR. J. MICHAEL GILMORE

PROGRESS IN TESTING

Mr. Chairman, Senator Cochran, members of the committee, my testimony reviews the progress made in flight and ground testing over the past year and provides an update to my fiscal year 2012 annual report on the Joint Strike Fighter (JSF) program. Testing has been productive in allowing expansion of the aircraft's flight envelope (the conditions under which aircraft are permitted to fly) in flight sciences and in demonstration of the limited mission systems capabilities provided by early software versions. However, problems revealed by ongoing testing, particularly of mission systems, have required additional time and effort to resolve relative to the program's plans, and the most challenging portions of the flight envelope and mission systems capabilities are yet to be tested. Consequently, if no relief is provided to current limits on the cost and schedule for completing System Design and Development (SDD), it is possible all the military capability now associated with the Block 3F versions of JSF will not be provided for operational testing in 2018. Nonetheless, since the conclusion of the 2011 re-planning of JSF testing that yielded Integrated Master Schedule 7, which in turn followed the 2010 technical baseline review, flight testing has been planned and executed using a much more realistic set of assumptions for achieving progress than had been used previously. Overall, through the past year, the rate of flight test sorties has met or slightly exceeded the plan and the volume of test points attempted nearly conforms to that planned. The resources added in test aircraft, staffing, instrumentation, and support equipment have made this possible. However, there have also been challenges that have required the program to add testing, such as to diagnose discoveries that have occurred in all types of flight test, regression testing (to verify corrections to problems

did not create additional problems) of new mission systems and vehicle systems software, and investigations into unexpected shortcomings like that performed on the helmet mounted display system.

None of the analyses conducted to date, by the Program Office or discussed in this testimony, have accounted for the effects of sequestration. Reduced funding for test resources and infrastructure while the F–35 is in development—such as reductions or elimination of funding for the McKinley lab, the test chambers, and support aircraft—will only add to the pressure to either extend SDD or accept reductions in capability. Additionally, reductions in developmental testing, which I understand are being considered by the Program Office, without the appropriate matching reductions in capability, will not remedy this situation. This approach would likely result in significant discoveries in operational testing and cause the program to extend until the discoveries are diagnosed and remedied.

FLIGHT SCIENCES PROGRESS

Flight sciences testing in all three variants has focused on what is needed to provide the flight envelope expected for release of Block 2B capability to the Services in 2015, which will provide a limited subset of the combat capability planned for Block 3F. Testing has been underway to achieve air refueling capability, increase combat maneuverability by evaluating performance in high angle-of-attack regimes, perform weapons integration tests, and prepare for shipboard operations/suitability testing for the F–35B and F–35C.

The test centers were affected by two stop orders earlier this year. The F–35B fleet was grounded after the first British production aircraft, BK–1, experienced a fueldraulic line failure in the Short Take-off Vertical Landing (STOVL)-unique swivel nozzle at Eglin Air Force Base (AFB) on January 16, 2013. The cause was determined to be a poor manufacturing process used for the hoses, leading to crimping dimensions being out of specification; the stop order was lifted nearly 4 weeks later on February 11, 2013, allowing all F–35B flights to resume. The entire F–35 fleet was grounded on February 21, 2013, after a crack was discovered on February 19, 2013, in one of the third stage low-pressure turbine blades in the engine of AF–2, a flight sciences test aircraft at Edwards. The cause of the crack was determined to be a rupture due to thermal creep, a condition where deformation of material forms from the accumulated exposure to elevated temperatures at high stress conditions. The stop order was lifted 1 week later, on February 28, 2013, with the requirement for additional inspections of the engines to ensure the effects of creep, if they occur, are within tolerances. Discovery of excessive wear on the rudder hinge attachments on AF–2 in early March 2013 also affected availability of test aircraft. As a result, the test fleet was grounded for inspections and maintenance actions, including replacing part of the hinge on AF–2 and adding wear-preventing washers to the hinges of the rest of the test fleet. In total, AF–2 was down for 6 weeks for replacement of the engine and rudder hinge repair. BF–2 experienced a polyalphaolefin (PAO) coolant leak in February, grounding the aircraft for 77 days. Inflight refueling for the F–35A test fleet was expanded in January to allow nontest wing based tankers to support test flight operations, allowing for more efficient use of the test aircraft at Edwards.

F–35A Flight Sciences.—Testing on the F–35A has included envelope expansion for weapons, continued examination of flutter and loads, and some high angle-of-attack testing. During early high angle-of-attack testing, problems with the air data computer algorithms were discovered, requiring an adjustment to the control laws in the air vehicle software. The updated control laws, once installed, permitted portions of the high angle-of-attack testing to continue; however, some portions of the testing will need to wait for the next update of software expected to be delivered to flight test in October. The result has been a delay in opening up high angle-of-attack portions of the envelope, which are required to realize the full capabilities, including flight envelope and weapons delivery, planned for Block 2B.

As of the end of April, progress in test points required for 2B envelope fleet release is behind the plan for the year, having completed 473 of 614 points planned for completion through the end of April 2013, or 77 percent. Progress in weapons integration is also behind schedule, having completed only 7 of 19 total separation events versus the plan to have completed 14 events by the end of April. Accounting for test activity prior to calendar year 2013, the program has completed approximately three-fourths of the total number of test points needed to clear the Block 2B flight envelope for the F–35A.

F–35B Flight Sciences.—Testing this year has focused on STOVL mode operations, in preparation for the second set of ship trials planned for August onboard the USS *Wasp*, Block 2B envelope expansion, air refueling, and weapons separations. High

angle-of-attack testing has not started in the F–35B. Progress on test points for Block 2B envelope in 2013 is behind the plan through the end of April, as the test center has completed 152 of 371 planned points, or 41 percent. Only 6 of the 24 total weapons separations for Block 2B had been completed, with 10 planned to be completed by the end of April. Accounting for prior test activity, the program has completed approximately two-thirds of the total number of test points needed to clear the 2B flight envelope for the F–35B.

F–35C Flight Sciences.—Test point progress has proceeded as planned so far this year for Block 2B envelope expansion in the F–35C; however, no weapons separations or high angle-of-attack testing has been completed. The first set of sea trials are scheduled to start in the summer of 2014 (June 30), with two test aircraft from the flight test center. The first of these two aircraft is scheduled to be modified with the updated arresting hook system and upgraded nose landing gear brace later this year, which will permit catapult and arresting hook testing to begin again. The second aircraft is scheduled to be modified in the spring of 2014. Testing for electromagnetic environmental effects will need to be completed on both aircraft prior to the ship trials as well.

Progress on test points for the Block 2B envelope is slightly behind the plan through the end of April, as the test center has completed 574 of 599 planned points, or 96 percent. Accounting for prior test activity, the program has completed approximately 70 percent of the total number of test points needed to clear the Block 2B flight envelope for the F–35C.

Buffet and transonic roll off (TRO) (when lift is unexpectedly lost on a portion of one wing) continue to be a concern to achieving operational combat capability for all variants. Control laws have been changed to reduce buffet and TRO, with some success; however, both problems persist in regions of the flight envelope, and are most severe in the C model. The program plans to assess the effects of buffet and TRO by collecting data while flying operationally representative flight profiles later this year, after the next version of air vehicle software is released to flight test. No further changes to the control laws are being considered, as further changes will adversely affect combat maneuverability or unacceptably increase accelerative loading on the aircraft's structure.

MISSION SYSTEMS PROGRESS

Although mission systems testing has been able to keep pace with the program plans for generating sorties and accomplishing the test points, the program is falling behind in achieving progress in delivering capability. This lack of progress is caused in part by the need to add unplanned testing to evaluate problems, such as the 221 added points for dedicated testing of the helmet mounted display system, as well as for regression testing of new software loads delivered to flight test, where 366 test points have been added already in calendar year 2013 to evaluate four new software releases. The test centers began flight testing Block 2A software in March 2012, and, as of the end of May 2013—15 months of flight testing later—had completed about only 35 percent of the 2A test points, all of which should have been completed by the end of February 2013, according to the integrated master schedule. The first build of Block 2B software was delivered to flight test in February 2013, and, as of the end of May 2013, 54 of 2,974 Block 2B baseline test points—less than 2 percent—had been completed. As of the end of April 2013, 303 of 1,333 total planned baseline mission systems test points for the year with all versions of software had been accomplished. An additional 532 added (or "growth") points were flown to evaluate discoveries and for regression testing, which is 2.5 times the growth allotted in flight test plans through the end of April 2013. If this trend in added testing is maintained throughout Block 2B development, completing flight test by October 2014, as reflected in the program's current plans, will not be possible.

Additionally, mission systems software development and delivery to flight test have lagged behind the plan reflected in the program's integrated master schedule. The final Block 2B software configuration is now forecast to be delivered to flight test 8 months later than expected by the current integrated master schedule—a delay from August 2013 to April 2014. The delay adds to the challenge of completing 2B flight test by October 2014, which is necessary to support an operational evaluation of Block 2B capability planned now to be conducted in calendar year 2015. Block 2B as now planned will provide limited capability to conduct combat. If Block 2B F–35 forces are used in combat, they would likely need significant support from other fourth-generation and fifth-generation combat systems to counter modern, existing threats, unless air superiority is somehow otherwise assured and the threat is cooperative. Reductions to this limited Block 2B capability, particularly if they are

taken in the remaining, harder-to-achieve capabilities that are yet to be tested, could be difficult for operators to accept if they expect to use Block 2B aircraft in combat against a capable adversary.

Two of the additional aircraft expected by the program plan to support mission systems flight test, which were borrowed from operational test squadrons, were delivered to the test team in April 2013. The mission systems flight test teams are accomplishing testing in the final Block 2A and early Block 2B configurations, which are comparable in providing more combat-relevant functionality than Block 1, such as limited simulated weapons delivery, datalink, track fusion, and electronic warfare capability. Aircraft start-up problems continue during pre-flight operations. Flight test teams have also experienced several problems in flight such as lost data link messages, split target tracks, incorrectly fused tracks, and difficulty maintaining targets/scenes using the electro-optical tracking system. The program began a focused effort this year to determine the cause of position errors due to drift in the ownship kinematic model, which provides critical flight parameters and spatial situation awareness to the pilot. Errors from drift in vertical velocity must be resolved before certification for night or instrument meteorological flight is possible. In the coming weeks, testing of fixes and the capability to warn pilots drift is occurring will begin.

The program has also dedicated 42 flights to investigating deficiencies in the helmet mounted display system. Seven aircraft from all three variants flew test missions from October 2012 through May 2013 to investigate jitter in the helmet mounted display system, night vision camera acuity, latency in the Distributed Aperture System projection, and light leakage onto the helmet display under low-light conditions. Although some progress has been achieved, results of these tests have been mixed according to comments from the test pilots. Testing could not be completed within the full operational flight envelope evaluating mission-related tasks, as the full combat flight envelope has not been released. Filters for reducing the effects of jitter have been helpful, but have introduced instability, or "swimming," of the projected symbology. Night vision acuity was assessed as not acceptable with the current night vision camera, but may be improved with the ISIE–11 camera under consideration by the program. Latency with the Distributed Aperture System projection has improved from earlier versions of software, but has not yet been tested in operationally representative scenarios. Light leakage onto the helmet display may be addressed with fine-tuning adjustments of the symbology brightness—a process pilots will have to accomplish as ambient and background levels of light change. Although not an objective of the dedicated testing, alignment and "double vision" problems have also been identified by pilots and were noted in my report earlier this year on the F–35A Ready for Training Operational Utility Evaluation (OUE). Whether the progress achieved in resolving the problems discussed immediately above has been adequate will likely not be known with confidence until the Block 2B operational evaluation is conducted in 2015.

Later this year, the program plans to begin testing mission systems Block 3i, which includes significant hardware changes to the aircraft's integrated core processor, electronic warfare processor, communications-navigation-identification processor, and the multifunction array (radar). Block 3i software is needed for Lot 6 (and beyond) production aircraft equipped with this new hardware to be able to fly. Initially, Block 3i capability will be more limited than the Block 2B capability that will be concurrently fielded. This is because the timeline to develop, test, and clear Block 3i for use in production aircraft next year requires that Block 3i start with an early Block 2B version in lab tests very soon this year; thus, the capability provided in Block3i will lag Block 2B by about 6 months. Maturing Block 3i hardware and software will be a significant challenge in the next 12 to 18 months. Simultaneously, the program will need to make progress on Block 3F development. The ability of the program to successfully execute this concurrent software development is the most significant source of uncertainty regarding what combat capability the JSF will actually provide in 2018.

WEAPONS INTEGRATION

Weapons integration progress has been very slow since it began last year. Safe separation testing for the laser-guided bomb, GBU–12, has been delayed until a new lanyard and lanyard routing procedure are available. Deficiencies, some of them recently discovered, in the electro-optical tracking system's ability to maintain a track have also hampered progress in laser-guided bomb employment testing. As a result, the first end-to-end GBU–12 weapons delivery test is not likely before October 2013. Integration of the AIM–120 medium-range missile has experienced problems that have been difficult to replicate in lab and ground testing. A safe separation event

in which an AIM–120 missile was launched from a flight sciences aircraft occurred on June 5, 2013; this event was testing the ability to safely release the missile and ignite the rocket motor from the weapons bay—there was no target or sensor fusion providing track/guidance data. The first end-to-end weapons delivery test using AIM–120 missiles is not likely to occur before November 2013, and meeting this date depends upon implementing essential corrections to deficiencies in the mission systems software and completion of remaining safe separation testing. Testing with the Joint Direct Attack Munition (JDAM) found that the aircraft was not able to transfer position and velocity data accurately to the weapon, a procedure required to spatially align the weapon with the target and to determine launch parameters and support release. A fix to this alignment problem has been developed and recently tested, showing some improvement. However, additional fixes and testing are required to ensure the alignment problem is fully resolved and to permit JDAM weapons testing to proceed. The first end-to-end weapons delivery testing with the JDAM weapon is not likely to occur before December 2013. Several deficiencies of the mission systems and fire-control system have been identified as "must fix" by the test team in order for weapons integration to proceed. For example, a problem with erroneous target coordinates derived from the synthetic aperture radar mapping function, for which a potential fix has recently entered flight test, and problems with the electro-optical tracking system mentioned above, have significantly delayed weapons integration tests. The result is that approximately 9 months of margin for regression and discovery in weapons integration test plans has been used before the first end-to-end developmental test event, and there is no margin remaining in the schedule for completing testing and achieving integrations of both the Block 2B or Block 3F weapons capabilities. Consequently, the final Block 3F weapon integration tests are likely to be completed in late 2017, instead of fall 2016. This will make beginning operational testing of Block 3F in January 2018 a challenge.

FATIGUE TESTING

Durability testing of all three variant ground test articles has progressed as scheduled and the number and frequency of discoveries have been consistent with what has been observed in testing of previous fighter aircraft. The first of two aircraft lifetimes of testing has been completed on the F–35A and F–35B; detailed inspections are ongoing. Discoveries this year on the F–35A test article include cracks in the engine thrust mount shear webs on both sides of the aircraft, which are designed to carry some of the fore and aft engine load, and a crack in the frame of the web stiffener located at fuselage station 402. The program has redesigned the thrust mounts for production cut in with Low-Rate Initial Production 6, and retrofits to be completed on earlier aircraft during depot modification periods. Root cause, corrective action, and modification plans for the frame crack are to be determined. Second lifetime testing for the F–35A is scheduled to start in September 2013. The program plans to conduct third lifetime testing on the F–35A test article beginning in the second quarter of calendar year 2015.

Discoveries in the F–35B include cracks on the left and right hand sides of the wing aft spar lower flanges and cracking in the frame of the jack point stiffener, a portion of the support frame outboard of the main fuselage above the main landing gear designed to support load bearing of the aircraft during jacking operations. Redesign, modification, and retrofit plans for these discoveries have not yet been determined by the program. Second lifetime testing for the F–35B is schedule to start in August 2013. Durability testing of the redesigned auxiliary air inlet doors through two lifetimes (full test) was completed on March 29, 2013. The program is investigating two issues observed during testing, both of which involve the crank assembly used to open and close the doors and were awaiting resolution at the time of this testimony.

The F–35C fatigue test article restarted testing on January 9, 2013, after previously completing 4,000 hours of testing and associated inspections; it has now completed 6,869 equivalent flight hours of testing, or 86 percent of the first lifetime, as of May 21, 2013. The program expects to complete first lifetime testing in August 2013. Discovery of cracks in the floor of the avionics bay housing in February 2013 caused a 2-month pause in testing while interim repairs were completed, allowing testing to continue. Less than 1,000 hours of testing later, more cracks were found in the floor of the avionics bay housing and, similar to the F–35B, cracking in the frame of the jack point stiffener was also discovered. Repairs, modifications, and retrofits need to resolve these discoveries are to be determined. The program plans to restart testing on June 12, 2013.

TRAINING SYSTEM

I reported on the F–35A Ready for Training OUE in February of this year. In mid-2010, the JSF Program Executive Officer (PEO) requested an assessment of the readiness to begin F–35A pilot training, which, at that time, was planned to begin in August 2011. Throughout 2011 and part of 2012, the JSF Program Office and the Air Force worked to achieve a flight clearance that would allow pilot training to begin. The JSF Operational Test Team (JOTT) completed a test plan using evaluation criteria developed by Air Force Air Education and Training Command (AETC) in mid-2011. The JSF PEO certified the system ready for test following an Operational Test Readiness Review in July 2012, leading to the start of the OUE in September.

The JOTT, JSF Program Office, and Air Force Air Education and Training Command designed the Ready for Training OUE to assess whether the F–35A aircraft and the training system were ready to begin training pilots in the Block 1A syllabus. The Block 1A syllabus includes basic aircraft systems training, emergency operating procedures, simulated instrument flying procedures, ground operations (taxi), and six flights in the F–35A, the last of which is a qualification and instrument procedures check ride.

The Block 1A training syllabus used during the OUE was substantially limited by the restrictions of the aircraft. Aircraft operating limitations prohibited flying the aircraft at night or in instrument meteorological conditions; hence, pilots needed to avoid clouds and other weather. However, the student pilots are able to simulate instrument flight in visual meteorological conditions to practice basic instrument procedures. These restrictions were in place because testing has not been completed to certify the aircraft for night and instrument flight. These restrictions are still in place on the training system.

The aircraft also were prohibited from flying close formation, aerobatics, and stalls, all of which would normally be in this early familiarization phase of transition training that typically is an introduction to aircraft systems, handling characteristics throughout the aircraft envelope, and qualification to operate/land in visual and instrument meteorological conditions. This familiarization phase is about one-fourth of the training in a typical fighter aircraft transition or requalification course. In a mature fighter aircraft, the familiarization phase is followed by several combat-oriented phases, such as air combat, surface attack, and night tactical operations. During the OUE, the F–35A did not have the capability to train in these phases, nor any actual combat capability, because it is still early in system development. The first F–35A aircraft configured in the Block 2A capability, which will possess a limited ability to simulate weapons deliveries, are being delivered to Eglin AFB this month. This may enable more combat-oriented training, albeit still limited by envelope restrictions and lacking integrated mission systems capability.

During the OUE, sustainment of the six Block 1A F–35A aircraft was sufficient to meet the student training sortie requirements of the syllabus, but with substantial resources and workarounds in place. Some aircraft subsystems, such as the radar, did not function properly during the OUE, although they were not required for accomplishing the basic syllabus events. Had the syllabus been more expansive, where these subsystems were required to complete training, these subsystem problems would have hampered the completion of the OUE. Three additional F–35A aircraft in the Block 1B configuration were also flown during the OUE, by the instructor pilots, to meet sortie requirements.

The limitations, workarounds, and restrictions in place in an air system this early in development limit the utility of training. Also, little can be learned from evaluating training in a system this immature. However, the evaluation indicated areas where the program needs to focus attention and make improvements. The radar, the pilot's helmet mounted display system, and the cockpit interfaces for controlling the radios and navigational functions should be improved. Discrepancies between the courseware and the flight manuals were frequently observed, and the timelines to fix or update courseware should be shortened. The training management system lags in development compared to the rest of the Integrated Training Center and does not yet have all planned functionality.

Since the OUE completed in November 2012, all six of the Block 1A F–35A aircraft have been modified to the Block 1B configuration. Training is ongoing at Eglin in the 9 Block 1B F–35As for the Air Force and in the 11 Block 1B F–35Bs assigned to the Marine Corps. Additionally, Eglin accepted its first Block 2A-configured F–35A in May, which will be used for training in an expanded syllabus currently under development. The Air Force intends to start training pilots in a Block 2A syllabus in early 2014.

SHIP INTEGRATION

The program plans to conduct the second set of ship trials with two F–35B test aircraft in August 2013. Test objectives for this deployment include conducting night operations, carrying stores, evaluating the carrier landing system, and expanding the take-off and vertical landing envelope for varying wind-over-deck conditions and for a broader range of aircraft weight and center of gravity conditions. Flying qualities with an updated version of control software, based on data taken during the first deployment, will be assessed. Two SDD test aircraft will be operated by program test pilots during the test. Minimal changes to USS *Wasp* are anticipated, as this will be the second deployment to the ship. Some restrictions to the electromagnetic environment on the ship may be necessary as a result of the electromagnetic environmental effects testing on the aircraft. The logistics support environment will not be representative of fleet operations; rather, it will be similar to that used in the first ship trials in 2011 that employed workarounds to reach back to land-based systems and personnel as necessary to sustain operations.

The test center also plans to train additional test pilots to be qualified in STOVL operations for the deployment, and for conducting land-based work-up maneuvers.

The program intends to conduct the first set of carrier-based ship trials with two F–35C test aircraft in the summer of 2014. The prerequisite activity with the aircraft leading up to the sea-borne trials is extensive. The new arresting hook system—which has yet to start the planned verification, structural, or durability testing—will have to be installed on both aircraft, and shore-based roll-in testing and hook engagement testing completed with one aircraft, which will compose approximately 6 months of testing. An improved nose landing gear drag brace, required for catapult launches, will also be a part of the pre-deployment set of modifications. Both aircraft will need to undergo electromagnetic environmental effects testing prior to deployment. For the carrier, the Department of the Navy is working integration issues that will need to be resolved prior to the first operational deployment, but will not necessarily be solved prior to the first set of ship trials. Examples of integration issues include storage of the lithium-ion batteries on the carrier, resupplying engines while underway, and integration of the autonomic logistics information system. Some initial noise and thermal effects testing have been completed at land-based test facilities, and will be a part of the test activity during the first ship trial period. Modifications of the jet blast deflector system on the carrier may be necessary prior to the ship-borne trials to ensure adequate cooling of the deflector during JSF operations.

LIVE FIRE TEST AND EVALUATION

F–35 survivability is heavily dependent on its low-observability features, advanced electronic systems (e.g., advanced sensors for situational awareness, multispectral data fusion, datalinks, etc.), and its advanced countermeasures. These features work together to reduce F–35 threat susceptibility. However, no amount of susceptibility reduction can eliminate the possibility of an F–35 being successfully engaged, either by ground-based threats or by enemy aircraft, particularly during high-risk missions such as visual close air support and within-visual-range air-to-air combat (i.e., "dog fighting"). In such cases, the F–35 survivability can largely depend on its ability to tolerate threat-induced damage; that is, its vulnerability reduction features.

Live fire tests and analyses conducted during the last year focused on the threats involved in these types of high-risk engagements to assess the vulnerability of the F–35 propulsion system and to identify any risks to propulsion integration, flight transition, stability and control, and airframe structure:

—A range of operationally realistic threat encounter conditions were considered in tests that evaluated engine vulnerability to fuel ingestion events. Tests have shown that the engine can tolerate ingestion of fuel leak rates representative of single-missile fragment-induced damage to fuel tanks surrounding the engine inlet. Further analysis is required to assess the impact of multiple fragments, which are probable in any case where a missile achieves a near miss on the aircraft, on engine response to fuel ingestion. A Concept Demonstrator Aircraft engine test in fiscal year 2005 showed that the engine could not tolerate ingestion of fuel leak rates representative of damage from a larger gun projectile impacting at low-altitude, high-speed and high-engine thrust—a type of encounter that might be expected on a close-air support mission.

The program made no design changes in response to these test results. This vulnerability, accepted by the program leadership, remains in the final, production engine design. The implications of this vulnerability are exacerbated by the program's previous decision to remove a fuel tank ballistic liner during its weight-reduction

efforts, saving 48 pounds. The ballistic liner could have reduced threat-induced fuel leakage to levels this single-engine aircraft can tolerate. A follow-on ballistic test is planned to re-evaluate vulnerability to fuel ingestion.

—F–35B lift system live fire testing showed the system is tolerant to selected single missile fragments. The single fragment-induced damage to the lift fan produced in this test did not degrade the overall propulsion system performance. Nonetheless, analysis predicts that fragment-induced damage could result in more severe effects that could lead to catastrophic lift system failure (e.g., more than 25 percent lift fan blade loss leading to fan disintegration) as a consequence of certain engagements. To preserve the test article for future engine tests, such engagement conditions were not tested. Other more severe threats expected to be encountered in low-altitude flights or air-to-air gun engagements, considered likely to cause critical system failures leading to aircraft loss, were not tested because their effects are well understood. Additional testing of the sensitivities of the F–35B propulsion system to clutch and shaft damage needs to be conducted.

—The tests also considered diagnostics to inform the pilot of propulsion system damage. Damage to the static lift system received in combat may not be detectable until the lift system is engaged for a landing. The quickly accelerating fan might fail catastrophically before the pilot can react and return the aircraft to wing-borne flight. There are no sensors to warn the pilot of damage to the system to prevent this situation. Sensors in the Prognostics and Health Monitoring system monitor rotating component vibrations for maintenance purposes and could provide some warning, but they are not sufficiently qualified to provide information to the pilot nor any timely warning regarding damage to the vast majority of lift system components. To ensure no aircraft is lost due to lift system, engine, or control failures, it is imperative that the pilot be aware of damage that occurred during regular flight to the F–35B propulsion system at the earliest possible time when converting to STOVL flight. Data analyses are ongoing to identify controllability and damage indications that might be available to the pilot.

Live fire test and evaluation (LFT&E) activities have also focused on other concerns:

—*On-Board Inert Gas Generator System (OBIGGS)*.—The program completed the OBIGGS/lightning protection Critical Design Review in February 2013. F–35B fuel system simulator testing and ground tests on all three variants will be conducted in the near term to verify that the redesigned system can provide fuel tank protection from lightning and from threat induced fuel tank explosion. Testing will include a spectrum of mission profiles including high decent-rate dives to ensure OBIGGS effectiveness without compromising fuel tank and wing structure integrity. Inflight inerting protects the aircraft against catastrophic fuel tank explosions, but not against damage to the airframe resulting from lightning-induced currents. While most line-replaceable units (e.g., actuators, components of the electrical power system) have passed lightning tolerance qualification testing, the existing F–35 airframe fasteners, selected to satisfy weight reduction criteria, are not lightning tolerant. Airframe inspections will be required following known lighting strikes, which may be costly since access to many fasteners is limited and penetrations though the aircraft skin will be required. Lightning tolerance qualification testing for any remaining components, along with current injection tests, still need to be completed before lifting the current restrictions upon aircraft operating within 25 miles of known lightning. The concept for providing lightning protection for aircraft on the ground requires periodic re-inerting of static aircraft using nitrogen bottle carts to purge combustible air that diffuses back into the fuel system over time. This approach could be very resource intensive for an operational F–35 unit, requiring manpower and sufficient nitrogen to re-inert each aircraft as often as every 24 hours. The program is evaluating the practicality of this approach before considering its implementation.

—*Polyalphaolefin Shut-Off Valve*.—In fiscal year 2012, following live fire tests that demonstrated F–35 vulnerability to polyalphaolefin (PAO) fire (underneath the cockpit area), the program re-evaluated installing a PAO shutoff system. In 2008, the previous Director, Operational Test and Evaluation recommended retaining this design feature after the program decided on removal for weight reduction. Lockheed Martin is working to design a PAO shutoff system providing the sensitivity to detect leaks and respond with shutoff that testing has demonstrated is needed. However, the design solution details, results from cost/benefit studies, and the official decision to reinstate this vulnerability reduction feature, are not yet available.

—*Fueldraulic Fuses*.—A live fire test in fiscal year 2012 demonstrated the fueldraulics system is vulnerable to missile fragments resulting in potential fire and loss of aircraft. An F–35B engine fueldraulics line failure during a routine test flight in January 2013 demonstrated a similar safety-related concern with the fueldraulics system. The F–35 program should reinstate an effective fueldraulics shutoff to inhibit fuel flow in the event of a system leak. The fueldraulic shutoff feature would mitigate a vulnerability that could be a result of either threat-induced damage or system/mechanical failure.

—*Chemical/Biological Vulnerability*.—The program continues to make progress in the development of the decontamination system in preparation for the fiscal year 2017 full-up system-level test. The Joint Service Aircrew Mask variant for the F–35, however, has a high schedule risk because of the requirements for integration with the F–35's helmet mounted display system.

—*Gun Ammunition Lethality*.—The U.S. Air Force is leading an evaluation of a new frangible armor piercing design for the F–35A ammunition; the Navy is evaluating existing PGU–32 semi-armor piercing high explosive incendiary ammunition for the F–35B and F–35C; and the Norwegian Ministry of Defense is evaluating a new armor piercing explosive ammunition for its F–35A variant and possibly the U.S. F–35B and F–35C variants. Terminal ballistic tests of all ammunition variants against common vehicle armor and masonry wall designs will start in fiscal year 2013 and continue in fiscal year 2014. All test data will feed Joint Munitions Effectiveness Models.

SUITABILITY

A logistics test and evaluation of the initial fielded release of the Autonomic Logistics Information System (ALIS) version 1.0.3, required to support the acceptance and flight operations of Block 1B and 2A aircraft at Eglin, Edwards, Yuma and Nellis AFBs, was conducted between September and October 2012. The test was conducted at Edwards using two of the mission systems test aircraft updated with software to be compatible with the new version of ALIS. The first version of ALIS software used in the test, version 1.0.3A3, was found to be deficient in response times at the beginning of the evaluation period, and an updated software version—1.0.3A3.1—was developed and fielded to permit the evaluation to proceed. Subsequent testing revealed numerous significant deficiencies in ALIS, such as inaccurate recording of component life—a key component of the prognostic health function—as well as the health management component of the system requiring unneeded, excessive grounding of aircraft. Post-flight delays in data transfer lengthened aircraft turnaround time. Overall, 58 deficiency reports were submitted from the evaluation, 4 of which were critical (designated as Category 1) and the test team recommended not fielding ALIS 1.0.3A3.1. The program developed and released another version of the ALIS 1.0.3 software, version 1.0.3A3.2, to address some of the deficiencies and more testing was accomplished in December 2012. The software update allowed for manual data entries, vice relying on automated processes embedded in the aircraft, to transfer data to ALIS. Although the test team considered the software to be adequate for fielding—and the 1.0.3A3.2 version is in use at Yuma, Nellis, and Edwards AFBs (for the operational test aircraft)—the reliance on manual data entry is laborious, prone to error, and not consistent with the lean design of maintenance support expected for fielded operations.

The most recent reliability data for the F–35 fleet indicate that all variants are currently below planned reliability performance for failures directly chargeable to the primary contractors as well as for flying hours between critical failures. The F–35A's demonstrated flying time between critical failures is below 50 percent of the planned level, while the F–35B and F–35C are just over 70 percent of the planned level. The following subsystems have been problematic:

—Upper lift fan door actuator (F–35B only);
—Thermal management system fan;
—Nose landing gear brake assembly (F–35A/B only);
—270 volt DC battery;
—80 kW inverter/converter/controller;
—Augmentor fuel pump;
—Open-loop compressor isolation valve;
—Sensor for display processor, thermal management system;
—Ventilation nacelle fan; and
—Display management computer/helmet.

The direct time maintainers currently spend working on each aircraft per flying hour is less than required for the full operational system. However, fielded aircraft currently have very few functional mission systems and no weapons capabilities,

which resulted in fewer failure modes and less demands on maintainer time. Additionally, direct maintenance time does not include time spent on Action Requests maintainers submit to Lockheed Martin when they cannot find a solution to a maintenance problem in the aircraft technical data, or if they do not trust results from the prognostic health management system. Maintainers cannot proceed without a response to an Action Request. As both the technical data and prognostic health management system are immature, maintainers required a great deal of unreported time to deal with Action Requests. As the program matures, the time needed to fulfill Action Requests should decrease.

ELECTRONIC WARFARE

Early in 2012, I identified several critical shortfalls in test resources needed to faithfully replicate current threats to JSF and other weapon systems. These deficiencies in test capability prevent adequate developmental and operational testing of the F–35. The Department's budget now includes resources for improvements to open-air range capabilities, an anechoic chamber, and the JSF electronic warfare-reprogramming laboratory. We need to maintain a high degree of urgency within the offices that have been made responsible for delivering these resources to assure they will be available in time to support JSF Block 3F operational testing in 2018; otherwise, that testing will be delayed.

Senator DURBIN. Thank you very much, Dr. Gilmore.

Mr. Sullivan.

STATEMENT OF MICHAEL J. SULLIVAN, DIRECTOR, ACQUISITION AND SOURCING MANAGEMENT TEAM, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. SULLIVAN. Thank you, Mr. Chairman, Senator Cochran, Senator Shelby. It is a pleasure to be here this morning to discuss the F–35 Joint Strike Fighter acquisition program.

As the chairman pointed out, the program is now 12 years old, having begun in 2001. Since then, its development cost has grown by more than $20 billion, and the estimated average cost to buy one F–35 has doubled from about $69 million to $137 million. Clearly, the program's original business case was deeply flawed.

In 2012, after the program breached its cost estimate, the Department did reset its business case. You talked about that in the first panel. They added significant dollars to the cost estimate, more time to deliver aircraft, and since then, the manufacturing process appears to have stabilized and has shown progress in delivering F–35 aircraft.

Today, however, we are here to discuss risks to this reset business case moving forward, and from our perspective, there are three. These are software development, concurrency between flight testing and production, and the funding assumptions from the program that underpin the current business case.

In the area of software development, the F–35 will depend on about 24 million lines of software code, both on and off the aircraft, to be able to fly and to meet its missions. Today software delivery has continued to lag behind, and the contractor continues to struggle to meet schedules. As long as software delivery is questionable, the initial capability of the aircraft is at risk.

With regard to concurrency, the program is now negotiating its sixth and seventh production lots of aircraft. When that negotiation is complete, it will have invested about $34 billion to procure 150 aircraft with less than half of the flight testing completed. As we have heard repeatedly on the first panel and from Dr. Gilmore, this creates risks that problems found during testing will force design

changes that will have to be retrofit onto aircraft in production or already delivered at additional cost to the Government.

Finally, the program's current cost estimate assumes annual funding of more than $12 billion on average for development and procurement over the next 24 years and continues to estimate operation and support costs at over $1 trillion across the F–35's 30-year lifecycle. The Department has already deemed this unaffordable. It is setting targets to try to reduce this, and the Congress may want to consider whether these funding assumptions are reasonable in our current fiscal environment.

PREPARED STATEMENT

From our perspective, these are the risks that this committee must weigh as the program moves forward. As it stands today, the Department plans to buy almost 2,500 aircraft to replace and improve upon today's fleet. If these risks are not controlled and the cost of the F–35 grows much more, the program is in danger of falling into a much too familiar cycle of quantity reductions in order to meet budget, and that will result in less buying power for the Department. It would also force decisionmakers to consider other options for maintaining our tactical fleet.

With that, I will conclude, Mr. Chairman. I would be happy to answer questions.

[The statement follows:]

PREPARED STATEMENT OF MICHAEL J. SULLIVAN

F–35 JOINT STRIKE FIGHTER: RESTRUCTURING HAS IMPROVED THE PROGRAM, BUT AFFORDABILITY CHALLENGES AND OTHER RISKS REMAIN

Chairman Durbin, Ranking Member Cochran, and members of the subcommittee: Thank you for the opportunity to discuss our work on the F–35 Lightning II, also known as the Joint Strike Fighter (JSF). At a cost approaching $400 billion, the F–35 is the Department of Defense's (DOD) most costly and ambitious acquisition program. The program is developing and fielding three aircraft variants for the Air Force, Navy, and Marine Corps and eight international partners. The F–35 is the linchpin of U.S. and partner plans to replace existing fighters and support future combat operations. In a time of austere Federal budgets, DOD continues to project significant long-term sustained funding requirements for the F–35 while, at the same time, pursuing several other expensive systems. Over the past 3 years, DOD has extensively restructured the F–35 program to address poor cost, schedule, and performance outcomes. Most recently, in March 2012, DOD established a new, more realistic, F–35 acquisition program baseline that reflects increased costs, longer schedule times, and deferred procurement of 410 aircraft to the future. Appendix I tracks program baseline changes since the start of system development in 2001.[1]

We have reported annually on F–35 issues since 2005.[2] My testimony today is largely based on the results of our latest review,[3] and addresses (1) the progress the F–35 program made in 2012 and (2) the major risks that the program faces going forward. To conduct our work, we reviewed program status reports and briefings, management objectives, test plans and results, and internal DOD analyses with a focus on accomplishments in calendar year 2012 compared to original plans for that year. We obtained manufacturing data and cumulative outputs from the start of production in 2007 through the end of 2012, and discussed development and production issues and results to date, future expansion plans, and improvement efforts with DOD, F–35 program, and contractor officials. We toured the aircraft manufacturing plant, obtained production and supply performance indicators, identified cumulative and projected engineering changes, and discussed factory improvements

[1] See GAO Highlights at the end of this statement.
[2] See related GAO products at the end of this statement.
[3] GAO, *F–35 Joint Strike Fighter: Current Outlook Is Improved, but Long-Term Affordability Is a Major Concern,* GAO–13–309 (Washington, DC: March 11, 2013).

and management controls with members of the contractor's work force and DOD plant representatives. We evaluated DOD's restructuring actions and impacts on the program, tracked cost and schedule changes from program start to the March 2012 baseline, and determined factors driving the changes. We obtained current projections of acquisition funding needs through 2037 and estimated lifecycle sustainment funding requirements. We conducted this work in accordance with generally accepted government auditing standards.

F–35 PROGRAM PERFORMANCE IMPROVED IN 2012

The F–35 program made progress in 2012 on several fronts. The program met or substantially met most of its key management and development testing objectives for the year. We also found that the program made progress in addressing key technical risks, as well as improving software management, manufacturing, and supply processes.

Most Management and Development Testing Objectives Were Achieved

The F–35 program met or substantially met most of its key management objectives established for calendar year 2012. The program office annually establishes major management objectives that it wants to achieve in the upcoming year. The F–35 program achieved 7 of its 10 primary objectives in 2012. Those included, among other things, the completion of development testing on early increments of software, the beginning of lab testing for both variations of the helmet mounted display, the beginning of pilot training for two aircraft variants, and the completion of negotiations on the restructured development contract. Although the program did not complete its software block 3[4] critical design review as planned in 2012, it did successfully complete its block 3 preliminary design review in November 2012 and the critical design review in late January 2013. The program did not meet its objectives to (1) deliver 40 production aircraft in 2012 and (2) receive approval from the Defense Contract Management Agency of the contractor's plan for correcting deficiencies in its system for tracking and reporting cost and schedule progress.[5]

The F–35 development flight test program also substantially met 2012 expectations with some revisions to original plans. The program exceeded its planned number of flights by 18 percent, although it fell short of its plan in terms of test points[6] flown by about 3 percent, suggesting that the flights flown were not as productive as expected. Test officials had to make several adjustments to plans during the year due to operating and performance limitations with aircraft and late releases of software to test. As a result, none of the three variants completed all of their planned 2012 baseline points, but the test team was able to add and complete some test points that had been planned for future years. Testing accomplished on each of the aircraft variants in 2012 included:

—*Conventional Takeoff and Landing Variant (F–35A)*.—Accomplished high angle of attack testing, initial weapons separation, engine air start, expansion of the airspeed and altitude envelopes, and evaluated flying qualities with internal and external weapons.[7]

—*Short Takeoff and Vertical Landing Variant (F–35B)*.—Accomplished the first weapons release, engine air start tests, fuel dump operations, flight envelope expansion with weapons loaded, radar signature testing, and tested re-design air inlet doors for vertical lift operations.

—*Carrier Suitable Variant (F–35C)*.—Conducted speed and altitude range verification and flights with external weapons, prepared for simulated carrier landings, and conducted shore-based tests of a redesigned arresting hook.

Progress Made in Addressing Key Technical Risks

In 2012, the F–35 program also made considerable progress in addressing four areas of technical risk that if left unaddressed could substantially degrade the F–35's capabilities and mission effectiveness. However, additional work remains to

---

[4] Software capabilities are developed, tested, and delivered in three major blocks. Block 3 is to provide the F–35 its full warfighting capability.

[5] This specifically refers to the contractor's Earned Value Management System, which has been found to be deficient. Earned value management is a disciplined process for tracking, controlling, and reporting contract costs and schedule. DOD requires its use by major defense suppliers to facilitate good insight and oversight of the expenditure of Government dollars.

[6] Flight test points are specific, quantifiable objectives in flight plans that are needed to verify aircraft design and performance.

[7] Due primarily to operating restrictions and deficiencies in the air refueling system, the F–35A did not accomplish as many flights as planned and fell short of planned test points by about 15 percent.

fully address those risks. These risk areas and the actions taken in 2012 are discussed below:

1. *Helmet Mounted Display (HMD)*.—DOD continued to address technical issues with the HMD system. The original helmet mounted display, integral to mission systems, encountered significant technical deficiencies and did not meet warfighter requirements. The program is pursuing a dual path by developing a second, less capable helmet while working to fix the first helmet design. In 2012, DOD began dedicated ground and flight testing to address these issues. Both variations of the helmet mounted display are being evaluated and program and contractor officials told us that they have increased confidence that the helmet deficiencies will be fixed. DOD may make a decision in 2013 as to which helmet to procure.
2. *Autonomic Logistics Information System (ALIS)*.—ALIS is an important tool to predict and diagnose aircraft maintenance and supply issues. ALIS systems with limited capability are in use at training and testing locations. More capable versions of ALIS are being developed and program and contractor officials believe that the program is on track to fix previously identified shortcomings and field the fully capable system in 2015. Limited progress was made in 2012 on developing a smaller, transportable version needed to support unit level deployments to operating locations.
3. *Arresting Hook System*.—The carrier variant arresting hook system was redesigned after the original hook was found to be deficient, which prevented active carrier trials. The program accomplished risk reduction testing of a redesigned hook point to inform this new design. The preliminary design review was conducted in August 2012 and the critical design review in February 2013. Flight testing of the redesigned system is slated for late 2013.
4. *Structural Durability*.—Over time, testing has discovered bulkhead and rib cracks on the aircraft. Structural and durability testing to verify that all three variants can achieve their expected life and identify life-limited parts was completed in 2012. The program is testing some redesigned structures and planning other modifications. Officials plan to retrofit and test a production aircraft already built and make changes to the production line for subsequent aircraft. Current projections show the aircraft and modifications remain within weight targets.

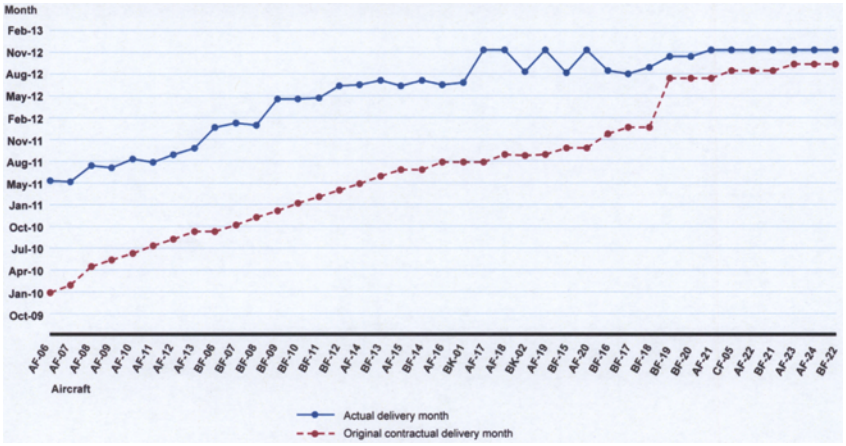
Software Management and Output Improved

In 2012, the F–35 aircraft contractor and program office took steps to improve the program's software management and output. The program began the process of establishing a second system integration laboratory, adding substantial testing and development capacity. The program also began prioritizing and focusing its resources on incremental software development as opposed to the much riskier concurrent development approach. In addition, the program began implementing improvement initiatives recommended by an independent software review, and evaluated the possible deferral of some of the aircraft's capabilities to later blocks or moving them outside of the current F–35 program altogether. At the same time, program data regarding software output showed improvement. For example, program officials reported that the time it took to fix software defects decreased from 180 days to 55 days, and the time it took to build and release software for testing decreased from 187 hours to 30 hours.

Manufacturing Process Metrics Improved

Key manufacturing metrics and discussions with defense and contracting officials indicate that F–35 manufacturing and supply processes improved during 2012. While initial F–35 production overran target costs and delivered aircraft late, the latest data through the end of 2012 shows labor hours decreasing and deliveries accelerating. The aircraft contractor's work force has gained important experience and processes have matured as more aircraft are built. We found that the labor hours needed to complete aircraft at the prime contractor's plant decreased, labor efficiency since the first production aircraft improved, time to manufacture aircraft in the final assembly area declined, factory throughput increased, and the amount of traveled work declined. In addition, program data showed that the reliability and predictability of the manufacturing processes increased while at the same time aircraft delivery rates improved considerably. Figure 1 illustrates the improvement in production aircraft delivery timeframes by comparing actual delivery dates against the dates specified in the contracts.

FIGURE 1: F–35 PRODUCTION AIRCRAFT DELIVERIES COMPARED TO CONTRACT DATES



Source: GAO analysis of DOD data.

Note: The numbered aircraft are in order of delivery. AF = U.S. Air Force F–35A, BF = U.S. Marine Corps F–35B, CF = U.S. Department of the Navy F–35C; and BK = United Kingdom F–35B.

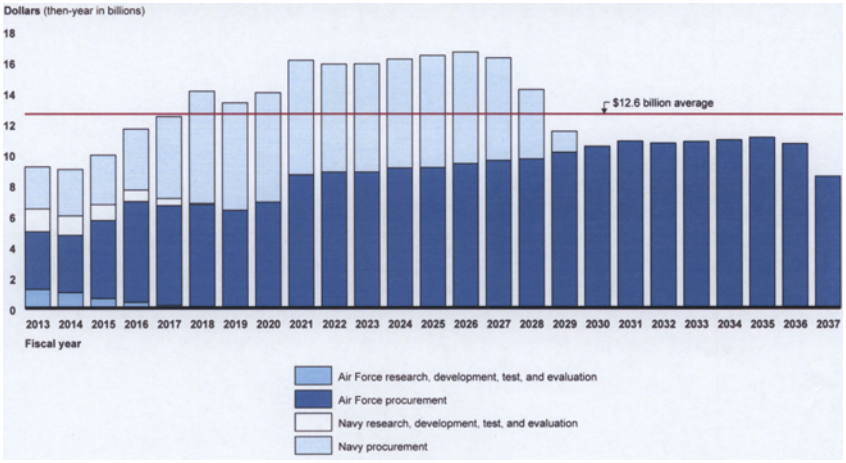
F–35 PROGRAM STILL FACES RISKS

Ensuring that the F–35 is affordable and can be bought in the quantities and timeframes required by the warfighter will be of paramount concern to the Congress, U.S. military and international partners. As we recently reported, the acquisition funding requirements for the United States alone are currently expected to average $12.6 billion per year through 2037, and the projected costs of operating and sustaining the F–35 fleet, once fielded, have been deemed unaffordable by DOD officials. In addition, the program faces challenges with software development and continues to incur substantial costs for rework to fix deficiencies discovered during testing. As testing continues additional changes to design and manufacturing processes will likely be required, while production rates continue to increase.

Long-Term Affordability Remains a Concern

We recently concluded that while the March 2012 acquisition program baseline places the F–35 program on firmer footing, the aircraft are expected to cost more and deliveries to warfighters will take longer than previously projected. The new baseline projects the need for a total of $316 billion in development and procurement funding from 2013 through 2037, or an average of $12.6 billion annually over that period (see figure 2). Maintaining this level of sustained funding will be difficult in a period of declining or flat defense budgets and competition with other "big ticket items" such as the KC–46 tanker and a new bomber program. In addition, the funding projections assume the financial benefits of the international partners purchasing at least 697 aircraft. If fewer aircraft are procured in total or in smaller annual quantities—by the international partners or the United States—unit costs will likely rise according to analysis done by the Office of the Secretary of Defense (OSD) Cost Assessment and Program Evaluation (CAPE) office.

FIGURE 2: F–35 PROGRAM BUDGETED DEVELOPMENT AND PROCUREMENT FUNDING REQUIREMENTS, FISCAL YEARS 2013–2037



Source: GAO analysis of DOD data.

Note: Development and procurement of the Marine Corps variant is included in the Department of the Navy budget accounts.

In addition to the costs for acquiring aircraft, we found that significant concerns and questions persist regarding the cost to operate and sustain the F–35 fleet over the coming decades. The current sustainment cost projection by CAPE for all U.S. aircraft, based on an estimated 30-year service life, exceeds $1 trillion. Using current program assumptions of aircraft inventory and flight hours, CAPE recently estimated annual operating and support costs of $18.2 billion for all F–35 variants compared to $11.1 billion spent on legacy aircraft in 2010. DOD officials have declared that operating and support costs of this magnitude are unaffordable and the department is actively engaged in evaluating opportunities to reduce those costs, such as basing and infrastructure reductions, competitive sourcing, and reliability improvements.

Because of F–35 delays and uncertainties, the military services have made investments to extend the service lives of legacy F–16 and F–18 aircraft at a cost of $5 billion (in 2013 dollars). The Navy is also buying new F/A–18E/F Super Hornets at a cost of $3.1 billion (in then-year dollars) to bridge the gap in F–35 deliveries and mitigate projected shortfalls in fighter aircraft force requirements. As a result, the services will incur additional future sustainment costs to support these new and extended-life aircraft, and will have a difficult time establishing and implementing retirement schedules for existing fleets.

Software Development Challenges Remain

Our report found that over time, F–35 software requirements have grown in size and complexity and the contractor has taken more time and effort than expected to write computer code, integrate it on aircraft and subsystems, conduct lab and flight tests to verify it works, and to correct defects found in testing. Although recent management actions to refocus software development activities and implement improvement initiatives appeared to be yielding benefits, software continued to be a very challenging and high-risk undertaking, especially for mission systems.[8] While most of the aircraft's software code has been developed, a substantial amount of integration and test work remain before the program can demonstrate full warfighting capability. About 12 percent of mission systems capabilities have now been validated, up from 4 percent about a year ago. However, progress on mission systems was limited in 2012 by contractor delays in software delivery, limited capability in

[8] Mission systems are critical enablers of F–35's combat effectiveness, employing next generation sensors with fused information from on-board and off-board systems (i.e., electronic warfare, communication navigation identification, electro-optical target system, electro-optical distributed aperture system, radar, and data links).

the software when delivered, and the need to fix problems and retest multiple software versions. Further development and integration of the most complex elements—sensor fusion and helmet mounted display—lie ahead.

F–35 software capabilities are being developed, tested and delivered in three major blocks and two increments—initial and final—within each block. The testing and delivery status of the three blocks is described below:

—Block 1.0, providing initial training capability, was largely completed in 2012, although some final development and testing will continue. Also, the capability delivered did not fully meet expected requirements relating to the helmet, ALIS, and instrument landing capabilities.

—Block 2.0, providing initial warfighting capabilities and limited weapons, fell behind due to integration challenges and the reallocation of resources to fix block 1.0 defects. The initial increment, block 2A, delivered late and was incomplete. Full release of the final increment, block 2B, has been delayed until November 2013 and will not be complete until late 2015.

—Block 3.0 providing full warfighting capability, to include sensor fusion and additional weapons, is the capability required by the Navy and Air Force for declaring their respective initial operational capability dates. Thus far, the program has made little progress on block 3.0 software. The program intends initial block 3.0 to enter flight test in 2013. This is rated as one of the program's highest risks because of its complexity.

Design Changes and Rework Continue to Add Cost and Risk

Although our recent review found that F–35 manufacturing, cost, and schedule metrics have shown improvement, the aircraft contractor continues to make major design and tooling changes and alter manufacturing processes while development testing continues. Engineering design changes from discoveries in manufacturing and testing are declining in number, but are still substantial and higher than expected from a program this far along in production. Further, the critical work to test and verify aircraft design and operational performance is far from complete. Cumulatively, since the start of developmental flight testing, the program has accomplished 34 percent of its planned flights and test points. For development testing as a whole, the program verified 11.3 percent of the development contract specifications through November 2012. As indicated in table 1, DOD continues to incur financial risk from its plan to procure 289 aircraft for $57.8 billion before completing development flight testing.

TABLE 1: F–35 PROCUREMENT INVESTMENTS AND FLIGHT TEST PROGRESS

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cumulative procurement (then-year dollars in billions)	$0.8	$3.5	$7.1	$14.3	$21.3	$27.6	$33.8	$40.1	$47.9	$57.8	$69.0
Cumulative aircraft procured	2	14	28	58	90	121	150	179	223	289	365
Percent total flight test points completed	—	<1%	<1%	2%	9%	22%	34%	54%	74%	91%	100%

Source: GAO analysis of DOD data.

Notes: Years listed denote fiscal years. Flight test data reflects the percentage of total flight test points completed in time to inform the next year's procurement decision. For example above, the F–35 program accomplished about 22 percent of total planned flight test points through the end of calendar year 2011 that could help inform the fiscal year 2012 procurement decision. The program intends to complete developmental flight test points in 2016 and would be in a position to fully support the 2017 procurement buy.

This highly concurrent approach to procurement and testing increases the risk that the Government will incur substantial costs to retrofit (rework) already produced aircraft to fix deficiencies discovered in testing. In fact, the F–35 program office projects rework costs of about $900 million to fix the aircraft procured on the first four annual procurement contracts. Substantial rework costs are also forecasted to continue through the 10th annual contract (fiscal year 2016 procurement), but at decreasing amounts annually and on each aircraft. The program office projects about $827 million more to rework aircraft procured under the next 6 annual contracts.

DEPARTMENT OF DEFENSE ACTIONS ON GOVERNMENT ACCOUNTABILITY OFFICE RECOMMENDATIONS HAVE VARIED, BUT F–35 RESTRUCTURING WAS A POSITIVE STEP

We have reported on F–35 issues for over a decade and have found that the magnitude and persistence of the program's cost and schedule problems can be largely traced to (1) decisions at key junctures made without adequate product knowledge;

and (2) a highly concurrent acquisition strategy that significantly overlapped development, testing, and manufacturing activities.[9] Over that time, our reports included numerous recommendations aimed at reducing risk in these areas and improving the chances for successful outcomes.[10]

DOD has implemented our recommendations to varying degrees. For example, in 2001 we recommended that DOD delay the start of system development until the F–35's critical technologies were fully mature. DOD disagreed with that recommendation and chose to begin the program with limited knowledge about critical technologies. Several years later, we recommended that DOD delay the production decision until flight testing had shown that the F–35 would perform as expected, and although DOD partially concurred with our recommendation, it chose to initiate production before sufficient flight testing had been done. Citing concerns about the overlap—or concurrency—among development, testing, and production, we have recommended that DOD limit annual production quantities until F–35 flying qualities could be demonstrated. Although DOD disagreed with our recommendation at the time, it has since restructured the F–35 program and, among other things, deferred the production of hundreds of aircraft into the future, thus addressing the intent of our recommendation and reducing program risk. Appendix II lists these and other key recommendations we have made over time, and identifies the actions DOD has taken in response.

In conclusion, while the recent restructuring of the F–35 program placed it on a firmer footing, tremendous challenges still remain. The program must fully validate the F–35's design and operational performance against warfighter requirements, while at the same time make the system affordable so that the United States and partners can acquire new capabilities in the quantity needed and can then sustain the force over its lift cycle. Ensuring overall affordability will be a challenge as more austere budgets are looming.

Chairman Durbin, Ranking Member Cochran and members of the subcommittee, this completes my prepared statement. I would be pleased to respond to any questions you may have.

APPENDIX I: CHANGES IN REPORTED F–35 PROGRAM QUANTITY, COST, AND DELIVERIES, 2001–2012

	October 2001 (system development start)	December 2003 (approved baseline)	March 2007 (approved baseline)	June 2010 (Nunn-McCurdy)	March 2012 (approved baseline)
Expected Quantities					
Development quantities	14	14	15	14	14
Procurement quantities (U.S. only)	2,852	2,443	2,443	2,443	2,443
Total quantities	2,866	2,457	2,458	2,457	2,457
Cost Estimates (then-year dollars in billions)					
Development	$34.4	$44.8	$44.8	$51.8	$55.2
Procurement	196.6	199.8	231.7	325.1	335.7
Military construction	2.0	0.2	2.0	5.6	4.8
Total program acquisition	$233.0	$244.8	$278.5	$382.5	$395.7
Unit Cost Estimates (then-year dollars in millions)					
Program acquisition	$81	$100	$113	$156	$161
Average procurement	69	82	95	133	137

[9] We have an extensive body of work looking at knowledge-based best practices in successful private and public acquisitions of new technology. Defense policy and the Weapon Systems Acquisition Reform Act of 2009 incorporate elements of the knowledge-based approach. For an overview of the best practices criteria and methodologies, and how current defense programs including the F–35 fared, see GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs,* GAO–12–400SP (Washington, DC: March 29, 2012).

[10] See related GAO products for a list of previous F–35 reports.

APPENDIX I: CHANGES IN REPORTED F–35 PROGRAM QUANTITY, COST, AND DELIVERIES, 2001–2012—Continued

	October 2001 (system development start)	December 2003 (approved baseline)	March 2007 (approved baseline)	June 2010 (Nunn-McCurdy)	March 2012 (approved baseline)
Estimated Delivery and Production Dates					
First production aircraft delivery	2008	2009	2010	2010	2011
Initial operational capability	2010–2012	2012–2013	2012–2015	TBD	TBD
Full-rate production	2012	2013	2013	2016	2019

Source: GAO analysis of DOD data.
Note: TBD means to be determined.

APPENDIX II: PRIOR GAO REPORTS AND DOD RESPONSES

GAO report	Est. dev. costs dev. length aircraft unit cost	Key program event	Primary GAO message	DOD response and actions
2001 GAO–02–39	$34.4 billion 10 years $69 million	Start of system development and demonstration approved.	Critical technologies needed for key aircraft performance elements not mature. Program should delay start of system development until critical technologies mature to acceptable levels.	DOD did not delay start of system development and demonstration stating technologies were at acceptable maturity levels and will manage risks in development.
2005 GAO–05–271	$44.8 billion 12 years $82 million	The program undergoes replan to address higher than expected design weight, which added $7 billion and 18 months to development schedule.	We recommended that the program reduce risks and establish executable business case that is knowledge-based with an evolutionary acquisition strategy.	DOD partially concurred but did not adjust strategy, believing that its approach is balanced between cost, schedule and technical risk.
2006 GAO–06–356	$45.7 billion 12 years $86 million	Program sets in motion plan to enter production in 2007 shortly after first flight of the nonproduction representative aircraft.	The program planned to enter production with less than 1 percent of testing complete. We recommended program delay investing in production until flight testing shows that JSF performs as expected.	DOD partially concurred but did not delay start of production because it believed the risk level was appropriate.
2007 GAO–07–360	$44.5 billion 12 years $104 million	Congress reduced funding for first two low-rate production buys thereby slowing the ramp up of production.	Progress was being made but concerns remained about undue overlap in testing and production. We recommended limits to annual production quantities to 24 a year until flying quantities are demonstrated.	DOD nonconcurred and felt that the program had an acceptable level of concurrency and an appropriate acquisition strategy.
2008 GAO–08–388	$44.2 billion 12 years $104 million	DOD implemented a Mid-Course Risk Reduction Plan to replenish management reserves from about $400 million to about $1 billion by reducing test resources.	We believed new plan increased risks and DOD should revise it to address testing, management reserves, and manufacturing concerns. We determined that the cost estimate was not reliable and that a new cost estimate and schedule risk assessment is needed.	DOD did not revise risk plan or restore testing resources, stating that it will monitor the new plan and adjust it if necessary. Consistent with a report recommendation, a new cost estimate was eventually prepared, but DOD refused to do a risk and uncertainty analysis.

APPENDIX II: PRIOR GAO REPORTS AND DOD RESPONSES—Continued

GAO report	Est. dev. costs dev. length aircraft unit cost	Key program event	Primary GAO message	DOD response and actions
2009 GAO–09–303	$44.4 billion 13 years $104 million	The program increased the cost estimate and adds a year to development but accelerated the production ramp up. Independent DOD cost estimate (JET I) projects even higher costs and further delays.	Moving forward with an accelerated procurement plan and use of cost reimbursement contracts is very risky. We recommended the program report on the risks and mitigation strategy for this approach.	DOD agreed to report its contracting strategy and plans to Congress and conduct a schedule risk analysis. The program completed the first schedule risk assessment with plans to update semi-annually. The Department announced a major restructuring reducing procurement and moving to fixed-price contracts.
2010 GAO–10–382	$49.3 billion 15 years $112 million	The program was restructured to reflect findings of recent independent cost team (JET II) and independent manufacturing review team. As a result, development funds increased, test aircraft were added, the schedule was extended, and the early production rate decreased.	Costs and schedule delays inhibit the program's ability to meet needs on time. We recommended the program complete a full comprehensive cost estimate and assess warfighter and IOC requirements. We suggest that Congress require DOD to tie annual procurement requests to demonstrated progress.	DOD continued restructuring, increasing test resources and lowering the production rate. Independent review teams evaluated aircraft and engine manufacturing processes. Cost increases later resulted in a Nunn-McCurdy breach. Military services are currently reviewing capability requirements as we recommended.
2011 GAO–11–325	$51.8 billion 16 years $133 million	Restructuring continued with additional development cost increases; schedule growth; further reduction in near-term procurement quantities; and decreased the rate of increase for future production. The Secretary of Defense placed the STOVL variant on a 2 year probation; decoupled STOVL from the other variants; and reduced STOVL production plans for fiscal years 2011 to 2013.	The restructuring actions are positive and if implemented properly, should lead to more achievable and predictable outcomes. Concurrency of development, test, and production is substantial and provides risk to the program. We recommended the program maintain funding levels as budgeted; establish criteria for STOVL probation; and conduct an independent review of software development, integration, and test processes.	DOD concurred with all three of the recommendations. DOD lifted STOVL probation, citing improved performance. Subsequently, DOD further reduced procurement quantities, decreasing funding requirements through 2016. The initial independent software assessment began in and ongoing reviews are planned through 2012.
2012 GAO–12–437	$55.2 billion 18 years $137 million	The program established a new acquisition program baseline and approved the continuation of system development, increasing costs for development and procurements and extending the period of planned procurements by 2 years.	Extensive restructuring places the program on a more achievable course. Most of the program's instability continues to be concurrency of development, test, and production. We recommend the Cost Assessment Program Evaluation office conduct an analysis on the impact of lower annual funding levels; JSF program office conducts an assessment of the supply chain and transportation network.	DOD partially concurred with conducting an analysis on the impact of lower annual funding levels and concurred with assessing the supply chain and transportation network.

Note: Est. dev. is abbreviation of estimated development.

Source: DOD data and GAO analysis in prior reports cited above.

RELATED GOVERNMENT ACCOUNTABILITY OFFICE PRODUCTS

Defense Acquisitions: Assessments of Selected Weapon Programs. GAO–13–294SP. Washington, DC: March 28, 2013.

F–35 Joint Strike Fighter: Current Outlook Is Improved, but Long-Term Affordability Is a Major Concern. GAO–13–309. Washington, DC: March 11, 2013.

Joint Strike Fighter: DOD Actions Needed to Further Enhance Restructuring and Address Affordability Risks. GAO–12–437. Washington, DC: June 14, 2012.

Joint Strike Fighter: Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern. GAO–12–525T. Washington, DC: March 20, 2012.

Joint Strike Fighter: Implications of Program Restructuring and Other Recent Developments on Key Aspects of DOD's Prior Alternate Engine Analyses. GAO–11–903R. Washington, DC: September 14, 2011.

Joint Strike Fighter: Restructuring Places Program on Firmer Footing, but Progress Still Lags. GAO–11–325. Washington, DC: April 7, 2011.

Joint Strike Fighter: Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time. GAO–10–382. Washington, DC: March 19, 2010.

Joint Strike Fighter: Accelerating Procurement before Completing Development Increases the Government's Financial Risk. GAO–09–303. Washington DC: March 12, 2009.

Joint Strike Fighter: Recent Decisions by DOD Add to Program Risks. GAO–08–388. Washington, DC: March 11, 2008.

Joint Strike Fighter: Progress Made and Challenges Remain. GAO–07–360. Washington, DC: March 15, 2007.

Joint Strike Fighter: DOD Plans to Enter Production before Testing Demonstrates Acceptable Performance. GAO–06–356. Washington, DC: March 15, 2006.

Tactical Aircraft: Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy. GAO–05–271. Washington, DC: March 15, 2005.

GOVERNMENT ACCOUNTABILITY OFFICE HIGHLIGHTS

June 19, 2013

Highlights of GAO–13–690T, a testimony before the Subcommittee on Defense, Committee on Appropriations, United States Senate

F–35 JOINT STRIKE FIGHTER: RESTRUCTURING HAS IMPROVED THE PROGRAM, BUT AFFORDABILITY CHALLENGES AND OTHER RISKS REMAIN

Why GAO Did This Study

The F–35 Lightning II, the Joint Strike Fighter, is DOD's most costly and ambitious aircraft acquisition. The program is developing and fielding three aircraft variants for the Air Force, Navy, Marine Corps, and eight international partners. The F–35 is critical to long-term recapitalization plans as it is intended to replace hundreds of existing aircraft. This will require a long-term sustained funding commitment. Total U.S. investment is nearing $400 billion to develop and procure 2,457 aircraft through 2037. Fifty-two aircraft have been delivered through 2012. The F–35 program has been extensively restructured over the last 3 years to address prior cost, schedule, and performance problems. DOD approved a new acquisition program baseline in March 2012.

This testimony is largely based on GAO's recently released report, GAO–13–309. This testimony discusses (1) progress the F–35 program made in 2012, and (2) major risks that program faces going forward. GAO's work included analyses of a wide range of program documents and interviews with defense and contractor officials.

What GAO Recommends

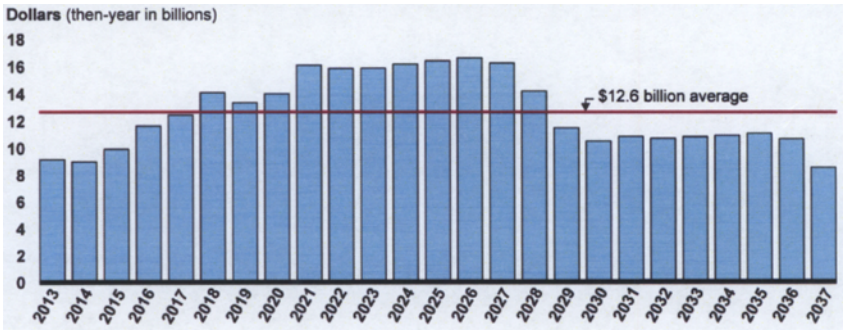
GAO's prior reviews of the F–35 made numerous recommendations to help reduce risk and improve outcomes. DOD has implemented those recommendations to varying degrees.

What GAO Found

The new F–35 acquisition baseline reflects positive restructuring actions taken by the Department of Defense (DOD) since 2010, including more time and funding for development and deferred procurement of more than 400 aircraft to future years. Overall, the program progressed on several fronts during 2012 to further improve the current outlook. The program achieved 7 of 10 key management objectives and made substantial progress on one other. Two objectives on aircraft deliveries and a corrective management plan were not met. The F–35 development test program substantially met expectations with some revisions to flight test plans and made considerable progress addressing key technical risks. Software management practices and some output measures improved, although deliveries to test continued to lag behind plans. Manufacturing and supply processes also improved—indicators such as factory throughput, labor efficiency, and quality measures were positive. While initial F–35 production overran target costs and delivered aircraft late, the latest data shows labor hours decreasing and deliveries accelerating.

Going forward, the F–35 program still faces considerable challenges and risks. Ensuring that the F–35 is affordable and can be bought in the quantities and time required by the warfighter will be a paramount concern to the Congress, DOD, and international partners. With more austere budgets looming, F–35 acquisition funding requirements average $12.6 billion annually through 2037 (see below). Once fielded, the projected costs of sustaining the F–35 fleet have been deemed unaffordable by DOD officials; efforts to reduce these costs are underway. Software integration and test will be challenging as many complex tasks remain to enable full warfighting capability. The program is also incurring substantial costs for rework—currently projected at $1.7 billion over 10 years of production—to fix problems discovered during testing. With two-thirds of development testing still to go, additional changes to design and manufacturing are likely. As a result, the program continues to incur financial risk from its plan to procure 289 aircraft for $57.8 billion before completing development flight testing.

F–35 JOINT STRIKE FIGHTER ACQUISITION FUNDING REQUIREMENTS



Source: GAO analysis of DOD data.

Senator DURBIN. Thanks, Mr. Sullivan.
Mr. O'Hanlon.

STATEMENT OF MICHAEL O'HANLON, SENIOR FELLOW AND DIRECTOR OF RESEARCH FOR THE FOREIGN POLICY PROGRAM, BROOKINGS INSTITUTION

Mr. O'HANLON. Good morning, Senators. It is an honor to be here.

I would like to do something a little different with my testimony and that is just to sketch out an alternative way to think about the F–35 and how many we might buy instead of the program of record of close to 2,500. And what I want to do is form a premise of acknowledging the need for the program and, frankly, the excellence of the plane. I think we have heard a lot of very good technical discussion that you in the Congress pushed the Pentagon to continually work on, which is to make this plane operationally effective, to make it realistically priced, and to take this very difficult concept and make it work. And all that is challenging and all that is hard. There have been mistakes along the way, but I support the plane.

Having said that, I think there was a fundamental assumption in the way the overall procurement buy was sized that I would challenge, and I think to put it simply, we came up with a number of planes to replace existing force structure, close to one for one, not exactly one for one, but we essentially looked at aircraft like the Harrier jet and the F–16 and the F–18 and several others, and we said how many of them do we have. We want to keep the majority of the force structure that those different types of planes, roughly half a dozen, currently populate, and that takes close to 2,500 aircraft. Now, I think there was an assumption that the F–35 could be a little better and produce a little more effectiveness, maybe a little higher sortie rate or kill rate per sortie. But, nonetheless, you essentially were replacing force structure. And the hope was that if you had all three Services cooperate and you bought a lot and you got international partners, you could drive down unit cost.

But, Senator Durbin, I do have some sympathy for your image of creating a program that is too big to fail not because I am opposed to this program but because I think we have put a tremen-

dous number of eggs in one basket, and we have done it in this hope or in this expectation that we can drive down unit cost so much as to make that logic work.

I would come up with a different approach to sizing the number of planes I would buy, which is a threat-based approach. In other words, what parts of the world, which potential adversaries and scenarios are going to require us to have a lot of fifth generation ground attack aircraft and also air superiority aircraft? And I think primarily of advanced aircraft made by Russia and China, as was mentioned in the first panel, as well as some of the advanced air-to-air and surface-to-air capabilities. And we hear about those even in conflicts like Syria. So I acknowledge that it would be nice to have F–35s everywhere for everything because you never know where there is going to be an advanced SAM. But realistically speaking, we have done a lot of operations around the world the last two decades with extremely low attrition rates to our airplanes with fourth generation planes, and I think a lot of our future military missions will continue in that vein.

So I would recommend sizing the future purchases of this F–35 plane primarily to the threat environment and principally to the possibility that China could be an adversary. I do not expect that. I certainly do not hope that, but it is a possibility we have to plan for. And also, of course, Iran. Those would be the two most prominent cases. There could be others. I would basically want to have enough high-end airplanes that for a scenario that I can imagine and war game, that for the bases that we are going to have available to us in that region of the world, that we can fill them up with as many F–22s and F–35s as we think appropriate. That is the way I would size it. It is a threat-based approach.

Now, once you accept that premise, then you can have a more detailed conversation about what do you do to each of the three variants. And in my testimony, I spell out one specific proposal. It is certainly debatable. Even if you accept that main premise, there are different ways you could implement it. I could go through it, but maybe I will save most of that for discussion.

I will point out that I do support the F–35B, the Marine Corps variant, because I worry about runways being threatened in the future and being damaged. And I like the idea of a short take-off vertical landing airplane. But people can debate that as well.

PREPARED STATEMENT

The overall point here is—I will conclude on this simple observation—if you were to cut the purchases in half overall—I am recommending we buy about 1,200, 1,250 instead of 2,450—you are only going to save about maybe 20–25 percent of the total program cost because most of that force structure you still want to keep, which means you have to buy something else or refurbish something else to keep it going. And so those refurbished F–16s and so on are still going to cost money. So I do not consider this to be an easy way to lop off hundreds of billions of dollars from expected Pentagon spending, but I think you might be able to save, let us say, 20 percent in the acquisition costs of the program, something in that neighborhood, with this approach.

Thank you.

[The statement follows:]

PREPARED STATEMENT OF MICHAEL O'HANLON

Thank you for the opportunity to testify today on the important and impressive Lightning II aircraft. The bottom line of my testimony is that I favor purchasing roughly half the number of jets now scheduled to be acquired by the Department of Defense over the next two decades.[1]

In other words, while I am a supporter of the program, I am also a critic about the scale of the planned procurement. Even as drones have become much more effective, even as precision-guided ordnance has become devastatingly accurate, and even as real-time surveillance and information grids have evolved rapidly, plans for modernizing manned combat systems have remained essentially at previous quantitative levels.

All together, the Air Force, Navy, and Marine Corps still plan to buy nearly 2,500 F–35 combat jets at a total acquisition price of more than $300 billion in constant 2013 dollars. Production is just beginning at low rates, with the big ramp-up expected in the next few years. The Pentagon will spend about $15 billion annually on the plane starting in mid-decade. Three-fourths of the projected funds are yet to be spent. The Pentagon's independent cost assessment office believes the average unit procurement price could be 15 to 20 percent higher than official estimates, exceeding $115 million per plane in 2013 dollars. And once purchased, the same office estimates that the F–35 will also cost one-third more to operate in real terms than planes like the F–16 and F–18 that it is replacing.[2]

It is important to acknowledge some strengths of the F–35, though, and to challenge some common criticisms. Some have opposed the Marine Corps variant of the plane (the F–35B), with its extra engine as needed for short or vertical take offs and landings. But in fact, that variant has value for an era in which airfields are increasingly vulnerable to precision ordnance of the types that countries such as Iran and China are fielding. The United States needs enough F–35Bs to be able to populate bases nearest potential combat zones, such as the Gulf States (for scenarios involving Iran) and Okinawa (in regard to China). As Marine Corps Commandant General James Amos has noted, there are 10 times as many 3,000 foot runways in the world adequate for such short-takeoff jets as there are 8,000 foot runways suitable for conventional aircraft—and the Marines can lay down an expeditionary 3,000 foot runway in a matter of days in other places.[3]

An alternative concept for F–35 production could be as follows:

—Purchase a total of 1,250 instead of 2,500.

—Leave the Marine Corps plan largely as is, scaling back only by 10 to 20 percent to account more fully for the proven capacity of unmanned aerial vehicles to carry out some missions previously handled by manned aircraft.

—Cancel the Navy variant (the F–35C), with its relatively limited range compared with likely needs—buying more F/A–18 E/F Super Hornets in the meantime while committing more firmly to development of a longer range unmanned carrier-capable attack aircraft.[4] The X–47B unmanned system, which completed demonstration tests on a carrier in 2012, is scheduled to conduct flight operations from an aircraft carrier in 2013, so this capability is progressing.[5]

—Reduce Air Force numbers, currently expected to exceed 1,700 F–35 planes, by almost half.

Of the 800 planes that the Air Force was counting on, but would not get under this approach, the difference can be made up in the following ways. First, cut back 200 planes by eliminating two tactical fighter wings. Second, view the 200 large combat-capable unmanned aerial vehicles (UAVs) currently owned by the Air Force,

---

[1] This testimony is drawn largely from my recent Brookings book, *Healing the Wounded Giant: Maintaining Military Preeminence While Cutting the Defense Budget*.

[2] Statement of Christine H. Fox, director of cost assessment and program evaluation, Department of Defense, before the Senate Armed Services Committee, May 19, 2011 (www.armed-services.senate.gov/e witnesslist.cfm?id=5213); and Andrea Shalal-Ela, "Exclusive: U.S. Sees Lifetime Cost of F–35 Fighter at $1.45 Trillion," Reuters, March 29, 2012 (www.reuters.com/article/2012/03/29/us-lockheed-fighter-idUSBRE82S03L20120329).

[3] See Statement of General James F. Amos before the House Armed Services Committee on the 2011 Posture of the United States Marine Corps, March 1, 2011, p. 13 (http://armedservices.house.gov/index.cfm/files/serve?File id=6e6d479e-0bea-41a1-8f3d-44b3147640fe).

[4] See Captain Henry J. Hendicks and Lt. Col. J. Noel Williams, "Twilight of the $UPERfluous Carrier," *Proceedings* (U.S. Naval Institute, May 2011) (www.usni.org/magazines/proceedings/2011-05/twilight-uperfluous-carrier).

[5] Northrop Grumman, "X–47B UCAS," (Washington: 2013) (www.as.northropgrumman.com/products/nucasx47b/index.html). An additional virtue of unmanned systems is the ability to conduct training for pilots less expensively.

together with the 300 or more on the way, as viable replacements for some manned fighter planes. The Air Force is buying the equivalent of five wings of large UAVs; perhaps it could transform two manned combat wings into unmanned combat aircraft wings as a result.[6] For the remaining planes, employ further purchases of F–16 jets and refurbishments of existing F–16s to make up the difference as needed.[7]

This approach will produce net savings of some $60 billion in Air Force aircraft purchase costs. The F–16 option is still available since the production line is currently making aircraft for Morocco and Oman among others, but it may not remain open for more than a couple years, so this option could have to be exercised fairly promptly to make economic sense.[8] Additional savings in the Marine Corps and Navy will add up to another $20 billion to $25 billion.

Average annual savings from this alternative approach to F–35 production might be $5 billion. Over time up to another $2 billion a year or so in savings would be achievable in operating accounts from the sum total of all these changes in tactical aircraft. These savings will not kick in right away, since it is important to get the F–35 production line working efficiently to keep unit costs in check. More of the savings will accrue in the 2020s.

It should also be remembered that a fair amount of risk is inherent in this alternative plan, since entirely canceling the F–35C Navy version of the plane will leave the Navy with less stealthy aircraft over the next decade. This is probably a tolerable risk but is not a trivial one.[9] In an era of fiscal austerity and defense budget cuts, we need to take calculated risks in defense planning as a nation—not reckless risks, but calculated and reasonable ones. I believe that halving the size of the planned overall F–35 buy follows that philosophy properly and prudently.

Senator DURBIN. Thanks, Mr. O'Hanlon. And that gets to the question I would like to ask.

This committee has been handed the baton on one of the last legs of the race. We hope it is the last leg of the race on the F–35. And the question, obviously, looking back on the earlier stages of the race, how could we have done this better, how could we be further ahead, less cost?

Going back to the beginning, Mr. Sullivan, looking at what we were trying to achieve 12 years ago, anticipating a threat, anticipating technology changes, how did we miss it by so much where the unit cost of the airplane is almost double what we thought it would be? And what could we have done differently to be in a better place today?

Mr. SULLIVAN. First of all, I would say that this program is not unique in many ways. A lot of the major acquisitions go down this exact same road. I think it is very complex why programs get off to this kind of start, but if you look at the mechanics of a program, just the best way to set a business case, I think where this program went wrong when it set requirements and it did not do enough due diligence up front before it had its milestone B in 2001 and the requirements were, more or less, not achievable with the resources that they were estimating at that time. So they made a cost estimate based on parametric analysis, no real actuals, quantum leap in capability. It is very hard to model. You know, they

[6] See U.S. Air Force, Fact Sheet on MQ–9 Reaper, January 2012 (www.af.mil/information/factsheets/factsheet.asp?id=6405); and Congressional Budget Office, *Policy Options for Unmanned Aircraft Systems* (Washington: June 2011), pp. ix–x (www.cbo.gov/sites/default/files/cbofiles/ftpdocs/121xx/doc12163/06-08-uas.pdf).

[7] These are ongoing; see Bill Carey, "F–35 Delay Forces $3 Billion Upgrade Request for U.S. Air Force F–16s" AINOnline, November 4, 2011 (www.ainonline.com/aviation-news/ain-defense-perspective/2011-11-04/f-35-delay-forces-3-billion-upgrade-request-us-air-force-f-16s).

[8] Leithen Francis, "Mission Impossible," *Aviation Week and Space Technology,* August 15, 2011, p. 27.

[9] The chief of naval operations, while not abandoning support for the F–35C, has nonetheless voiced some doubts about the central role of stealth in future force planning. See Admiral Jonathan W. Greenert, "Payloads over Platforms: Charting a New Course," *Proceedings,* vol. 138, no. 7 (U.S. Naval Institute, July 2012) (www.usni.org/magazines/proceedings/2012-07/payloads-over-platforms-charting-new-course).

talk about modeling and simulation to prove that you can do things, but you cannot really model some of the capabilities that they had here.

So they had very immature technologies when they started. A number of the technologies—there were eight critical technologies on this aircraft in 2001 that they knew they would have to have to be capable to meet requirements.

Senator DURBIN. Let me go to the point that Dr. Gilmore raised and perhaps Mr. O'Hanlon also alluded to. This notion that you would somehow put this aircraft in the hands of those who will ultimately use them, let them respond and tell you how it is functioning and what it needs and the like, really seems to me to be thinking that might have applied a long time ago when technology was moving at a much slower pace.

Mr. SULLIVAN. Well, and that is "fly before you buy" is kind of the term that they use for that. But when you have requirements that are so demanding with such immature technologies and you start a program before you understand that, the development program will really be at a loss for a long time. There is going to be a lot of churn as you wait for those technologies to mature. In some cases, we are talking about technologies that were just concepts. They did not even have a component for the technology——

Senator DURBIN. So, Dr. Gilmore, how would you address that part of it, this "fly before you buy" versus concurrency?

Dr. GILMORE. There is always going to be a certain amount of concurrency in the programs, as Mr. Kendall mentioned. This was an extreme case that I think he accurately characterized as acquisition malpractice.

But to get back to the question you asked about what caused this to happen, I guess I have a little bit different perspective than Mr. Sullivan. I actually think it is pretty simple. The Department has a long history of deceiving itself early on in programs about their costs, schedule, and difficulty. In this particular case, there were a number of assumptions that were made, for example, that there would be high commonality in the structural parts among the various aircraft. That not surprisingly over time—and I was a career person in the Department when the program started, and there were plenty of people who were indicating warnings at the time that, well, you know, you are making some unrealistic assumptions here about commonality in order to drive the unit cost down in the analyses that you are doing, because at that point everything was just on paper and was being done by analysis. And, of course, those assumptions on commonality turned out to be unrealistic.

But those kinds of unrealistic assumptions, which then carried through into the program when it decided to start production without any flight test—you know, one of the assumptions at that point was that the modeling and simulation, the structural modeling and simulation, the modeling and simulation of fusion capabilities and of how the sensors would respond and so forth and so on, was going to be so exquisite that there would be no surprises in the flight test program. And, of course, that has turned out not to be the case.

And I would point out in the flight test program up to this point, we have not actually tested any combat capability. We have tested the handling characteristics of the aircraft. We have done nec-

essary precursors to testing actual combat capability. But the first time we will be flight testing combat capability is in Block 2B. When we finally get the Block 2B software released to the test program, then we will be flight testing some actual combat capability, although it will be limited and we will have to wait till Block 3F.

So my perspective is that what happened here is, unfortunately, at the onset of the program back in the 1990s was what happens frequently, and that is that everyone got together in the Department and basically deceived themselves about how hard the job was going to be and how expensive it was going to be. And then reality intruded, and reality always wins.

Senator DURBIN. You used the word "deception." We heard the word "optimism" before. It seems like they brought us to the same place.

Mr. O'Hanlon, just briefly. I looked at this, too, from the viewpoint of America's industrial base, our capacity to build what we need next, our capacity to sustain this innovation, creative spirit, and keep it in a safe place so that we can really entrust to the people who are doing it our national security, which in the last week or two has again been brought into question.

How do you view this in terms of what we should have done with F–35 and what we may need in the future and whether we would be ready for it?

Mr. O'HANLON. I guess, Senator, one observation I would have is that I do not want to depend too much on just one company or just one airplane. And it goes back to your point about "too big to fail."

I think Lockheed has done, generally, a good job, and Lockheed is making a wonderful F–16 still, which is part of the airplane in my alternative. I want to make more F–16s for the United States. We are making them primarily or exclusively now, I think, for foreign customers. So I have nothing against Lockheed, but I do think the idea of having more than one airplane, more than one modern airplane in the works is a good one. And part of the alternative, therefore, that I propose is to focus on this X–47, this naval unmanned, carrier capable plane that is getting some attention, some resources right now, but the service's commitment to it, the Navy's commitment, is probably a little bit shaky partly because their budget is so overstressed by the F–35. And so one of the lessons I would draw is make sure you have a couple or three things in the works when it comes to something as important as combat aircraft.

Senator DURBIN. Senator Cochran.

Senator COCHRAN. Mr. Sullivan, Government Accountability Office (GAO) has noted the improved performance and outlook for the F–35 program but continues to identify long-term affordability as a major concern. What work are you doing to identify savings in the projected cost to sustain the F–35 once it is fielded?

Mr. SULLIVAN. Well, right now, as has been stated earlier, the operations and support (O&S) costs—you are referring to the lifecycle costs, the sustainment cost. We are reviewing what the Program Office has now in this review that we are undertaking right now, and in addition to that, we are talking with the Cost Assessment and Program Evaluation group, known as CAPE, in the Department to see what kind of assumptions they are using to de-

termine future O&S costs and what targets they are using to try to reduce those. So we, more or less, are relying on the initial data that they are providing us and reviewing that.

Senator COCHRAN. What do you believe are the key factors that must be achieved for the program to meet affordability targets?

Mr. SULLIVAN. Reduction of the O&S costs would be number one, and I think the things that they have to look at—the first panel discussed a lot of efforts. Reliability on the aircraft is very critical to sustainment, and right now, they are not quite meeting their reliability targets that they were supposed to achieve at this point in the program. And in fact, they are about halfway to achieving the kind of reliability growth that they have to do on the aircraft. So I think Mr. Kendall pointed out that is one of his top concerns, and I would agree with him on that.

In addition, they need to look at fuel costs. They need to look at how they man the aircraft, how they train. You know, I think General Bogdan said that when you do the concept of operations on this, you have to pay a lot of attention to how much time you are going to fly the aircraft, things like that.

Senator COCHRAN. What is your current assessment of the F–35 manufacturing process?

Mr. SULLIVAN. Right now, last year when we visited—we actually toured the process last year, and we gathered data on a number of different things that indicate manufacturing, like efficiency rates, the labor hours that they take to deliver aircraft, the span times between deliveries. And in every case, even in the engineering changes that are the result of concurrency, the program looks like it is trending in an improved way, and we would like to see that continue. We think probably it will. They have worked through about 40 percent of the flight tests. So they understand the flight envelope, and most of those design changes are probably behind them. So we think that the manufacturing processes will continue to improve.

Senator COCHRAN. Comparing this process with others, how is it similar or not in the various stages of development and production?

Mr. SULLIVAN. The manufacturing process?

Senator COCHRAN. Yes.

Mr. SULLIVAN. Well, the first thing about this one that is unique to most every manufacturing process I have looked at is the fact that they have three variants going through final assembly on the same line. So it is more complex in that regard. And I think they have done a pretty good job of working that out.

Other than that, on the major acquisitions I have looked at—F–22 was one of those, B–2 bomber, and some other ones—it is very similar in that the concurrency on the program causes—I would say that concurrency between flight testing and production—it does have a cost of design changes that you have to go back and retrofit aircraft on, but in addition to that, it creates an awful lot of chaos on the manufacturing floor. I do not know how you capture those costs of concurrency, but this program probably has been much less efficient than it could be if it were less concurrent.

Senator COCHRAN. Thank you, Mr. Chairman.

Senator DURBIN. Senator Shelby.

Senator SHELBY. Thank you.

Dr. Gilmore, you have a very important job. You are the Director of Operational Test and Evaluation at DOD, and you have talked about the plane today.

Modeling and simulation are very important, as far as not just planes but anything else that comes along. Is there any real substitute once you pass that for testing and evaluation once you get into that?

Dr. GILMORE. Senator, we use modeling and simulation in numerous operational test activities because we have no choice. In the particular case of Joint Strike Fighter, it is currently under development. It is an analog to what is currently called the air combat simulator down in Marietta that was used during F–22 operational testing, and it is being used for all the follow-on development that is being done to improve the capabilities of the F–22 where you have a full-up effect space simulation of the aircraft and you can take operational pilots into the simulator and have them fly the aircraft as realistically as you can in a simulator.

We are going to be doing the same thing with the Joint Strike Fighter. However, those simulations must be rigorously verified, validated, and accredited based on open air flight test data. If they are not, then they are meaningless. So there is——

Senator SHELBY. You are fooling yourself if they are not, are you not?

Dr. GILMORE. Pardon me?

Senator SHELBY. You are fooling yourself if they are not real evaluative tests.

Dr. GILMORE. Correct. And so we are pushing the flight test program to give us the data to verify, validate, and accredit rigorously what is called the verification simulation for the Joint Strike Fighter, which is under development. There will be a version that is used in developmental tests and an even more capable version that is used in operational tests.

But again, we must get data out on the open air test ranges, the western test range, where they are doing developmental testing and where we will be doing the open air operational testing, which will take a year, to validate that model. We can only do, even in that year, a relatively small number of open air sorties under limited conditions.

For example, we will not, on the open air test ranges, be able to fly the aircraft against the dense integrated air defense systems that actually the aircraft is being designed to be able to penetrate on the first day of war. But we can fly against selected air defense assets and take that data, use it to verification, validation, and accreditation (VV&A) the simulations, and then in the simulations, fly against the simulated, very dense integrated air defense systems. And then we can also do many more simulated flights in the simulator than we can open air, thereby getting a statistically significant sample of data. But the linchpin for all of that is the VV&A from the actual open air flight test data. If we do not have those data, then the simulation, as you point out, is not meaningful.

Senator SHELBY. You have to have it.

Mr. Sullivan, how do we get the cost down? Is it, as we call it, economy of scale? Mr. O'Hanlon was talking about recommending

half the purchase, whereas most people who deal with economics as a rule—the more you make, the price comes down. I mean, I think that is just basic. Explain your views.

Mr. SULLIVAN. Well, if you are talking about total program cost, you can reduce the total amount of expenditure in procurement by reducing the quantities, but each one you buy is going to cost more. So there is a difference, you know, looking at the unit cost and the overall total program cost.

For example, on the F–22 program, the F–22 program roughly estimated that it would cost about $70 billion to develop and procure 750 aircraft. They started cutting costs on that by reducing aircraft. They wound up with about 180 aircraft for $70 billion. So the cost of the program did not go up, but the cost of each aircraft did.

You know, that is the one way to save budget on this program, and this is a program that is going to cost, if you just look at acquisition costs, as I said in my statement, over $12 billion a year for the next 25 years. You can try to get efficiencies, and I am sure they are going to continue to drive the learning curve down, but in the end, this happens with most programs. You have to start reducing quantities.

Senator SHELBY. This is not new, as was brought up earlier. This is not new to probably any development of a weapons system we have seen over the years.

Mr. SULLIVAN. The B–2 bomber was supposed to be 132 aircraft. They wound up 20 tanks, same thing. It is part of this legendary death cycle that you hear about on acquisition programs where too much is promised. They cannot budget for all of it. They have trouble meeting the requirements, and eventually they are spending too much money and they cannot buy as much.

Senator SHELBY. Mr. Sullivan, do you believe that more competition in the acquisition process will help solve some of the structural problems that we have had?

Mr. SULLIVAN. I think more competition always results in not only a better price, but better responsiveness. You know, this is a sole source engine, as well as aircraft. So there is not going to be any competition in the engine here either, and we have seen in the past where when you have competition at that level, you get reduced costs and better responsiveness from the industrial base.

Senator SHELBY. We had some votes on that, did we not?

Mr. SULLIVAN. Yes, we did.

When you are talking about a fighter like this, it is pretty hard to have competition with something this complex, but you can maintain competition in some cases longer than at the start of the program. Sometimes you should think more about competing up to a critical design review, for example, you know, when you have a stable design, things like that.

Senator SHELBY. Mr. O'Hanlon, you mentioned the F–16, which we know is a good plane. Of course, it had a few bumps along the road too. But that is a current generation of plane, a great one. It has been. But technology moves on either with us or with our would-be adversaries. Have you considered that in your recommendation?

Mr. O'HANLON. Yes, Senator.

And by the way, I also agree with your earlier point, even though you might not have guessed that I would, because I think you have to factor this in. If you are going to have a smaller buy and try to construct a portfolio of airplanes that winds up purportedly being cheaper, you have to factor in a higher unit cost as part of the calculation. And I have acknowledged that in my work. But that is part of why, even though I am proposing a much smaller F–35 program, the savings are nothing close to 50 percent. And so, again, that is an important thing to bear in mind.

And by the way, a compromise idea here could be keep trying to see if the F–35 cost curve comes down the way that Lockheed Martin hopes it will. If it does, then maybe you discard my backup plan in a couple of years, and if it does not, then you keep that in mind.

In terms of capability, Senator, your last question, what I tried to do when I sized my alternative was to say let me imagine, even though I am fairly hopeful on U.S.-China relations, that they do not go well for a number of years and we wind up with a number of bases in Southeast Asia, including some we do not even have now, that might be needed to carry out some kind of a containment policy, which is not our current policy, as you know, and I hope it will never have to be. But let us imagine it might. So I think about bases in the Philippines, bases in Vietnam, ongoing capability in Okinawa and other parts of Japan, Guam, maybe even Taiwan itself if there has been a Chinese attack.

Senator SHELBY. Korea.

Mr. O'HANLON. And Korea.

And if I do that and I imagine, let us say, up to a couple of wings in each of those places, then I get up to the kind of numbers that I am proposing. So it is a threat-based approach, and it is a fairly rigorous one in that regard. It is just not populating the entire force structure with F–35s.

Senator SHELBY. I will pose this last question. The chairman has been generous with me. My last question: Is it not important to this country and the decisions we make right here on funding or not funding things that will make this country secure to not just think about tomorrow—I mean, 2 years from now but 10 years from now, 15 years from now when we are building weapons systems and acquiring them for the future. And we look around the world—I mean, I hope we stay in peace always, but we realize that China has become a huge economic power. Following that throughout history there has been a build up of military strength and a possible notion of establishing some kind of a hegemony in that area. Does that concern all of you when we are thinking about weapons not just for today but for tomorrow?

Mr. O'HANLON. I can give a one-sentence answer to get out of the way. That is why I am ultimately a strong supporter of the F–35. So we are talking about the numbers. But in terms of the capability, especially in the western Pacific, I think it is quite important.

Dr. GILMORE. Senator, I would say that I agree with Frank Kendall and the service chiefs. I do not think we have an alternative but to develop this plane and make it work.

My caution is just that at this point anyone who projects when we will have certain capabilities is probably being a bit optimistic

based on what I have seen so far in the program. And again, it has improved its performance substantially, but still, these are very complex undertakings. I easily see a 6- to 12-month slip relative to what the program schedule is now. But that is a marked improvement from where we were in 2009. And so it is going to take a while to get this capability. It has taken a while to get all the capabilities in the F–22 that we wanted. In fact, we are still working on that. That has turned out to be a very capable aircraft, but it was also a program that was rather troubled and went through some of the same troubles that this one is going through. I agree that it is needed. But go ahead.

Senator SHELBY. Mr. Sullivan.

Mr. SULLIVAN. Yes, I think that the acquisition process for major weapons system acquisitions that the Department uses is broken in that when they set requirements for big bang, quantum leap kind of capabilities—you know, they project that they will take 10 years and they wind up taking 15. The world changes dramatically, as the chairman pointed out, in 15 years.

So one of the things we have looked at is that you need an acquisition process that can deliver much more quickly and be a lot more agile and maybe have incremental improvements to requirements so you can deliver added capability, maybe not the big bang, but in the next block maybe you get there.

The commercial world operates that way, and they make pretty good revolutions incrementally over a 10-year period. If you look at some products and look at how long it takes for a weapons system to deliver anything, there is an awful lot of electronics and things out there that just deliver, deliver, you know, it is an incremental kind of an approach. And you are in production a lot more than you are in development that way too.

So that would be a major change in the acquisition process to be able to look at a 5-year kind of production capability but maintain the vibrant tech base that we need. Right now, the acquisition process—it is not only concurrency between testing and production. It is also concurrency between technology development and product development, and that gets very inefficient.

Senator SHELBY. Mr. Chairman, thank you.

Senator DURBIN. Thank you very much, Senator Shelby and Senator Cochran.

I want to thank the staff for their preparations in this hearing and the panel for their valuable testimony, along with the first panel.

When I took over as chairman of this subcommittee, I knew I had a lot to learn, and this was one of the hearings that I asked for. This is the most expensive acquisition project underway. We are making sacrifices in the name of deficit reduction that relate to the number of troops, the training of our troops, suggested base closures, perhaps not equipping our Guard and Reserve units the way they need to be equipped, having just relied on them so much in the conflicts in Iraq and Afghanistan. Over and over again, we are being asked to make some hard decisions in the subcommittee, and I did not want the acquisition process to be separate from that conversation. And I wanted to start with the obvious big dog on the block, the F–35.

Your point, Mr. Sullivan, at the end is one I tried to make earlier and just keep returning to. When people sit down in my office and say, well, we started thinking about 12 years ago about battlefield communications and what our troops will need, we are still working on it, and I am thinking, my goodness, what has changed in this world in terms of communications in 12 years. And it is a challenge for us, a challenge we have to meet.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED TO HON. FRANK KENDALL, III

QUESTIONS SUBMITTED BY SENATOR PATRICK J. LEAHY

Question. Senator Reed asked you about the security of the F–35 from cyber threats, and your response indicated that you took it as a question about industrial espionage and the theft of F–35 design secrets by near peer powers.

Leaving aside the question of industrial espionage, given that the F–35 is the most software- and information technology-enabled aircraft in our Nation's history, what are your plans to protect it from operational cyber security threats? During the hearing General Bogdan called the jet "virtually a flying computer."

Answer. As Lieutenant General Bogdan indicated, the F–35 is remarkable in its extensive computer processing power and can be depicted as a "flying computer." As such, the F–35 aircraft, as well as its ground components, are monitored and managed like other Department of Defense (DOD) high-value computer networks and systems. U.S. Cyber Command, as well as other agencies, monitors emerging threats to DOD computer systems and issues warnings and alerts. The F–35 Joint Program Office (JPO) receives these warnings and alerts, develops appropriate patches and upgrades to the air system to counter the threat, and integrates those into the mission system and ground support software.

Likewise, the F–35 JPO, in concert with other security agencies, takes great care to analyze the persistent long-term threats to the F–35 air system and takes corrective actions when appropriate.

Question. It is not science fiction to imagine an enemy of the United States would seek to hack into and disable our fleet of F–35s. And the jet's information technology means that they have an avenue to do so.

You recently issued a DOD Instruction about assured microelectronics. How do you plan to assure the microelectronics and networked functionality of the F–35 from operational cyber attack? What is your trusted electronics plan for the F–35, and how will you protect that plan from downward budgetary pressures?

Answer. We issued DOD Instruction 5200.44, "Protection of Mission Critical Functions to Achieve Trusted Systems and Networks (TSN)" to ensure that all DOD programs apply risk management practices throughout the product lifecycle to minimize the risks mentioned above. The F–35 Joint Program Office (JPO) is also working closely with the Office of the Deputy Assistant Secretary of Defense for Systems Engineering to address all Program Protection Plan (PPP) elements to include criticality analysis, identification of Critical Program Information (CPI), and Supply Chain Risk Management (SCRM). The PPP is a living document, and the F–35 JPO is periodically updating the PPP and integrating a revised CPI and critical component list over the F–35 program lifecycle.

A primary concern with regard to a cyber attack on a platform like the F–35 is that mission capability would be impaired as a result of vulnerabilities in system design or subversion within the supply chain that affects a system's mission critical functions or critical components. The F–35 program has worked diligently to reduce vulnerabilities in the system design through sound system security engineering and through implementation of DOD 8500.2, JAFAN 6/3, and Telecommunications Electronics Material Protected from Emanating Spurious Transmissions (TEMPEST) requirements into the air system. The program utilizes Information System Security Engineering Working Groups (ISSEWG) and Technical Interchange Meetings (TIM) as regular forums to address, discuss, and resolve system security engineering concerns/topics relating to system design. The outputs of these discussions are used to guide program design changes and/or system security architecture improvements.

With regard to detecting, reducing and mitigating the consequences of products containing counterfeit components or malicious functions, the F–35 program has taken some proactive actions. First, all Lockheed Martin's (LM) suppliers are contractually required to comply with the best practices outlined in key Aerospace Standards AS–5553 and AS–6174, which while not a panacea, does provide a risk assessment framework for identifying potential problem areas and ensuring a full understanding of the specific risks. The F–35 JPO has further stipulated that as part of LM's Seller Plan, a Seller shall only purchase products directly from the Original Component or Equipment Manufacturer (OCM/OEM) or from an OCM/OEM authorized distributor chain, Aftermarket Manufacturer, or Authorized Reseller. In the few instances where items need to be purchased from independent distributors or brokers such as in cases of diminishing material supply (DMS) or obsolescence, the parts will be subjected to a screening process appropriate to the commodity as documented in the Program Counterfeit Parts/Material Prevention and Control Plan. On a recurring basis, Lockheed Martin Supplier Quality Management personnel will audit the suppliers' counterfeit parts prevention and as further mitigation, the F–35 suppliers are required to mask the intended use of the parts or components for use on the F–35 program.

In dealing with potential vulnerabilities within custom or commodity hardware/software, the F–35 program is taking some significant steps to mitigate those threats. We currently require compliance to Aerospace Standard 9120 which requires traceability of parts from receipt until delivery, as well as evidence of conformance to ensure the part has been rigorously tested and the likelihood of it being a counterfeit is minimized. For various components on the aircraft that are customized for F–35 uses, such as Application Specific Integrated Circuit (ASIC) components, the program is investigating the use of a Trusted Foundry for procuring those components.

Additionally, the program has been in discussions with the Defense Microelectronics Activity to investigate the potential sourcing of other components currently procured overseas from Trusted Domestic Sources. The current criticality analysis underway and the resulting vulnerability assessment outcome will influence the JPOs' risk assessment and decision whether to pursue that route. The outcome of the vulnerability assessment will also influence future decisions (Block Upgrades, Tech Refreshes and DMS Redesigns) to design vulnerable components out of the system.

Funding availability in a shrinking budget environment provides challenges to maintaining the current plan. The Department is dedicated to ensuring secure and effective microelectronics and networked functionality and will continue to prioritize these areas. The expanding and increasingly competitive Trusted Supplier network should provide an avenue to mitigate threats while lessoning budget pressures.

Question. "To start over, to go back 10 years, 20 years and invest $20 billion or $30 billion in the development of another aircraft in replacement of the F–35 just doesn't make any sense."

I agree. However, are there any plans to diversify the fighter fleet in line with alternative proposals, such as those made by Michael O'Hanlon of the second panel of witnesses?

Answer. Currently there are no plans to diversify the Department's Tactical Strike Fighter (TACAIR) fleet in line with any alternative proposals. The Department's TACAIR priority is to acquire 5th generation fighter/attack aircraft as quickly and efficiently as practical, while maintaining sufficient legacy aircraft inventory to meet current and near-term commitments. Legacy fighter/attack aircraft are important today, as evidenced by their involvement in ongoing operations in Afghanistan. However, the 4th generation aircraft are limited in their ability to combat adversaries employing Anti-Access and Area Denial threats. The Department is committed to transitioning to 5th generation capability and the F–35 will constitute the bulk of that inventory.

Question. Please explain how the cost of the F–35 program will not deprive the military of vital modernization in other areas.

Answer. Every element of the Department's budget represents an attempt to balance all the competing needs of the Department, the F–35 program is no exception.

To that end, F–35 production costs are coming down. Unit costs continue to go down with each successive production lot we have on contract. The Low Rate Initial Production (LRIP) Lot 5 contract was 4 percent lower than the LRIP Lot 4 contract. We expect that trend to continue provided we can ramp up to more economical production rates. These cost reductions are a result of an aggressive transition to fixed price-type contracts and agreements with the contractor that more equitably share in the risks associated with concurrency and overruns. The LRIP Lot 6 and 7 contracts will place the entire burden for any overruns on the contractor.

We are actively pursuing opportunities to reduce the long-term lifecycle costs as well. The Department, F–35 Program Office, and Services are reviewing increased opportunities for competitive sustainment in the areas of global supply chain, support equipment, and training. Additionally, sustainment business case analyses are assessing the appropriate mix of contractor and government maintenance and support to find the most cost effective way to reduce Operations and Support (O&S) costs. The F–35 Program Office estimate for O&S costs has come down in the last year, and the Department's independent estimate will be updated later this year.

Finally, the multirole F–35 is the cornerstone of the Department's future air dominance and precision attack capabilities. The F–35 will replace numerous aging legacy aircraft for the Air Force, Navy, and Marine Corps. The capabilities that the F–35 will bring to the warfighter are absolutely required to meet the projected threats in the future, and worth the investment required to modernize the fleet. My focus is to ensure that we deliver the required capability at the right cost.

QUESTIONS SUBMITTED TO ADMIRAL JONATHAN W. GREENERT

QUESTIONS SUBMITTED BY SENATOR JACK REED

Question. Will you have to modify existing carriers to accommodate the F–35 (e.g. arrested landing gear, catapults, elevators)? If so, how much will this cost, has any of this work begun in the planning stage, and when do you expect this work will have to be funded?

Answer. The current modernization plan for *Nimitz*-class carriers includes 16 separate ship alterations designed for integration of the F–35C. Nine of the 16 modifications have been developed while the remaining alterations are in varying stages of development, but will be complete in time to support Initial Operational Capability (IOC) for the F–35C. A number of the identified ship modifications are designed specifically for F–35C compatibility, and others will both enable F–35 seabasing and improve support for the rest of the aircraft in the carrier air wing, including the E–2 Hawkeye, F/A–18 Hornet and Super Hornet, EA–18 Growler, and the Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) system.

USS *Abraham Lincoln* (CVN 72) will be the first carrier to be "JSF-Ready." She will receive all 16 alterations, either as part of her current Refueling Complex Overhaul (RCOH), or in future planned incremental availabilities or modernization periods. The total cost of all 16 modifications for CVN 72 is estimated to be $53 million. The alterations for the remaining *Nimitz*-class carriers are expected to be similar in cost, and will be incrementally-funded between now and fiscal year 2022 to meet F–35C deployment schedules.

The nine ship alterations already fully developed are incorporated into the baseline design of *Gerald R. Ford* (CVN 78), the lead ship of the *Ford* class of carriers. The remaining seven modifications are planned for installation after CVN 78 has been delivered to the Navy.

Question. With respect to CVN–78 USS *Gerald R. Ford*—is the new Electromagnetic Aircraft Landing System (EMALS) being designed to accept both F–18s and F–35s? Is the EMALS system being tested with the F–35C and F–18s?

Answer. EMALS is being designed to launch all air wing aircraft, including F–35C and all variants of the F/A–18. Aircraft Compatibility Testing completed to date included the F–35C, F/A–18E, T–45C, C–2A, and E–2D. Additional testing will include all variants of the F/A–18.

QUESTIONS SUBMITTED BY SENATOR ROY BLUNT

Question. What is the total lifecycle cost to operate and sustain the F–35C program, and do you believe these costs are sustainable?

Answer. OSD CAPE has estimated operating and sustainment (O&S) cost for the entire F–35 program at $671 billion (fiscal year 2012). This O&S estimate is for all three United States variants based on an estimated 30-year service life and predicted attrition and usage rates. The F–35C estimate is approximately 15–18 percent of the total DOD F–35 O&S cost estimate. The estimate will be updated for the annual Defense Acquisition Board review of the F–35 program.

The program continues to make progress toward reducing sustainment costs. The Services continue to support the F–35 Joint Program Office (JPO) in its disciplined approach to analyzing and reducing sustainment costs.

Question. The recently released Select Acquisition Report (SAR) estimated the cost per flying hour of the F–35A, the conventional aircraft, to be approximately

$32,000 per hour. Costs were not provided for the F–35C, the Navy variant. Will the harsh carrier environment in which these aircraft operate increase the cost per flight hour above the AF variant?

Answer. Concurrent with F–35A cost estimation, several F–35C cost per flight hour estimates have been developed by the Joint Program Office. F–35C costs are projected to be about 3 percent higher or about $1,000 more per hour.

Factors causing the higher cost per hour are due to increased complexity required to operate in the carrier environment. The F–35C is substantially different in aircraft structure than the F–35A. Among the changes, the F–35C has a significantly larger wing area, 620 square feet, compared to 460 square feet for the F–35A. This larger wing poses higher costs to repair and maintain due to material costs and higher low observable maintenance manpower requirements. The F–35C has a folding wing, which is more complex, more expensive, and adds to repair cost. The F–35C requires reinforced landing gear and a tailhook to accommodate carrier landings and landing loads. Tire and wheel replacement will also be more frequent and more expensive.

Question. Do you have an estimate of the cost per flight hour of the F–35C at initial Operational Capability (IOC)?

Answer. Based on the current F–35 schedule, the F–35C will reach the IOC milestone between August 2018 (objective) and February 2019 (threshold). The F–35 Joint Program Office (JPO) and Department of the Navy (DON) continue to develop estimates for the F–35 cost per flight hour. Estimates for cost per flight hour at IOC are not available. However, at maturity, the F–35C cost per flight hour is estimated to be approximately $33,000.

Question. Can you compare the cost per flight hour of the F–35C at initial Operational Capability with the cost of the current fleet, which I understand has the lowest per hour in the Navy inventory?

Answer. At maturity, which is defined as operations with the peak number of aircraft in service, the F–35C total operating and support costs, less indirect costs, are estimated to be approximately $33,000 per hour compared to approximately $20,000 for the F/A–18E/F. This F–35C cost is a projected estimate, whereas the F/A–18E/F figure is an actual, observed cost. The F/A–18E/F program has significantly benefited from F/A–18A–D Fleet operational experience and numerous initiatives to reduce its sustainment costs. The Navy and the Joint Strike Fighter Joint Program Office remain committed to identifying efficiencies to reduce sustainment costs for the F–35C.

Question. I applaud the Navy for investing in additional airborne electronic attack capability this year to overcome our adversaries' evolving capabilities, particularly because we are investing in stealth technology that may already be vulnerable to new radars and weapons systems. Our adversaries are getting much better at detecting and countering stealth technology with new capabilities. One of the ways to overcome these technology improvements includes airborne electric attack. Can you discuss the importance of this capability?

Answer. Future conflicts will be fought and won in the electromagnetic spectrum and cyberspace, which are converging to become one continuous environment. This environment is increasingly important to defeating threats to access, since through it we can disrupt adversary sensors, command and control and weapons homing.

It is important to make investments that will allow us to shape the electromagnetic (EM) spectrum to our advantage. For more than a half century the Department of the Navy has been the leader in Airborne Electronic Attack and this naval capability remains in high demand. This is why the Navy has invested in airborne electronic attack systems such as the EA–18G Growler and the Next Generation Jammer. The Next Generation Jammer will operate over a wider frequency range and have greater flexibility than today's airborne jammers because of its digital processing and tunable antennae. This capability will allow it to do much more than jam enemy sensors; the Next Generation Jammer will be able to deceive, decoy, and inject false signals into enemy sensors. These are all ways we need to employ the spectrum to our advantage.

Future investments will continue to leverage our airborne electronic attack capability as part of a fully netted warfare concept, which will provide EM spectrum dominance by merging EM spectrum capabilities with cyberspace.

Question. You've been a thoughtful leader in exploring affordable alternatives to meet advancing threats. For example, you've discussed the importance of keeping today's aircraft platforms lethal by upgrading their payloads, such as stand-off weapons and sensors. Can these types of advanced payloads on current platforms serve as affordable alternatives while still maintaining a qualitative edge over our adversaries?

Answer. Upgrading payloads for existing platforms offers a rapid and cost-effective way to improve or integrate new capabilities into proven platforms. Aircraft naturally lend themselves to a payload focus because they are designed with hard points and junctions into which a number of modular payloads can be connected. We also need a deliberate, comprehensive, and effective process to design advanced platforms to recapitalize existing ships and aircraft. The key in designing new platforms is to control their cost and incorporate the space, weight, power, and cooling margin needed to host a range of new platforms over its life. Payloads extend the effectiveness of platforms and are an important part of the mix in balancing capability and capacity.

Upgrading current aircraft enables us to maintain a qualitative edge, while developing and producing new aircraft allows the Navy to provide the necessary capabilities in the future. A complementary mix of upgraded F/A–18E/F and future F–35C squadrons will provide the air wing the proper balance of capability, responsiveness and affordability across the spectrum of military operations. Both F/A–18 E/F and F–35C carry or will carry a wide range of payloads and Navy will continue to develop and expand additional payload capability to pace threat development.

QUESTIONS SUBMITTED TO GENERAL MARK A. WELSH, III

QUESTIONS SUBMITTED BY SENATOR PATRICK J. LEAHY

Question. In your comments to the committee, you stated, ". . . we need to determine when do we need [the F–35], how much of it do we need, and then how do we mix it with a fourth generation capability that we will have in our fleet for years?"

Answer. The Air Force remains committed to the F–35, but budget reductions are forcing the Air Force to seek a balance between investing in new aircraft and sustaining/modernizing our aging fighter fleet. Under any reasonable forecast, the Air Force will continue to field a mix of 4th and 5th generation fighters for the next two decades; however, as long as potential adversaries pursue advanced threats to our fighter forces we see no alternative to the F–35. The fiscal year 2014 President's budget, as submitted, funds F–35 procurement and legacy fighter modernization to include F–16 service life extensions. However, under sequestration budget levels, some 4th generation modernization programs will have to be slowed or terminated.

Question. Does this statement signal any lessening of the Air Force's commitment to the F–35 in the future? Specifically, do you intend to service-life extend F–16s beyond their current sunset date, or to maintain a future Air Force that will fly both F–35s and F–16s for the foreseeable future?

Answer. The Air Force remains committed to the F–35, but budget reductions are forcing the Air Force to seek a balance between investing in new aircraft and sustaining/modernizing our aging fighter fleet. Under any reasonable forecast, the Air Force will continue to field a mix of 4th and 5th generation fighters for the next two decades; however, as long as potential adversaries pursue advanced threats to our fighter forces we see no alternative to the F–35. The fiscal year 2014 President's budget, as submitted, funds F–35 procurement and legacy fighter modernization to include F–16 service life extensions. However, under sequestration budget levels, some 4th generation modernization programs will have to be slowed or terminated.

Question. During the hearing, you mentioned that ". . . [F–35s] can't fly within 25 miles of lightning. They can't fly in the weather yet. That's going to require software development that's due and is on track to be delivered. By the time we reach our initial operational capabilities at the end of 2016 for the Air Force, those problems will be in the past."

These are clearly major operational deficiencies. What other capability gaps do you perceive in the aircraft that will be resolved by future block updates to software or hardware? When do you anticipate they will be resolved? What capability gaps will never be resolved by future engineering changes?

Answer. The F–35 development program delivers incremental capability through hardware and software block upgrades. Initial operational capability for the Air Force includes basic close air support (CAS), Air Interdiction, and limited Suppression and Destruction of Enemy Air Defense (SEAD/DEAD) operations in a contested environment. The Joint Program Office conducted a Critical Design Review for the final capability block on 25–27 June. Based on the current program schedule, the F–35 Joint Program Office is moderately confident the F–35A will meet those capabilities by the initial operational capability date in 2016. The final block of capability in the F–35 System Development and Demonstration program is anticipated for August 2017. It is expected to include full warfighting capability, including close

air support, Air Interdiction and Strategic Attack, SEAD/DEAD, Offensive and Defensive Counter Air, with an expanded flight envelope and array of weapons.

Question. What air forces and what defense systems is the F–35 designed to counter? What planes will those countries fly in opposition to the F–35? In what ways is the F–35 superior to those planes?

Answer. Countries like Russia and China continue to make tremendous leaps in the technology and capability within their own air forces. Fighters, such as the SU–30 and SU–35, are equipped with improved targeting systems, cutting edge electronic jammers, and advanced air-to-air weapons. These aircraft are on par to our own legacy fleet and are already deployed in significant numbers. These fighters are offered for sale worldwide to any potential adversary. The SU–35 was "center stage" at this year's Paris Air Show, marketed as the counter to America's air superiority advantage.

Russia and China are also developing their own fifth generation fighters such as the PAK–FA, J–20, and J–31. With improved aerodynamic performance, reduced radar cross sections (i.e., "stealth"), sophisticated digital radar systems, and networked targeting solutions, these aircraft are designed to challenge our F–22 and F–35 for control of the skies.

The F–35, however, will hold the advantage against these advanced fighter threats. Its fifth generation capabilities in stealth, electronic attack and protection, combined with a networked and sensor fused targeting solution, ensure our F–35s will "see first, shoot first, kill first" in any future air-to-air conflict. Details on these capability advantages are classified, but can be provided upon request.

Question. What air defense systems and equipment will the F–35 be expected to attack, and is it capable of doing that job? How vulnerable is the F–35 to surface-to-air missiles? Which radar systems now manufactured, installed and exported by Russia, by China, and by other countries are incapable of detecting the F–35?

Answer. The F–35, with its fifth generation capabilities of advanced stealth, improved electronic attack and protection, and fused and networked sensors for enhanced situational awareness, achieves unmatched levels of survivability and lethality against the most advanced integrated air defense systems. Because of this, the Air Force expects to employ the F–35 in the most challenging threat environments; areas our current legacy fleet simply cannot operate in and survive. This allows the Air Force to hold the enemy's most defended targets at risk, while we maintain the ability to protect the U.S. military personnel in the air and on the ground.

When the F–35 is fielded in the Block 3F configuration, it will have the full complement of capabilities and weapons needed to ensure mission success in the most contested, anti-access and area denied environment. The Air Force fully expects it will perform superbly in the role of suppression and destruction of enemy air defenses and it will ensure our air advantage in any potential future conflict.

Details on the F–35's performance against specific adversary radar systems are classified, but can be provided upon request. However, in general terms, the F–35's fifth generation capabilities of improved stealth, advanced electronic attack and protection, and fused and networked sensors will ensure it can detect, target, track, and destroy the most advanced air defense systems that Russia or China are fielding or exporting well before they can detect and target the F–35 in return.

Stealth and signal management are not just "magic paint" we add to an airplane to make it invisible to an enemy's radar. It is a combination of inherent design features including aircraft shape, internal weapons and fuel, and special coatings, designed to significantly reduce the radar energy return coming from the F–35. When used in combination, these design features provide the reduced radar cross section needed to reduce the adversary's ability to detect and engage the F–35, providing the freedom of movement needed to hold targets at risk in these heavily defended environments. Without them, as is the case for our legacy fourth generation fleet, we simply cannot survive and operate in these environments.

Question. Please explain how the F–35 will perform its role of close ground support. How vulnerable is the F–35 to destruction by rifle fire?

Answer. The U.S. Air Force cannot provide detailed descriptions of how the F–35 will perform close air support (CAS) in an unclassified forum. However, we can provide a general discussion of the capabilities that make the F–35 a superb platform for CAS and provide detailed information on operational procedures in a more appropriate forum if requested.

The F–35 provides increased survivability and lethality with its fused sensors, precision weaponry, large payload and fuel load, and data-link capability, all offering distinct advantages in a CAS role. The F–35 can provide precision fire on CAS targets while remaining out of range of returning small arms fire and tactical surface-to-air threats. In addition, the F–35's advanced stealth and improved electronic

attack and protection capabilities will allow it to conduct CAS missions in areas where legacy platforms cannot operate and survive.

To ensure survivability when conducting CAS, the F–35 program is conducting extensive live-fire testing of the aircraft's ability to survive battle damage, the most exhaustive live-fire testing the U.S. military has ever conducted for a tactical fighter. This live-fire testing includes extensive analysis of the impacts to the F–35's survivability due to small arms fire.

SUBCOMMITTEE RECESS

Senator DURBIN. Thank you for your testimony. Thanks, everyone, for attending.

And this meeting of the subcommittee stands adjourned.

[Whereupon, at 11:35 a.m., Wednesday, June 19, the subcommittee was recessed, to reconvene subject to the call of the Chair.]