S. HRG. 114–302

PROCUREMENT, ACQUISITION, TESTING, AND OVERSIGHT OF THE NAVY'S GERALD R. FORD–CLASS AIRCRAFT CARRIER PROGRAM

HEARING

BEFORE THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

OCTOBER 1, 2015

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PROCUREMENT, ACQUISITION, TESTING, AND OVERSIGHT OF THE NAVY'S GERALD R. FORD–CLASS AIRCRAFT CARRIER PROGRAM

THURSDAY, OCTOBER 1, 2015

U.S. SENATE,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

The committee met, pursuant to notice, at 9:31 a.m. in Room SD–G50, Dirksen Senate Office Building, Senator John McCain (chairman) presiding.

Committee members present: Senators McCain, Wicker, Ayotte, Fischer, Cotton, Rounds, Ernst, Tillis, Sullivan, Reed, McCaskill, Manchin, Gillibrand, Donnelly, Hirono, Kaine, and King.

OPENING STATEMENT OF SENATOR JOHN McCAIN, CHAIRMAN

Chairman McCAIN. Good morning.

For more than seven decades, the aircraft carrier has been the centerpiece of America's global power projection. We rely on our carrier fleet to defend our interests, our values, and our allies around the world, a mission that is more important than ever today as global threats multiply from Gulf to the Western Pacific to the North Atlantic.

For 13 years, the Department of Defense has sought to develop our newest aircraft carrier, the USS *Gerald R. Ford*, marking the beginning of an entire new class of this ship. The *Ford*-class aircraft carrier program is one of our Nation's most complex and most expensive defense acquisition projects. It's also become, unfortunately, one of the most spectacular acquisition debacles in recent memory. And that's saying something. The *Ford*-class program is currently estimated to be more than $6 billion over budget. Despite the recent announcement of a 2-month delay, the first ship is scheduled for delivery next year. The second ship, however, is 5 years behind schedule. Significant questions still remain about the capability and reliability of the core systems of these aircraft carriers. And yet, when I asked the former Chief of Naval Operations [CNO] who's responsible for the cost overrun on the USS *Gerald R. Ford*, he said he didn't know.

This committee has been actively involved with this program from the very start. And, since the beginning of this year, our oversight has increased significantly. At the direction of Senator Reed and myself, committee staff have conducted a thorough investigation of the *Ford*-class program. This work has entailed the request and review of thousands of pages of work plans, proprietary documents, contracting information, correspondence, and operational testing data, as well as numerous interviews with key players from the Office of the Secretary of Defense, the Navy, and the industry. This work has been done on a bipartisan basis, in keeping with the best traditions of this committee.

As a result, we meet today with clear goals: to examine what has gone wrong with this program, to identify who is accountable, to assess what these failures mean for the future of our aircraft carrier fleet and Navy shipbuilding, and to determine whether any reforms to our defense acquisition system could prevent these failures from ever happening again.

To help us answer these questions today are the key civilian and military officials who are responsible for developing, procuring, testing, and overseeing the *Ford*-class program. The Honorable Katrina McFarland, Assistant Secretary of Defense for Acquisition, is the principal advisor to the Secretary of Defense and Under Secretary of Defense for Acquisition, Technology, and Logistics [AT&L] on matters relating to acquisition. The Honorable Sean Stackley, Assistant Secretary of the Navy for Research, Development, and Acquisition, is the Navy's acquisition executive responsible for the research, development, and acquisition of Navy and Marine Corps systems. Rear Admiral Michael Manazir, who is Director of Air Warfare on the Navy staff, is responsible for Navy—naval aviation requirements. Rear Admiral Thomas Moore, Program Executive Officer for Aircraft Carriers, is responsible for aircraft carrier acquisition. Rear Admiral Donald Gaddis, Program Executive Officer for Tactical Aircraft, is responsible for naval tactical aircraft acquisition programs, including aircraft launch and recovery equipment. The Honorable J. Michael Gilmore, Director of Operational Test and Evaluation [DOT&E], is the senior advisor to the Secretary of Defense for operational and live-fire test and evaluation of weapon systems. And Mr. Paul Francis, Managing Director of Acquisition and Sourcing Management at the Government Accountability Office, whose 40-year career with GAO [Government Accountability Office] is focused mostly on major weapons acquisitions, especially shipbuilding.

We thank each of our distinguished witnesses, and thank them for joining us today.

In 2002, Secretary Donald Rumsfeld, the Office of the Secretary of Defense, and the Navy conceived of the USS *Gerald Ford—Gerald R. Ford,* or CVN–78, as a, quote, "transformational weapon system." They decided to develop concurrently and integrate onto one ship all at once a host of advanced and entirely unproven technologies, including a new nuclear reactor plant, a new electrical distribution system, a new enlarged flight deck, a new dual-band radar [DBR], a new electromagnetic catapult system to launch aircraft, and new advanced arresting gear [AAG] to recover them. This was the original sin, in my view, that so damaged this program.

Since 2008, the estimated procurement cost for CVN–78 has grown by $2.4 billion, or 23 percent, for a total cost of $12.9 billion. The story of the USS *John F. Kennedy*, or CVN–79, could be worse, because the Department of Defense began building it before proving the new systems on CVN–78 and while continuing to make major changes to the CVN–79, including a new radar. This has made CVN–79, in essence, a second lead ship, with all of the associated problems. Its estimated cost has risen to $11.5 billion, a $2.3-billion, or 25-percent, increase, and the ship has been delayed 5 years, to 2024.

Much of the cost growth and scheduled delays for the ship itself have been due to problems with its major components which the Navy has been developing separately. These systems, especially those that launch and recover aircraft, have faced their own significant cost growth and schedule delays, and they still are not ready. For example, the advanced arresting gear, or AAG, was built as a more efficient and effective way to recover a wider variety of aircraft on the carrier deck. However, AAG's development costs have more than quadrupled, and it is expected to make—to take twice as long as originally estimated, 15 years in total, to complete. As a result, if CVN–78 goes to sea as planned in 2016, it will do so without the capability to recover all of the types of aircraft that would land on the ship. Furthermore, the cost and schedule programs with AAG have so driven up its per-unit cost that the Navy will be unable to upgrade on our older *Nimitz*-class carriers with this new system as originally planned. This means that, by the 2030s, many of our naval aircraft may be able to land on just a few of our carriers.

The *Ford*-class program is actually symptomatic of a larger problem, the dysfunction of our defense acquisition system as a whole. A decade of oversight reporting show that CVN–78 has been plagued by the same problems found throughout Navy shipbuilding, and indeed, most major defense acquisition programs: unrealistic business cases, poor cost estimates, new systems rushed to production, concurrent design and construction, and problems testing systems to demonstrate promised capability. All of these problems have been made worse by the absence of competition in aircraft carrier construction.

What's more, the *Ford*-class program exemplifies the misalignment of accountability and responsibility in our defense acquisition system. To my knowledge, not a single person has ever been accountable—held accountable for the failures of this program. That is due, in no small part, to diffusion of authority across multiple offices and program managers. These blurred lines of accountability allow the leaders of our defense acquisition system to evade responsibility for results. Everyone is responsible, so no one is responsible.

While the Navy and the contractors deserve much of the blame, the milestone decision authority for the *Ford*-class program rests with the Office of the Secretary of Defense, specifically the Under Secretary of Defense for Acquisition, Technology, and Logistics. AT&L is responsible for determining whether a program has a sound business case and for approving the start of development and production. The Navy can be faulted for excessive optimism and deficient realism. But, AT&L was neither complacent—was either complacent or complicit. Indeed, AT&L authorized the Navy to start construction of CVN–78 when only 27 percent of the ship was designed and just 5 of its 13 new systems were mature. Despite 10 years of warnings from its own independent cost estimators and weapons testers, as well as the GAO, AT&L failed to make timely and effective course corrections.

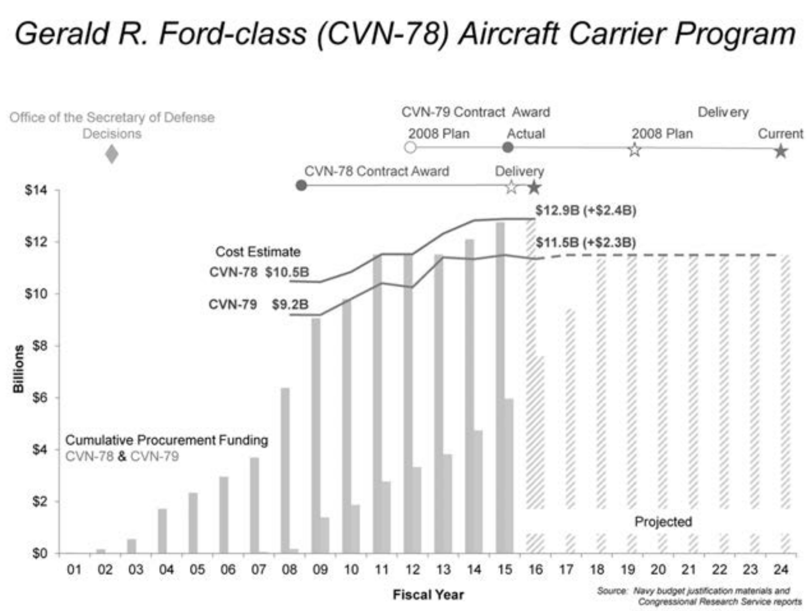
And lest anyone think that Congress is above reproach, we are not. While congressional oversight has helped to control the cost and improve the program, we could have intervened more forcefully and demanded more from the Department of Defense. And we did not.

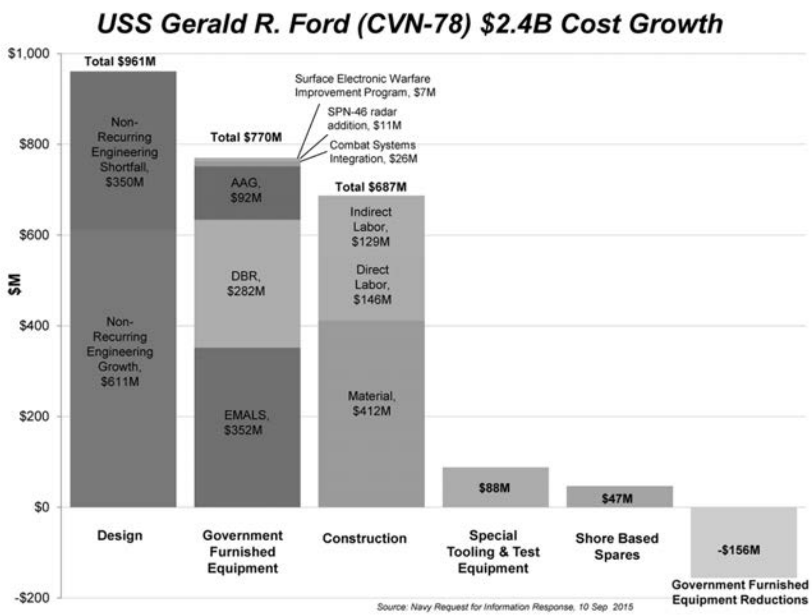
Ultimately, all of us need to internalize the lessons of this program. I am encouraged that the Navy appears to be doing so in their efforts to stabilize the program and change their approach to contracting for CVN–79.

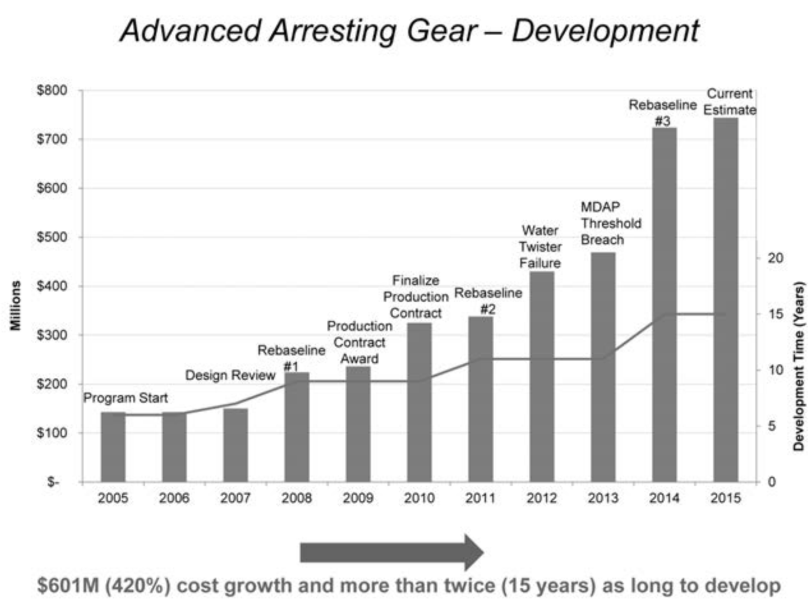
This year's National Defense Authorization Act [NDAA] also contains several provisions that increase oversight of the *Ford*-class program, streamline authority, accountability, and responsibility in our defense acquisition system. But, perhaps the lesson I would most stress is this: we cannot afford another acquisition failure like the *Ford*-class aircraft carrier, especially in the current fiscal environment. We simply cannot afford to pay $12.9 billion for a single ship. And if these costs are not controlled, we must be willing to pursue alternatives that can deliver similar capability to our warfighters on time and on budget. We must be willing to question whether we need to go back to building smaller, cheaper aircraft carriers that could bring new competitors into this market. We might even have to consider rebalancing our long-range strike portfolio with fewer carriers and more land-based or precision-guided weapons. If we can't do better, everything must be on the table. And so long as I am Chairman, it will.

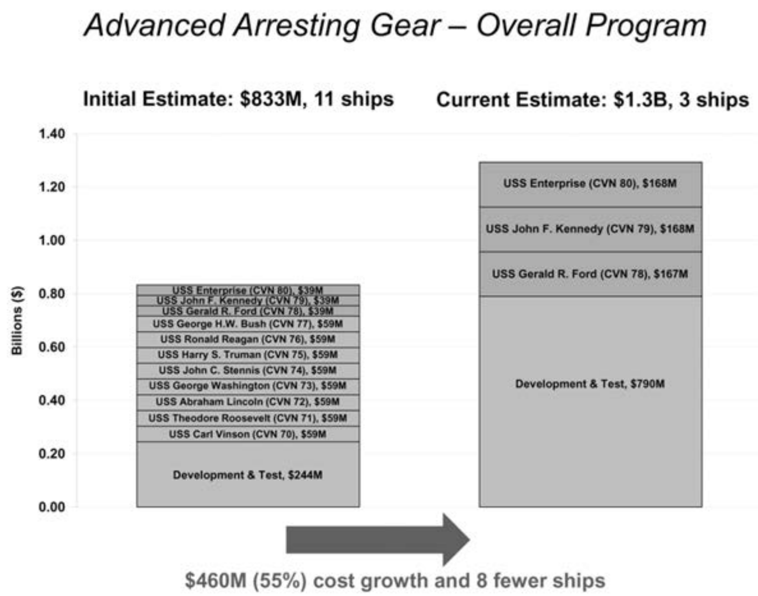
I thank the witnesses and look forward to their testimony.

[A series of charts follow:]




USS Gerald R. Ford (CVN-78) $2.4B Cost Growth
$M
Total $961M
Non-Recurring Engineering Shortfall, $350M
Non-Recurring Engineering Growth, $611M
Total $770M
Surface Electronic Warfare Improvement Program, $7M
SPN-46 radar addition, $11M
Combat Systems Integration, $26M
AAG, $92M
DBR, $282M
EMALS, $352M
Total $687M
Indirect Labor, $129M
Direct Labor, $146M
Material, $412M
$88M
$47M
-$156M
Design
Government Furnished Equipment
Construction
Special Tooling & Test Equipment
Shore Based Spares
Government Furnished Equipment Reductions
Source: Navy Request for Information Response, 10 Sep 2015


Advanced Arresting Gear – Development
Millions
Development Time (Years)
Program Start
Design Review
Rebaseline #1
Production Contract Award
Finalize Production Contract
Rebaseline #2
Water Twister Failure
MDAP Threshold Breach
Rebaseline #3
Current Estimate
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
$601M (420%) cost growth and more than twice (15 years) as long to develop



Chairman McCain. Senator Reed.

STATEMENT OF SENATOR JACK REED

Senator Reed. Well, thank you very much, Mr. Chairman. Let me commend you for calling this extremely important hearing, and not only calling the hearing, but for your attention to this issue over many, many years, and your advice and your insistence that we pay close attention to this program, and other programs, too.

The *Gerald Ford*-class aircraft carrier program has been plagued by delays and cost overruns since its inception over a decade ago, and today's hearing will focus on many of the problems that we've seen during the execution of the program.

Some of these delays and inefficiencies are the responsibility of the shipbuilder, who has been operating on a cost-plus incentive-fee type of contract and has been slow to apply modern building techniques that the shipbuilder is using in other programs, such as the *Virginia*-class program.

Some of the problems stem from including new technologies that were not sufficiently matured into the design of the ship. These immature technologies included systems that are critical for successful operation of the aircraft carrier: the advanced arresting gear, the electromagnetic aircraft launch system [EMALS], and the dual-band radar. Each of these systems have posed schedule challenges and is millions of dollars over budget.

While we recognize that designing and building an aircraft carrier is a difficult and costly enterprise, the committee is concerned that some of these problems were foreseeable and should have been resolved years ago. But, I believe there's a larger issue woven into this drama. If we look back at the inception of the program, the

Navy was facing the inevitable retirement of the USS *Enterprise,* CVN–65, which was scheduled to run out of fuel about 2013 or 2014. This pressurized a schedule for starting the first ship in the CVN–21 program, which evolved into what would become the next aircraft carrier, the *Gerald R. Ford.* The CVN–21 program was intended to evolve technologies over a two-ship program, CVNX–1 and CVNX–2, and install new systems when they had achieved sufficient maturity to warrant inclusion. While that might not have been a perfect—the two-step approach—the two-step plan was more in keeping with the spiral acquisition approach favored by the Weapon Systems Acquisition Reform Act of 2009. However, in late 2002, the Navy was directed, as Senator McCain indicated, by the Secretary of Defense to pursue a program that was more transformational. This involved incorporating all of the new technologies on the first ship, which caused DOD [Department of Defense] to make risky choices in the aircraft carrier program. And we are living with the results of those choices now in the delayed deliveries and increased cost.

The Navy is not blameless in this process, either. The Navy shares blame for failing to lay out potential off-ramps for risky technologies that did not mature in time to meet the underlying schedule. I believe the Navy could have done this even within the parameters of transformation. While such off-ramps may not have prevented all the problems we have faced, it would have had—at least given us better options when we had unpleasant discoveries during the development phase.

The Navy and the contractors share blame for starting construction of ship before sufficient work had been completed on the design of the ship. And history has shown that this inevitably leads to inefficient production, schedule delays, and cost increase.

Finally, Congress shares responsibility for having approved the Department of Defense approach to acquiring these aircraft carriers. The only change to the program that Congress insisted upon was instituting a legislative cost cap on the three ships in the program. And, while I think this cost gap has brought some better discipline to the program, it has not prevented cost and schedule problems.

I look forward hearing from these witnesses on this important program about changes that have been made and can be made in the future to prevent the cost and schedule overruns that we see today.

And, once again, thank you, Mr. Chairman, for your leadership.

Chairman MCCAIN. I thank the witnesses. And we will hear opening witness statements from Secretary McFarland, Secretary Stackley, Dr. Gilmore, and Mr. Francis, and then we will proceed with questions.

We will begin with you, Secretary McFarland. Welcome.

STATEMENT OF HON. KATRINA G. MCFARLAND, ASSISTANT SECRETARY OF DEFENSE (ACQUISITION), DEPARTMENT OF DEFENSE

Ms. MCFARLAND. Chairman McCain, Ranking Member Reed, and distinguished members of this committee, I appreciate the opportunity to appear today to testify about procurement, acquisition, testing, and oversight of the Navy's CVN–78 Gerald R. *Ford*-class aircraft carrier program.

I ask that my prepared statement be taken and submitted for the record.

Chairman MCCAIN. Without objection. All statements will be included.

Ms. MCFARLAND. Thank you.

The CVX program was initiated in 1996. Its development and procurement timelines have spanned numerous administrations and multiple changes in acquisition policy, as the Chairman and the Ranking Member noted. The program has been subject of many—multiple program reviews looking to reduce costs and achieve efficiencies that have redirected the acquisition approach or technical baseline.

As with all the Department's programs, the CVN–78 has had to compete for the resources in the President's budget review. And, while each change in policy, acquisition approach, or technical baseline was made in the best interests of the warfighter, the Department, and the taxpayer in mind, the cumulative effect of these changes has resulted in program instability.

Since 2010, and coincident with the introduction of the Department's better buying power initiatives, this program has been largely stabilized. While technical challenges remain, the Under Secretary of Defense for Acquisition, Technology, and Logistics continues to work with the Navy to tailor the program and ensure appropriate oversight at both the Navy staff level as well as OSD [Office of the Secretary of Defense].

We've established an excellent relationship with the Navy and worked together to change processes and policies that have impacted the ability of the program to succeed, to include revitalizing the acquisition workforce and the skills of them—of whom we represent here, several thousand men and women who lead our Nation's shipbuilding acquisition.

The timeline and complexities associated with the construction of aircraft carriers are enormous and sensitive to a wide range of technological, economic, policy, and business factors, many of which cannot be predicted in time to be readily mitigated. Nevertheless, we are committed to applying the resources needed to keep control of aircraft carrier program costs and schedules for the CVN–78, –79, and all that follow, and deliver these carriers to meet the needs of the warfighter.

Again, thank you for the opportunity to appear today. And I look forward to your questions.

[The prepared statement of Ms. McFarland follows:]

PREPARED STATEMENT BY MS. KATRINA G. MCFARLAND

Chairman McCain, Ranking Member Reed, and distinguished members of the Committee, I appreciate the opportunity to appear before the subcommittee and testify about the procurement, acquisition, testing, and oversight of the Navy's CVN–78 *Gerald R. Ford*-class aircraft carrier program.

EVOLUTION OF THE CVN–78 PROGRAM

The CVX program was initiated in 1996. This was right on the heels of the famous "Perry Memo" of 1994 which began Secretary of Defense Perry's reduction of the acquisition workforce and directed the armed services to use commercial specification and standards instead of the index of military specifications and standards. This was the era of Total Systems Performance Responsibility (TSPR) and Large Systems Integrators (LSI). We believed that trusting industry over Government was the right way to obtain the end of the Cold War Dividends. And as the acquisition strategy and material solution for the CVX was being deliberated, the 1997 Defense Reform Initiative led by Secretary of Defense William Cohen was codified, which had four pillars of reform: Re-engineer (adopt modern business practices), Consolidate (streamline organizations to eliminate redundancy) Compete, and Eliminate (which ultimately reduced the Acquisition Workforce by 56 percent).

With the turn of the century, USD AT&L Jacques Gansler put forth a new path with his 2000 acquisition reform initiative of 3 "top line" goals—reduce cycle time for the development and delivery of new weapon systems, reduce total ownership costs, and "right size" the Defense Acquisition Workforce and infrastructure to realize savings thru efficiencies. This continued to erode the engineering expertise within the Department of Defense (DOD) further (as evidenced later when in 2007, then Navy Secretary Don Winter would note the overreliance on contractors).

By 2000, the CVN(X) Acquisition Strategy that had been proposed by the Navy was an evolutionary, three-step development of the capabilities planned for the CVN. This evolutionary strategy intending to mature technology and align risk with affordability originally involved using the last ship of the CVN–68 *Nimitz*-class, USS *George H. W. Bush* (CVN–77), as the starting point for insertion of some near term technology improvements including information network technology and the new Dual Band Radar (DBR) system from the DD(X) (now DDG 1000) program, to create an integrated warfare system that combined the ship's combat system and air wing mission planning functions.

However, the then incoming Secretary of Defense Donald Rumsfeld in 2002 directed re-examination of the CVN program, among others, to reduce the overall spend of the department and increase the speed of delivery to the warfighters. As a result of the SECDEF's direction, the Navy proposed to remove the evolutionary approach and included a new and enlarged flight deck, an increased allowance for future technologies (including electric weapons), and an additional manpower reduction of 500 to 800 fewer sailors to operate. On December 12, 2002, a Program Decision Memorandum approved by then Deputy Secretary of Defense Paul Wolfowitz codified this Navy proposal and gave this direction back to the DOD enterprise. The ship was renamed the CVN–21 to highlight these changes. By Milestone B in April 2004, the Navy had evaluated the technologies intended for three ships, removed some of them, and consolidated the remaining ones into a single step of capability improvement on the lead ship. The new plan acknowledged technological, cost, and schedule challenges were being put on a single ship, but assessed this was achievable. The Acting USD AT&L (Michael Wynne) at that milestone also directed the Navy to use a hybrid of the Service Cost Position and Independent Cost Estimate (ICE) to baseline the program funding in lieu of the ICE, (although one can easily argue even the ICE was optimistic given these imposed circumstances).

By 2004, DOD and Congressional leadership had lost confidence in the acquisition system, and Deputy Secretary of Defense Gordon England established the Defense Acquisition Performance Assessment (DAPA) panel to conduct a sweeping and integrated assessment of "every aspect" of acquisition. The result was the discovery that the Industrial Base had consolidated, that excessive oversight and complex acquisition processes were cost and schedule drivers, and a focus on requirements stability was key to containing costs. From this, a review of the requirements of the CVN resulted in a revised and solidified "single ship" Operational Requirements Document (ORD) for the *Ford*-class as defined today, with the CVN–78 as lead ship.

On the heels of a delay because of the budgetary constraints in 2006, the start of the construction of CVN–78 was delayed until 2008, but the schedule for delivery was held constant, further compounding risks and costs. The Navy's testimony covers these technical and schedule risks and concurrency challenges well.

By 2009, this Committee had issued a floor statement in support of the Weapon Systems Acquisition Reform Act (WSARA). Congress was now united in its pursuit of acquisition reform and, in concert, USD AT&L re-issued and updated the Department of Defense's acquisition instruction (DODI 5000.2) in 2008. WSARA included strengthening of the 'Nunn-McCurdy" process with requires DOD to report to Congress when cost growth on a major program breaches a critical cost growth threshold. This legislation required a root-cause assessment of the program and assumed program termination within 60 days of notification unless DOD certified in writing that the program remained essential to national security.

WSARA had real impact on the CVN–78, as by 2008 and 2009 the results of all the previous decisions were instantiated in growth of cost and schedule. Then USD AT&L John Young required the Navy to provide a list of descoping efforts and directed the Navy to have an off-ramp back to steam catapults if the Electromagnetic Aircraft Launching System (EMALS) remained a problem for the program. He also directed an independent review of all of the CVN–78 technologies by a Defense Support Team (DST). Prior to the DST, the Navy had chartered a Program Assessment Review (PAR) with USD (AT&L) participation of EMALS/Advanced Arresting Gear (AAG) versus steam. One of the key PAR findings was converting the EMALS and AAG production contracts to firm, fixed price contracts to cap cost growth and imposed negative incentives for late delivery.

The Dual Band Radar (DBR) cost and risk growth was a decision by-product of the DDG 1000 program Nunn-McCurdy critical unit cost breach in 2010. Faced with a need to reduce cost on the DDG 1000 program and the resultant curtailment of the program, the expectation of development costs being borne by the DDG 1000 program was no longer the case and all of the costs associated with the S-band element development and a higher share of the X-band element then had to be supported by the CVN–78 program.

The design problems encountered with AAG development have had the most deleterious effects on CVN–78 construction of any of the three major advanced technologies including EMALS and DBR. Our view of AAG is that these engineering design problems are now in the past and although delivery of several critical components have been delayed, the system will achieve its needed capabilities before undergoing final operational testing prior to deployment of the ship. Again, reliability growth is a concern, but this cannot be improved until a fully functional system is installed and operating at the Lakehurst, New Jersey land based test site, and on board CVN–78.

With the 2010 introduction by then USD AT&L Ashton Carter (now in its third iteration by under USD AT&L Frank Kendall) of the continuous process improvement initiative that was founded in best business practices and WSARA called "Better Buying Power," the CVN underwent affordability, "Should Cost," and requirements assessment. Navy's use of the "Gate" process has stabilized the cost growth and reset good business practices .However, there is still much to do. We are in the testing phase of program execution prior to deployment and we had been concerned about the timing of the Full Ship Shock Trial (FSST). After balancing the operational and technical risks, the Department decided to execute FSST on CVN–78 prior to deployment.

EMALS and AAG are also a concern with regard to final operational testing stemming from the development difficulties that each experienced. The Navy still needs to complete a significant amount of land-based testing to enable certification of the systems to launch and recover the full range of aircraft that it is required to operate under both normal and emergency conditions. This land-based testing is planned to complete before the final at-sea operational testing for these systems begins.

WAY AHEAD

USD AT&L continues to work with Navy to tailor the program and ensure appropriate oversight at both the Navy Staff level as well as OSD. Our review of the Navy's plan for maintaining control of the cost for CVN–79 included an understanding of the application of lessons learned from the construction of CVN–78 along with the application of a more efficient construction plan for the ship including introduction of competition where possible. We have established an excellent relationship with the Navy to work together to change process and policies that have impacted the ability of the program to succeed, to include revitalizing the acquisition workforce and their skills.

We are confident in the Navy's plan for CVN–79 and CVN–80 and, as such, Under Secretary Kendall recently authorized the Navy to enter into the detail design and construction phase for CVN–79 and to enter into advanced procurement for long lead time materials for CVN–80 construction. OSD and the Navy are committed to delivering CVN–79 within the limits of the cost cap legislated for this ship.

Our focus areas from this point forward are:

- Getting CVN–78 delivered with no further cost growth.
- Preparing for and completing the remaining test program for CVN–78.
- Ensuring the cost reduction initiatives being implemented for CVN–79 construction are closely monitored and are paying off as projected.

From a programmatic standpoint we are minimizing the administrative burden on the program by tailoring program documentation and reporting requirements. This tailoring will ensure program personnel are focused on the shipyard and test programs rather than documentation for review purposes. In addition to the quarterly reports from the program, we are implementing an annual review of the program to maintain awareness of the progress on testing of CVN–78 and the cost of CVN–79. These reviews are expected to occur in the December timeframe each year.

CONCLUSION

The goals of the Department are to correct the problems encountered on the *Gerald R. Ford,* and deliver successive ships within cost, providing capability, and on schedule. This will not be easy. The timeline and complexities associated with the construction of aircraft carriers are enormous and sensitive to a wide range of technological, economic, policy and business factors, many of which cannot be predicted in time to be readily mitigated. Nevertheless, we are committed to applying the resources needed to keep control of aircraft carrier program costs and schedule for the CVN–78, CVN–79, and all that follow.

Chairman MCCAIN. Secretary Stackley.

STATEMENT OF HON. SEAN J. STACKLEY, ASSISTANT SECRETARY, RESEARCH, DEVELOPMENT, AND ACQUISITION, DEPARTMENT OF THE NAVY; ACCOMPANIED BY REAR ADMIRAL DONALD E. GADDIS, USN, PROGRAM EXECUTIVE OFFICER, TACTICAL AIRCRAFT, DEPARTMENT OF THE NAVY, AND REAR ADMIRAL THOMAS J. MOORE, USN, PROGRAM EXECUTIVE OFFICER, AIRCRAFT CARRIERS, DEPARTMENT OF THE NAVY, AND REAR ADMIRAL MICHAEL C. MANAZIR, USN, DIRECTOR, AIR WARFARE (OPNAV)

Mr. STACKLEY. Mr. Chairman, Ranking Member Reed, members of the committee, thank you for the opportunity to appear today to discuss the CVN–78 carrier program.

This committee, and no one more than you, Mr. Chairman, fully understands the role of the carrier as an instrument of American diplomacy, power projection, and global security. George Will summed it well in his column just yesterday, "The Navy's operations on which the sun never sets are the Nation's nerve endings connecting it with a turbulent world, for though the next President may be elected without addressing the Navy's size and configuration, for 4 years he or she will be acutely aware of where the carriers are."

The newest of these carriers will be the *Gerald R. Ford,* CVN–78, the Nation's first new carrier design since the *Nimitz* was authorized by Congress in 1967. The *Ford* itself will be in service for 50 years in a three-ship class until almost 2080. It is, therefore, imperative, as this committee has so clearly impressed upon the Department and reemphasizes here today, that our future carrier force have the capability necessary to defeat the future threat, but, two, that it does so at a cost that the Nation can bear.

Designing, building, manning, operating, and maintaining these incredibly complex ships is beyond any other nation's undertaking. Those members who have visited the *Ford* under construction fully appreciate the daunting numbers that measure her: tens of thousands of tons of structure, thousands of miles of cable and fiber optics, hundreds of miles of pipe, thousands of compartments, hundreds of ship systems, tens of thousands of sensors integrated to drive greater than 1,000 megawatts of nuclear power across the globe throughout its life. It is a remarkable demonstration of what American industry is able to achieve, and it is a quantum increase in capability for our warfighter, capability required by our Navy in the century ahead.

To be clear, however, this program has had significant challenges resulting in unacceptable cost growth. And to understand the cause of this cost growth, it's important to understand the carrier's history.

As the *Nimitz* approached mid-life, requirements were drafted to modernize future carriers to a traditional serial evolution of technology development, ship design, and construction. A total of 23 new capabilities were to be incrementally introduced across three ships, commencing with CVN–77, at a pace consistent with the maturity of the related technologies. These development capabilities would provide a 33-percent increase in the rate at which aircraft are launched and recovered, a propulsion plant providing three times the electrical generating capacity and 25 percent more energy than *Nimitz*, increased service life allowances to enable future modernization, increase survivability, including improvements to the combat system, firefighting systems, weapons handling, and basic hull design, and, importantly, a $4 billion reduction per ship in total ownership cost over the ship's 50-year life. Technology development was initiated for the electromagnetic aircraft launching system, or EMALS, the advanced arresting gear, or AAG, and the advanced weapons elevators. Modernization of weapons, sensors, and communications systems would be accomplished by incorporating new capabilities developed, or being developed, by other programs, including the DDG–1000's state-of-the-art dual- band radar. A new power distribution, advanced degalcing system, and automated control systems would be incorporated to improve survivability. A new reactor plant, propulsion and machinery control systems would be developed to meet power requirements. The carrier's superstructure, or island, would be redesigned to accommodate the new electronics systems and to enable improved flight-deck operations. And all of these upgrades would contribute to a total manpower reduction of 1,200 sailors.

As the Chairman has pointed out, in 2002 with priority placed on transformation by the Secretary of Defense, DOD changed course such that the three-ship incremental modernization would be accomplished in a single step on a single ship, CVN–78. This decision resulted in what has proven to be a critically high degree of concurrent development, design, material procurement, and construction. Costs were estimated, and design and construction proceeded with inadequate information regarding the complexity of the new systems and with inadequate risk factors to account for the high degree of concurrency, ultimately impacting cost and performance in each phase of development, design, build, and test of CVN–78.

Today, design is effectively complete, and production is near 95 percent complete, and we are focused on completing the test program and delivering the lead ship. Actions put in place from 2009 through 2011 have been effective in halting the early cost growth on CVN–78, including converting the design from a level of effort to a completion contract with a firm target and incentive fee, placing contract design changes under strict control, reducing fee consistent with contract provisions, yet incentivizing improvements upon current cost performance, removing overly burdensome specifications that impose unnecessary cost, contracting and competing alternative sources of supply to mitigate the significant impact of material delays, raising completion levels at each stage of construction to improve production efficiencies. Meanwhile, following a detailed Nunn-McCurdy-like review in 2009, the Navy converted the EMALS and AAG contract to a firm fixed- price contract for production to cap cost on each of those systems. And the shipbuilder subjected its build process to review by competitor shipyards in order to identify fundamental changes necessary to improve their performance.

Finally, management changes were instituted and coupled with increased readiness reviews focused on cost performance and critical path issues to ensure we're doing all that can be done to improve cost performance.

I personally conduct reviews on no less than a quarterly basis, often monthly, and have assigned, for these past 4-plus years, Rear Admiral Moore, the Navy officer with the single greatest experience across carrier operations, construction, and program management, as the program executive officer. And, importantly, while we confront the impacts of concurrency on CVN–78, we've made essential changes to eliminate these causes for cost growth and to further improve performance on CVN–79 and –80. As reported to Congress in May of 2013, requirements for CVN–70 are locked down, the design model is complete, and 80 percent of initial drawings released. New technologies on CVN–78 are virtually mature on CVN–79. Material is being ordered efficiently and on schedule. The shipbuilder has leveraged lessons learned, incorporated produceability improvements, made significant investments to modernize tooling and facilities, and has implemented build sequence changes to drive down production cost. And the Navy is implementing a two-phase delivery plan to allow the basic ship to be constructed and tested in the most efficient manner by the shipbuilder while enabling select ship systems and compartments to be completed in a second phase where the work can be competed, accomplished more effectively, and use of skilled installation teams.

The net result of all these actions was the recent award of CVN–79 as a fixed-price construction contract that, in conjunction with GFE, government furnished equipment, procures CVN–79 at or below the congressional cost cap. We're on target on CVN–79 and will continue to reduce the costs of future ships of the class.

Mr. Chairman, you've raised questions regarding accountability. I am accountable for the decisions I make about this ship or any Navy/Marine Corps program for which I am the service acquisition executive. But, this simple statement doesn't adequately address your concern. The current system is challenged to align responsibility, accountability, and decision-making for large, complex projects that take years to develop and deliver. This program, in particular, has spanned four Secretaries of the Navy, six Chiefs of Naval Operations, four naval acquisition executives, six defense acquisition executives, four program executive officers, four program managers, and eight Congresses. Gaps, seams, and course changes and decisions have been critical.

The decision to pursue a transformational approach driving three incrementally enhanced ships into one was made for what was believed to be the right decision at that time. As the acquisition executive, what can be done to stabilize the cost on CVN–78 and pursue cost-performance improvements on the remainder of the class, I believe is being done. We have much further to go in this regard, but I believe we are on the right path.

Going forward, under the Secretary's direction, the CNO, the Commandant, and I are changing the way we do business within the Department of the Navy to achieve much greater clarity of authority, traceability to cost, visibility to performance, and therefore, accountability for cost and schedule on our major programs. We hope to have the opportunity to share these details with you and your staff.

In sum, your Navy is committed to providing our sailors with the capability they need to perform their missions around the world, around the clock, every single day of the year. And we strive every day to do this in a way that enhances affordability while ensuring we maintain a robust industrial base to hedge against an uncertain future.

We look forward to answering your questions, sir.

[The prepared statement of Mr. Stackley follows:]

JOINT PREPARED STATEMENT BY HON. SEAN J. STACKLEY, RADM DONALD E. GADDIS, RADM THOMAS J. MOORE, AND RADM MICHAEL C. MANAZIR

I. INTRODUCTION

Mr. Chairman, Senator Reed, and distinguished members of the committee, thank you for the opportunity to appear before you today to address the nation's Aircraft Carrier Program.

The aircraft carrier is the centerpiece of the Navy's Carrier Strike Groups and central to Navy core capabilities of forward presence, deterrence, sea control, power projection, maritime security, and humanitarian assistance/disaster response. The Navy remains committed to maintaining a carrier force, and associated carrier air wings, that provide unparalleled responsiveness and flexibility to operational commanders across the full range of military options. Maintaining the aircraft carrier force structure at the level required by the Nation and mandated by law requires a combination of a steady-state *Ford*-class procurement plan, recapitalizing the *Nimitz*-class via the Refueling and Complex Overhaul (RCOH) program, maintaining an in-service aircraft carrier life cycle support program, and operating current CVNs for their full 50-year service life as *Ford*-class CVNs are delivered. The *Ford*-class will be the centerpiece of the carrier strike group of the future. Taking advantage of the *Nimitz*-class hull form, the *Ford*-class features an array of advanced technologies designed to improve warfighting capabilities and allow significant manpower reductions.

There is no greater proof of the tangible effects of the modern carrier on global events than those that occurred in the past year. The *George H.W. Bush* Strike Group relocated from the Arabian Sea to the north Arabian Gulf and was on-station within 30 hours, ready for combat operations in Iraq and Syria. Navy and Marine Corps strike fighters from the carrier generated 20 to 30 combat sorties each day for 54 days to project power against the Islamic State of Iraq and Syria. The *Carl Vinson* Strike Group and Carrier Strike Group One followed, flying 12,300 sorties, including 2,383 combat missions. Now, the USS *Theodore Roosevelt* with Carrier Strike Group Twelve is forward deployed at the Combatant Commander's disposal to combat a brutal enemy.

II. FORD-CLASS PROGRAM BACKGROUND

In order to provide the increased warfighting capability deemed essential for air dominance in the 21st century and to reduce the significant cost associated with operating and supporting our naval air force, the Navy embarked on a design for a new class of aircraft carrier. The *Gerald R. Ford* (CVN–78) class represents a substantial advancement in operational capability, survivability, and the flexibility to accommodate future improvements in technology and warfighting capability over its service life, with significantly lower total ownership cost than the *Nimitz*-class. Long range planning for the eventual replacement of the *Nimitz*-class began with a mission area analysis in 1995 and a subsequent concept exploration phase to evaluate a new class of aircraft carrier with four objectives:

- Maintain the critical capabilities of sea based aviation as defined by the Navy and approved by the Joint Chiefs. Independent of land bases, the carrier must be able to launch and recover aircraft in sustained forward combat operations that can simultaneously perform three missions: (1) surveillance; (2) battle space dominance; and (3) strike.
- Increase flexibility and growth potential to leverage new technologies, operate future manned/unmanned aviation systems, counter future threats, and take on new missions.
- Improve carrier affordability by reducing total ownership cost.
- Improve carrier survivability, vulnerability, sustainability and interoperability.

The subsequent analysis of alternatives examined 75 conceptual designs over a three year period, which included a variety of sizes and alternative propulsion concepts. A Navy and Office of the Secretary of Defense Flag level oversight group met quarterly to guide the effort.

In June 2000, the Department of Defense (DOD) approved a three-ship evolutionary acquisition approach starting with the last *Nimitz*-class carrier (CVN–77) and the next two carriers CVNX1 (later CVN–78) and CVNX2 (later CVN–79). This approach recognized the significant risk of concurrently developing and integrating new technologies into a new ship design incrementally as follows:

- The design focus for the evolutionary CVN–77 was to combine information network technology with a new suite of multifunction radars from the DDG 1000 program to transform the ship's combat systems and the air wing's mission planning process into an integrated warfare system.
- The design focus for the evolutionary CVNX1 (future CVN–78) was a new Hull, Mechanical and Electrical (HM&E) architecture within a *Nimitz*-class hull that included a new reactor plant design, increased electrical generating capacity, new zonal electrical distribution, and new electrical systems to replace steam auxiliaries under a redesigned flight deck employing new Electromagnetic Aircraft Launch System (EMALS) catapults together with aircraft ordnance and fueling "pit-stops". Design goals for achieving reduced manning and improved maintainability were also defined.
- The design focus for the evolutionary CVNX2 (future CVN–79) was a potential "clean-sheet" design to "open the aperture" for capturing new but immature technologies such as the Advanced Arresting Gear (AAG) and Advanced Weapons Elevators (AWE) that would be ready in time for the third ship in the series; and thereby permit the experience gained from design and construction of the first two ships (CVN–77 and CVN–78) to be applied to the third ship (CVN–79).

Early in the last decade, however, a significant push was made within DOD for a more transformational approach to delivering warfighting capability. As a result, in 2002, DOD altered the program acquisition strategy by transitioning to the new aircraft carrier class in a single transformational leap vice an incremental three ship strategy. Under the revised strategy, CVN–77 reverted back to a "modified-repeat" *Nimitz*-class design to minimize risk and construction costs, while delaying the integrated warfare system to CVN–78. Further, due to budget constraints, CVN–78 would start construction a year later (in 2007) with a *Nimitz*-class hull form but would entail a major re-design to accommodate all the new technologies from the three ship evolutionary technology insertion plan.

This leap ahead in a single ship was captured in a revised Operational Requirements Document (ORD) in 2004, which defined a new baseline that is the *Ford*-class today, with CVN–78 as the lead ship. The program entered system development and demonstration, containing the shift to a single ship acquisition strategy. The start of CVN–78 construction was then delayed by an additional year until 2008 due to budget constraints. As a result, the traditional serial evolution of technology development, ship concept design, detail design, and construction – including a total of 23 developmental systems incorporating new technologies originally planned across CVN–77, CVNX1, CVNX2—were compressed and overlapped within the program baseline for the CVN–78. Today, the Navy is confronting the impacts of this compression and concurrency, as well as changes to assumptions made in the program planning more than a decade ago.

III. FORD-CLASS REQUIREMENTS

The *Ford*-class requirements and design provide unparalled advances in operational availability, flexibility to accommodate high power/energy warfighting advances, increased sortie generation, and improved survivability to match projected threats. The *Ford*-class' ORD was again, re-validated without changes by the Joint Requirements Oversight Committee in April 2015. Specifically, the *Ford*-class provides:

- A Sustained Sortie Generation Rate (SGR) Key Performance Parameter (KPP) of 160 sorties per day sustained over a 30 day period, and a Surge SGR of 270 sorties per day through a four day period. This constitutes a 33 percent improvement over the *Nimitz*-class and is the heart of *Ford*-class war fighting capability.
- A propulsion plant providing three times the electrical generating capacity of a *Nimitz*-class, 25 percent more energy than *Nimitz,* allowing increased steaming days over the ship's 50-year life, a projected 30 percent reduction in propulsion plant maintenance and a 50 percent reduction in reactor department manning compared to *Nimitz*.
  - The increased electrical generating capacity allows for the introduction of advanced capabilities (discussed in detail below) such as the EMALS and the Dual Band Radar (DBR), all contributors to increased war fighting capability and survivability as well as reduced manning and ownership costs.
  - The generating capacity also provides flexibility for future modernization and the introduction of future technology over the ship's 50-year service life.
- Increased Service Life Allowances (SLA) for weight and stability as compared to the *Nimitz*-class current state, enabling future modernization and the ability to adapt to new missions over the ship's 50-year life cycle.
- Improved survivability, including improvements in the hull design, firefighting systems, and weapons stowage.
- A $4 billion reduction per ship in total ownership cost over the ship's 50-year life as compared to the *Nimitz*-class, highlighted by a manning reduction of 663 billets. With accompanying reductions to the airwing, total billets are reduced by nearly 1,200. These savings will begin to accrue on day one and continue throughout the entire life of the class.

Each of these requirements contributed to design and developmental challenges that have significantly impacted cost performance on the lead ship.

- The increased SGR required a complete redesign of the flight deck to provide more space and the development of a "pit-stop" refueling and re-arming concept to turnaround planes faster after returning from a mission. This also included a total redesign of the ship's weapons handling complex to allow for the more efficient movement of weapons from magazines in the bottom of the ship to the flight deck.
- The increased SLA for weight and stability required changing several ship characteristics including the design of a new capstan, lighter weight anchor and chain, and the use of thinner deck plate steel which proved to be a significant manufacturing challenge.
- Survivability and underwater protection drove changes to the underwater hull.
- The requirement to reduce total ownership cost impacted almost every aspect of the ship design. The lifetime manpower cost for a *Nimitz*-class represents over 40 percent of the total ownership cost for the class and was therefore a central focus area for ship designers. This included adding sensors, networks and machinery control systems to reduce watch standing requirements; major redesign of the propulsion plant to cut Reactor Department crew in half; the relocation of ship's stores elevators to ease material movement; and a complete redesign of the food service complex that reduced the number of galleys from four to two.

ADVANCED CAPABILITIES

The EMALS system is an electromagnetic catapult designed for use on the *Ford*-class aircraft carrier, which is far superior to the steam catapults on the *Nimitz*-class. The operational advantages are increased launch envelopes (that is the ability to launch both heavier and lighter aircraft), improved SGRs, reduced mechanical complexity, reduced maintenance and reduced carrier manning.

The AAG system provides the ability to recover current and projected carrier based tail-hook equipped air vehicles and replaces the MK7 arresting gear system that is manpower intensive and approaching its designed structural operating limit.

AAG will provide expanded operational capabilities, including the ability to safely and efficiently recover heavier/faster (higher recovery energy) aircraft and light weight unmanned air vehicles. In addition, AAG is designed to provide increased system availability in support of the ship's SGR requirement, at reduced manpower levels, with reduced maintenance man-hours, and reduced system installed weight.

The selection of the DBR for the CVN–78 design was intended to create economies of scale by leveraging the planned DDG 1000 production line. DBR integrates an X-band Multi-Function Radar (MFR) with an S-band Volume Search Radar (VSR) to provide a single interface to the ship's combat system. However, with the truncation of the DDG 1000 program from 32 to 3 ships and the subsequent removal of the S-band radar from the DDG 1000 baseline, CVN–78 became the only ship with the DBR. This resulted in CVN–78 bearing a higher share of the X-band MFR development and production costs than originally planned and all development and production costs for the S-band VSR.

The development, integration, and construction efforts required to overcome challenges inherent to these required advanced capabilities have significantly impacted cost performance on the lead ship.

IV. CVN–78 PROGRAM EXECUTION

Today, the ship's design is effectively complete and CVN–78 production is 93 percent complete. The Navy and shipbuilder are focused on activity necessary to finish construction, complete the test program, and deliver the ship.

- Seventy-five percent of compartments have been turned over to the crew and the crew has moved aboard and is feeding onboard as scheduled.
- More than 60 percent of the overall shipboard testing has been completed.
- EMALS shipboard catapult testing commenced on schedule in June and remains on schedule with the successful completion of over 100 "dead-load" launches completed on the two bow catapults.
- The Initial Light Off of DBR was accomplished in May 2015.
- Land based AAG performance testing is in progress to validate requirements.

Given the lengthy design, development, and build span associated with major warships, there is a certain amount of overlap or concurrency that occurs between the development of new systems to be delivered with the first ship, the design information for those new systems, and actual construction. Since this overlap poses cost and schedule risk for the lead ship of the class, program management activities are directed at mitigating this overlap to the maximum extent practicable.

In the case of the *Ford*-class, the incorporation of 23 developmental systems at various levels of technical maturity (including EMALS, AAG, DBR, AWE, new propulsion plant, integrated control systems) significantly compounded the inherent challenges associated with accomplishing the first new aircraft carrier design in 40-years. The cumulative impact of this high degree of concurrency significantly exceeded the risk attributed to any single new system or risk issue and ultimately manifested itself in terms of delay and cost growth in each element of program execution; development, design, material procurement (government and contractor), and construction. The following sections provide a detailed assessment of performance on the lead ship in each of these areas; specific actions taken to correct performance and control cost on the first-of-class, CVN–78, and the more comprehensive approach to improve performance on follow ships of the class.

CVN–78 DESIGN AND ENGINEERING

The high degree of concurrency in the development of new CVN–78 technologies and the ship detailed design while beginning ship construction led to major modifications and rework in the ongoing design of the ship that continued well past award of the Detail Design and Construction (DD&C) contract in 2008. Additionally, testing of new technologies was not yet complete and material procurement efforts were not all defined. Engineering efficiency deteriorated as efforts increased to complete the design and accommodate component design changes while new technology testing completed and ship construction efforts and material procurement progressed. Design risk that had been identified during the 2008 Defense Acquisition Board review, had not been adequately retired and the impact of that design risk on production cost performance had not been recognized. As a result of a complete review of remaining design effort conducted in 2009, the Navy requested an increase of $700 million in its fiscal year (FY) 2011 budget request for completion of CVN–78 non-recurring engineering (NRE). Additionally, and perhaps equally important, to reflect the defined scope, the CVN–78 design contract was converted from a level of effort fixed fee contract to a completion contract with a firm target incentive fee contract.

CVN–78 CONSTRUCTION

At the time of CVN–78 DD&C contract award in 2008, approximately $3.4 billion had been executed on the CVN–78 program to support construction preparation efforts including first-of-class engineering, planning, long lead time material procurement, and advance construction. This work was accomplished largely without a validated cost baseline for the entire ship, and therefore without a clear view of cost performance. During this early stage of the program, the significant concurrency of ship design and development slowed the progress of the design, and the concurrent nature of the design led to iterative changes to the shipboard configuration that later impacted construction performance and delayed material qualification and subsequent material deliveries to the ship. Delays in material availability ultimately impacted ship pre-outfitting, driving work to less efficient work centers in order to sustain overall ship construction. Workarounds were necessary at additional expense in order to sustain ship construction and avoid much greater downstream delays, rework and cost. The net result was that by the time a performance baseline was established following DD&C contract award, the ship commenced to immediately decline in cost performance and would require one-to-two years to stabilize.

In addition to these impacts, the many unique CVN–78 design features posed producibility challenges, significantly greater than estimated for the lead ship. For example, CVN–78's requirement for additional service life margin for weight and stability (in order to provide for modernization over its 50-year life) also created construction challenges and eventual rework during lead ship construction.

- Thinner, lighter weight steel plate selected as part of the design objective to reduce overall ship weight and restore growth margin in the ship's life cycle, necessitated the unplanned use of temporary bracing to allow handling of modules during assembly. The thinner steel plate also required additional work and structural reinforcement associated with large heavy component and equipment foundations in order to achieve proper fit up.
- Light scantlings also precluded higher outfitting levels prior to module erection because of stiffness limits.
- Additional work required to flame straighten thin plates that had been deformed by the cutting and welding process also contributed to inefficiencies.

These issues have been retired for CVN–79 and follow ships through exacting management of the ship's displacement margin and producibility improvements.

The CVN–78 design contains 10.3 million feet of total electrical power cable as compared to 8.7 million feet for CVN–77, reflecting the transition from all steam auxiliary systems on *Nimitz*-class to electrical auxiliary systems on *Ford*-class, providing major life cycle cost benefits for the *Ford*-class. The increase in linear feet, coupled with the increased effort to handle, bend and secure the 13.8 kilovolt (kV) cables, resulted in significant increases in electrician labor from previous construction efforts. This increase, while incorporated into the budget for CVN–78, required more electrical trade personnel than any other project ever completed at Huntington Ingalls Industries-Newport News Shipbuilding (HII–NNS) and greater than 25 percent increase from CVN–77. The CVN–78 design also contains four million feet of blown fiber optic cable as compared to 1.6 million feet for CVN–77. A 150 percent increase in fiber optics represents a significant increase in complexity of networked systems and required personnel to install and test compared to previous construction efforts.

Shipbuilder actions to resolve first-of-class issues retired much of the schedule risks to launch, but at an unstable cost. First-of-class construction and material delays led the Navy to revise the launch date in March 2013 from July 2013 to November 2013. Nevertheless, the four-month delay in launch allowed increased outfitting and ship construction that were most economically done prior to ship launch, such as completion of blasting and coating operations for all tanks and voids, installation of the six DBR arrays, and increased installations of cable piping, ventilation, electrical boxes, bulkheads and equipment foundations. As a result, CVN–78 launched at 70 percent complete and 77,000 tons displacement—the highest levels yet achieved in aircraft carrier construction. This high state of completion at launch enabled improved outfitting, compartment completion, an efficient transition into the shipboard test program, and the on-time completion of key milestones such as crew move aboard.

With the advent of the shipboard test program, first time energization and grooming of new systems have required more time than originally planned. As a result, the Navy expects the sea trial schedule to be delayed about six to eight weeks. The exact impact on ship delivery will be determined based on the results of these trials. The Navy expects no schedule delays to CVN–78 operational testing and deployability due to the sea trials delay and is managing schedule delays within the $12.887 billion cost cap.

Additionally, at delivery, AAG will not have completed its shipboard test program. The program has not been able to fully mitigate the effect of a two-year delay in AAG equipment deliveries to the ship. All AAG equipment has been delivered to the ship and will be fully installed on CVN–78 at delivery. The AAG shipboard test and certification program will complete in time to support aircraft launch and recovery operations in summer 2016.

GOVERNMENT FURNISHED EQUIPMENT (GFE)

Twelve of the 23 developmental systems introduced on CVN–78 are government furnished. In 2006, the Navy identified 10 of these new systems, including EMALS, AAG, and DBR, as critical technologies which posed the highest ship integration risk. A 27 month comprehensive test program, reportedly the most integrated and complex shipbuilding test program to date, was developed to address the integration of these technologies. This test program has proven to be highly effective at identifying design deficiencies and proving the performance of these equipments, but has been unable to mitigate the concurrent nature of the development efforts resulting in delays and cost growth to certain systems and equipments.

EMALS is arguably the most revolutionary of all new technology in the *Ford*-class. There was a lack of knowledge regarding the scope of challenges associated with developing and integrating this advanced system into CVN–78 at the time of contract award. In 2008, the Under Secretary of Defense (Acquisition, Technology, and Logistics) (USD(AT&L)), directed an independent Defense Support Team (DST) to assess the development of EMALS and its ability to support the CVN–78 schedule. The Navy expanded the scope of the DST and imposed "Nunn-McCurdy-like" criteria on the assessment. In February 2009, the DST recommended that the Navy continue with the development of EMALS for CVN–78 and future carriers and address findings of the DST to reduce schedule risk. In June 2009, after full deliberation by the requirements and acquisition chains of command, the Navy determined it would address the DST findings and continue with EMALS.

The basic installation and shipboard test schedule for EMALS at contract award was assumed to be comparable to legacy steam systems. As system development completed, however, it became clear that EMALS required a much more extensive shipboard test program than originally envisioned, adding further cost to the test program. This would be compounded as design changes were discovered during testing at the System Functional Demonstration site at Lakehurst, NJ, resulting in delayed completion of land based testing and subsequent delays to delivery of certain equipment to the shipyard.

The original AAG procurement strategy was based on a 2002 cost estimate that included forward fit on the *Ford*-class and backfit on the *Nimitz*-class (five ship sets). At the time of the AAG production contract award (2009), not only had the scope of the required system grown [from Technology Development Readiness Review in 2003 to the Critical Design Review in 2007], but the production quantity had been truncated, resulting in procurement of only a single ship set at a time. This reduction in quantity, when combined with escalation from 2002 to the 2009 contract award, accounts for the majority of the associated AAG procurement cost growth.

AAG is based on proven land-based arresting gear systems and had a Technology Readiness Level of "6" in 2011. Despite having been demonstrated in a relevant environment, AAG suffered major component failures (including the water twister, purchase cable drum, and cable shock absorber) after the Critical Design Review while testing at Lakehurst. Like EMALS, delays in the land based test program and subsequent incorporation of test results into AAG hardware have resulted in significant delays in delivery of this equipment to the shipbuilder. The Navy completed an AAG "Nunn-McCurdy-like" focused review in 2011 in order to re-evaluate component re-design, test progress, and projected component delivery relative to shipbuilder need dates. This review scrutinized continued delays in testing, which significantly increased programmatic risk resulting from the concurrency of development, testing, and ship integration.

The first-of-a-kind reactor plant GFE did however deliver on budget and schedule and resulted in saving several million dollars in construction costs. This effort included a first-of-a-kind early core load that eliminated several months of shipyard controlling path construction effort; manufacture of the largest naval reactors and steam generators to date; and other innovations that deliver a 30 percent reduction in maintenance requirements and a level of simplification and automation supporting reactor department crewing requirements.

PARALLEL SHIPYARD WORKLOAD EFFECT ON CVN–78 CONSTRUCTION

Compounding these issues, HII–NNS had several other large projects on-going at construction start. Throughout the *Gerald R. Ford* (CVN–78) construction span, USS *Enterprise* (CVN–65), USS *Carl Vinson* (CVN–70), USS *George H. W. Bush* (CVN–77), and USS *Theodore Roosevelt* (CVN–71) were undergoing construction or overhaul, and *Virginia*-class submarines were also undergoing various stages of construction. The competition for key resources on the delivery of the aforementioned platforms, particularly in the critical early construction phases for CVN–78 between 2008 and 2009, added risk.

V. CVN–78 COST CONTROL MEASURES

The Navy, in coordination with the shipbuilder and major component providers, implemented a series of actions and initiatives in the management and oversight of CVN–78 that crossed the full span of contracting, design, material procurement, GFE, production planning, production management and oversight. The Secretary of the Navy directed a detailed review of the CVN–78 program build plan to improve end-to-end aircraft carrier design, material procurement, production planning, build and test, the results of which are providing benefit across all carriers. These corrective measures include:

- CVN–78 design was converted from a 'level of effort, fixed fee' contract to a completion contract with a firm target and incentive fee. Shipbuilder cost performance has been on-target or better since this contract change.
- CVN–78 construction fee was reduced, consistent with contract provisions. However, the shipbuilder remains incentivized by the contract shareline to improve upon current cost performance.
- Contract design changes are under strict control; authorized only for safety, damage control, and mission-degrading deficiencies.
- Following a detailed "Nunn-McCurdy-like" review in 2008–2009, the Navy converted the EMALS and AAG production contract to a firm, fixed price contract, capping cost growth to each system.
- In 2011, Naval Sea Systems Command completed a review of carrier specifications with the shipbuilder, removing or improving upon overly burdensome or unneeded specifications that impose unnecessary cost on the program. Periodic reviews continue.

Much of the impact to cost performance was attributable to shipbuilder and government material cost overruns. The Navy and shipbuilder have made significant improvements upon material ordering and delivery to the shipyard to mitigate the significant impact of material delays on production performance.

These actions include:

- The Navy and shipbuilder instituted optimal material procurement strategies and best practices (structuring procurements to achieve quantity discounts, dual-sourcing to improve schedule performance and leveraging competitive opportunities) from outside supply chain management experts.
- The shipbuilder assigned engineering and material sourcing personnel to each of their key vendors to expedite component qualifications and delivery to the shipyard.
- The shipbuilder inventoried all excess material procured on CVN–78 for transfer to CVN–79.
- The Program Executive Officer (Carriers) has conducted quarterly Flag-level GFE summits to drive cost reduction opportunities and ensure on-time delivery of required equipment and design information to the shipbuilder.

The CVN–78 build plan, consistent with the *Nimitz*-class, had focused foremost on completion of structural and critical path work to support launching the ship on-schedule. Achieving the program's cost improvement targets required that CVN–78 increase its level of completion at launch, from 60 percent to 70 percent. To achieve this and drive greater focus on system completion:

- The Navy fostered a collaborative build process review by the shipbuilder with other Tier 1 private shipyards in order to benchmark its performance and identify fundamental changes that are yielding marked improvement.
- The shipbuilder established specific launch metrics by system and increased staffing for waterfront engineering and material expediters to support meeting

those metrics. This ultimately delayed launch, but drove up pre-outfitting to the highest levels for CVN new construction which has helped stabilize cost and improve test program and compartment completion performance relative to CVN–77.

- The shipbuilder linked all of these processes within a detailed integrated master schedule that has provided greater visibility to performance and greater ability to control cost and schedule performance across the shipbuilding disciplines.

These initiatives, which summarize a more detailed list of actions being implemented and tracked as a result of the end-to-end review, were accompanied by important management changes.

- In 2011, the Navy assigned a second tour Flag Officer with considerable carrier operations, construction, and program management experience as the new Program Executive Officer (PEO).
- The new PEO established a separate Program Office, PMS 379, to focus exclusively on CVN–79 and CVN–80, which enables the lead ship Program Office, PMS 378, to focus on cost control, schedule performance and the delivery of CVN–78.
- In 2012, the shipbuilder assigned a new Vice President in charge of CVN–78, a new Vice President in charge of material management and purchasing, and a number of new general ship foremen to strengthen CVN–78 performance.
- The new PEO and shipyard president began conducting bi-weekly launch readiness reviews focused on cost performance, critical path issues and accomplishment of the targets for launch completion. These bi-weekly reviews will continue through delivery.
- Assistant Secretary of the Navy (Research, Development, and Acquisition) (ASN (RD&A)) conducts quarterly reviews of program progress and performance with the PEO and shipbuilder to ensure that all that can be done to improve on cost performance is being done.

The series of actions taken by the Navy and the shipbuilder are achieving the desired effect of arresting cost growth, establishing stability, and have resulted in no changes in the Government's estimate at completion over the past four years. The Department of the Navy is continuing efforts to identify cost reductions, drive improved cost and schedule performance, and manage change. The Navy has established a rigorous process with the shipbuilder that analyzes each contract change request to approve only those change categories allowed within the 2010 ASN(RD&A) change order management guidance. This guidance only allows changes for safety, contractual defects, testing and trial deficiencies, statutory and regulatory changes that are accompanied by funding and value engineering change proposals with instant contract savings. While the historical average for contractual change level is approximately 10 percent of the construction cost for the lead ship of a new class, CVN–78 has maintained a change order budget of less than four percent to date despite the high degree of concurrent design and development.

Finally, the Navy has identified certain areas of the ship whose completion is not required for delivery, such as berthing spaces for the aviation detachment, and has removed this work from the shipbuilder's contract. This deferred work will be completed within the ship's budgeted end cost and is included within the $12,887 million cost estimate. By performing this deferred work in the post-delivery period using CVN–78 end cost funding, it can be competed and accomplished at lower cost and risk to the overall ship delivery schedule.

VI. CVN–78 TEST AND EVALUATION STATUS

EMALS AND AAG

The Navy established extensive land based test facilities in Lakehurst, NJ, to test and qualify EMALS and AAG software and hardware in order to reduce risk prior to the shipboard test program. As part of EMALS land based testing, the Navy team has conducted approximately 5,000 "no load" and more than 3,400 "dead-load" launches to date, at speeds of up to 180 knots—the highest end speed required to launch aircraft currently in the system's envelope. The Navy has also supported two phases of Aircraft Compatibility Testing (ACT), which began in December 2010 and successfully completed in April 2014. During ACT, various carrier situations were replicated in order to demonstrate EMALS' launch-critical reliability. A total of 452 manned launches were conducted with the following aircraft: F/A–18C Hornet; F/A–18E Super Hornet; T–45C Goshawk; C–2A Greyhound; E–2D Advanced Hawkeye;

and EA–18G Growler. First shipboard flight operations are scheduled for summer 2016.

CVN–78 began EMALS shipboard testing in August 2014. Catapult "dead-load" testing began in June 2015 and will continue into November 2015. The testing checks system functionality as well as establishes each catapult's individual performance characteristics. The ship's test data will be compared to land based test data, and following adjustments, will become the basis for the first manned F/A–18E aircraft launches off the ship next year. To date, the shipbuilder has met all shipboard test milestones and the system is performing well including the recent completion of 109 "deadload" launches from the bow catapults. Waist catapult testing will commence in October 2015 and the EMALS shipboard test program will conclude in November 2015.

Extensive land based AAG testing conducted at the Jet Car Track Site (JCTS) in Lakehurst, NJ, identified technical issues. The resultant AAG hardware re-designs are now complete, with every design change tested at the JCTS prior to implementation into the shipboard hardware. All AAG hardware has been delivered to CVN–78. The AAG system began shipboard testing in July 2015 and is projected to complete in time to support first scheduled flight operations in summer 2016. Current testing is focused on fine tuning the software control system, particularly for degraded mode arrestments. As of August 2015, the Navy team has executed 1,046 "deadload" arrestments with 663 conducted using the re-designed Water Twisters. The Navy is working to commission the Runway Aircraft Landing Site and conduct the first manned aircraft arrestment later this fall. Completion of the initial F/A–18E/F land based testing is on track to support flight operations on the CVN–78. The Navy is planning to have the remainder of the airwing available to support flight operations at the conclusion of the Post Shakedown Availability in 2017.

CVN–78 TEST AND EVALUATION

The Navy's shipbuilding and modernization efforts include test and evaluation to ensure the Navy provides the Fleet complete ships which are free from either contractor or government responsible deficiencies and which are capable of executing the platform's primary missions. The Navy applies an integrated test approach that incorporates collaborative planning and execution of both Developmental Test (DT) and Operational Test (OT) phases and events. This approach fully supports independent analysis, evaluation, and reporting by the developmental and operational test and evaluation communities in order to deliver the most combat capable platform to the Fleet.

The CVN–78 DT program leverages factory, shipbuilder and GFE provided land based testing, pre-delivery shipboard shipbuilder testing, Board of Inspection and Survey (INSURV) inspections, and at sea integration testing conducted on CVN–78 and the Self Defense Test Ship (SDTS). The CVN–78 DT program includes five phases of Developmental Test/Integrated Test to reduce risk to the program before entering the OT phase. The last phase continues through 2017 and includes activities such as Aircraft Compatibility Testing (ACT), Combat Systems Shipboard Qualification Test (CSSQT) and overall readiness assessment for Initial Operational Test and Evaluation (IOT&E).

Examples where the Navy has reduced risk through the use of developmental testing include: completing more than 90 percent of software testing in a land based facility for the new Machinery Control and Monitoring System (MCMS) prior to shipboard installation; land based testing of next generation HM&E systems; land based testing of the DBR at Naval Surface Warfare Center (Wallops Island) to include integrated testing of the combat system with the ship's Air Traffic Control and Ship Self Defense Systems; and land based C4I System integration to test intersystem communications prior to shipboard installation. Additionally, cybersecurity testing follows a robust certification and accreditation process where systems are scanned for vulnerabilities prior to granting them an authority to operate.

The Navy has developed a sound Operational Test and Evaluation (OT&E) program with an executable schedule and maintains frequent communication and collaboration with Director Operational Test and Evaluation (DOT&E) and Commander Operational Test and Evaluation Force, as they ensure that planned OT&E is adequate to confirm operational effectiveness and suitability of the *Ford*-class carrier in combat. To improve upon the Live-Fire Test and Evaluation strategy, the Navy has refined its schedule to include additional time for OT, and added the Total Ship Survivability Test (TSST) into the most recent Test and Evaluation Master Plan (TEMP) submittal to provide evaluators with demonstrations of recoverability from secondary damage, damage containment, and restoration. The most recent

TEMP submittal improves integrated platform-level developmental testing, reducing the likelihood that platform-level problems will be discovered during IOT&E.

The Navy applies rigorous systems engineering processes that start with deriving the reliability requirement based on the operational availability requirement, allocating reliability requirements at the subsystem and component level and, conducts testing, failure analyses, and corrective actions at these levels to engineer reliability into the systems. This rigorous process is also conducted at the system level as in the cases of EMALS, AAG, DBR and AWE. Working with DOT&E, the Navy incorporated the requirement for a Reliability Growth Program in TEMP Revision C and the recent System Engineering Plan revision. Reliability Growth Curves are an effective tool to plan, illustrate, and report the progress of obtaining testing or operating time information to demonstrate statistical confidence that design reliability requirements have been met.

The Navy's Reliability Growth test program is designed to find reliability problems through testing and correct those issues through a detailed root cause analysis and corrective action process. For EMALS and AAG, reliability growth will be accomplished via the specific tests targeting reliability growth and through other integration and qualification activities such as System Integration Laboratory testing, environmental qualification testing, commissioning, functional demonstration testing, and environmental stress screening. For DBR, previous empirical testing has been collected on reliability performance. This data will not be included in this reliability growth planning strategy, but it is important to note these periods of testing (e.g., land based DBR testing at Wallops Island, VA) as some improvements to DBR reliability have been made as a consequence.

Today, EMALS reliability is tracking slightly better than its December 2014 reliability growth plan and AAG has begun reliability growth tracking in land based performance testing. DBR has begun reliability tracking at Wallops Island and will continue through post-delivery testing onboard CVN–78. AWE reliability data tracking begins at ship delivery and will continue through post-delivery testing. All systems are expected to demonstrate suitable reliability to support IOT&E in 2018.

The Navy has developed EMALS and AAG training required to support the CVN–78 crew that will operate these systems. The comprehensive training program includes multiple hands-on training sessions. The CVN–78 crew has completed five EMALS training sessions, is currently performing hands on validation and verification of EMALS maintenance procedures and has commenced AAG classroom training. Incorporating the crew into the development of the training products has proven invaluable to the quality of the training received.

The Full Ship Shock Trial (FSST) is conducted to validate the integrated shock worthiness of the ship. The Navy's original 2004 CVN–78 TEMP included a FSST on CVN–78 prior to the ships first deployment which was based on CVN–78 delivering in 2013 and USS *John F. Kennedy* (CV 67) decommissioning in 2018. CVN–78's earlier delivery date (2013 vice current 2016) and projected force structure in 2004 provided a window to complete the FSST without operational impacts to the Navy prior to deploying the ship. Subsequently, the CVN–78 delivery date was moved to March 2016 primarily as a result of budget decisions that shifted the start of construction two years later, and the Navy ultimately decommissioned CV 67 ten years earlier than planned (in 2008 vice 2018). The Navy is currently planning to conduct CVN–78 FSST in 2019.

VII. CVN–79 CONSTRUCTION PERFORMANCE AND CLASS APPROACH

The CVN–79 cost cap was established in 2006 and adjusted by the Secretary of the Navy in 2013, primarily to address inflation between 2006 and 2013 plus $325 million of the allowed increase for non-recurring engineering to incorporate design improvements for the CVN–78 Class construction.

The Navy and the shipbuilder conducted an extensive affordability review of carrier construction and made significant changes to deliver CVN–79 at the lowest possible cost. These changes are focused on eliminating the largest impacts to cost performance identified during the construction of CVN–78 as well as furthering improvements in future carrier construction. The Navy outlined cost savings initiatives in its Report to Congress in May, 2013, and is executing according to plan.

Stability in requirements, design, schedule, and budget, are essential to controlling and improving CVN–79 cost, and therefore is of highest priority for the program. Requirements for CVN–79 were "locked down" prior to the commencement of CVN–79 construction. The technical baseline and allocated budget for these requirements were agreed to by the Chief of Naval Operations and ASN(RD&A) and further changes to the baseline require their approval, which ensures design stability and increases effectiveness during production. At the time of construction contract award, CVN–79 has 100 percent of the design product model complete (compared to 65 percent for CVN–78) and 80 percent of initial drawings released. Further, CVN–79 construction benefits from the maturation of virtually all new technologies inserted on CVN–78. In the case of EMALS and AAG, the system design and procurement costs are understood, and CVN–79 leverages CVN–78 lessons learned.

IMPROVEMENTS IN MATERIAL AVAILABILITY AND PRICING

A completed *Ford*-class design enabled the shipbuilder to fully understand the "whole ship" bill of materials for CVN–79 construction and to more effectively manage the procurement of those materials with the knowledge of material lead times and qualified sources accrued from CVN–78 construction. The shipbuilder is able to order ship-set quantities of material, with attendant cost benefits, and to ensure CVN–79 material will arrive on time to support construction need. Extensive improvements have been put in place for CVN–79 material procurement to drive both cost reductions associated with more efficient procurement strategies and production labor improvements associated with improved material availability. Improved material availability is also a critical enabler to many construction efficiency improvements in CVN–79.

The shipbuilder has developed an entirely new material procurement and management strategy for CVN–79. This new strategy consists of eight separate initiatives:

- **Define the "whole ship" bill of material—**This allows the shipbuilder to most economically procure material items from sub vendors. Reduced material costs will be realized and procurement effort is reduced—with an estimated 30 percent reduction in total number of purchase order lines as compared with CVN–78.
- **Establish a "ship view" of equipment by supplier to help incentivize suppliers and correlate supplier priorities based on construction progress and need—**Some sub-vendors produce multiple types of components in different geographic locations. Grouping orders by component type and sub vendor subdivision and location helps the shipbuilder define and communicate material priorities to the sub vendor across his enterprise, thereby improving material availability and reducing cost. This also reduces shipbuilder procurement support effort.
- **Optimize supplier production for cost avoidance—**The shipbuilder identified key components that needed to be purchased earlier than just-in-time construction need, allowing suppliers to level load their production lines and avoid incurring fees for accelerated production.
- **Investigate multi-ship material buys to leverage economic order quantity pricing—**The shipbuilder is investigating opportunities to procure parts common to multiple ship programs (e.g. CVN–79, *Virginia*-class submarines, *Nimitz*-class RCOH) in a grouped manner to leverage better pricing for all programs.
- **Improve material ordering schedule—**Development of, and management to a comprehensive material procurement plan that considers construction sequencing, timing, and most recent experience with vendor procurement lead time to schedule a bundled or combined procurement to ensure material is available at the first instance of use.
- **Solicit and implement vendor cost reduction initiatives—**The shipbuilder has worked with its suppliers to identify cost reduction ideas that may simplify material production and reduce procurement cost. An example is encouraging vendors to recommend changes to ship specification requirements to achieve technical equivalency at reduced cost.
- **Increase competition in subcontracting—**Competition is pursued at the subcontractor level. Components that were competitively awarded for CVN–78 construction are evaluated for re-competition in CVN–79 subcontracts. This approach includes competing new components that are introduced due to obsolescence or cost reduction actions as appropriate.
- **Procure commodity equipment directly from the original equipment manufacturer—**The shipbuilder can bulk order commodity equipment for a lower price than an individual sub vendor due to a larger order quantity. The shipbuilder would then provide the commodity material back to the sub vendor to assemble into the finished product at a lower cost.

The shipbuilder has undertaken these initiatives in a multi-faceted approach with the objective of driving material cost down, and material availability up to support an optimized construction schedule, within the constraints of the funding available for each fiscal year. As a comparison, at the time of DD&C contract award for CVN–78, 44 percent of the direct-buy material was on contract with material availability at 83 percent. At the time of CVN–79 DD&C contract award, 95 percent of the direct buy material was on contract with material availability at 97 percent. Accordingly, with higher CVN–79 material availability, the Navy and the shipbuilder provide a stable and predictable timing of material need, maintain an efficient construction sequence, increase pre-outfitting in the shops vice outfitting on the ship, and ultimately avoid costly construction and engineering re-work.

The Navy has also employed outside supply chain management experts to help develop additional optimal contractor furnished material procurement strategies. Furthermore, the Navy has increased its oversight of contractor furnished material procurement, ensuring that it is competed (where competition is available); that it is fixed priced; that commodities are bundled to leverage economic order quantities; and that the vendor base capacity and schedule for receipt supports the optimal build plan being developed for production of CVN–79. The increased oversight has included Program Office visits to several key vendors to ensure a deeper, first hand understanding of cost drivers and issues.

SIGNIFICANT CHANGES TO BUILD STRATEGY AND SHIPBUILDING PROCESSES

The shipbuilder and the Navy have performed a comprehensive review of the build strategy and processes used in construction of CVN–78 Class aircraft carriers as well as consulted with other Navy shipbuilders on best practices. As a result, the shipbuilder has identified and implemented a number of changes in the way they build aircraft carriers, with a dedicated focus on executing construction activities where they can most efficiently be performed. The CVN–79 build sequence installs 20 percent more parts in shop, and 30 percent more parts on the final assembly platen, as compared to CVN–78. This work will result in an increase in pre-outfitting and work being pulled to earlier stages in the construction process where it is most efficiently accomplished.

As part of this strategy, the shipbuilder is also expanding shop construction of complex assemblies. These are assemblies of piping, valves, pumps, etc., that would previously have been 'stick built' on the final assembly platen or on the ship. Building these assemblies in a shop environment, which is far more efficient, allows shop testing and painting currently being done on the platen or ship to be done in the shop environment, ultimately optimizing the eventual transportation of the complex assembly to the ship. The ship design has been reviewed by deck plate foremen who built CVN–78 to identify candidates for this complex assembly process. Over 1,800 assemblies have been identified which can be shop built, thus shifting hundreds of thousands of man-hours of work into more efficient shop construction areas.

An additional element of the strategy of moving more work into the shops is the expanded use of digital data from the product model for production. This allows for automated blast etching of locations of outfitting items in the shop, rather than the old practice of manually laying out the location of each individual item on the platen or in the dry-dock, using step ladders, tape measures, and paper drawings. To date, this has allowed for digitally locating and marking over 27,000 electrical stud locations, over 32,000 insulation stud locations, and the locations of thousands of other outfitting items which can then be installed simply and cost effectively in the shop. Pre-outfitting of these bulkheads and decks in the shops provides for much earlier starting points for subsequent assembly and outfitting being performed on the final assembly platen, thus enabling more work to be brought earlier in the build sequence

Design Changes for Greater Producibility

In conjunction with the Navy and the shipbuilder's comprehensive review of the build strategy and processes used in construction of CVN–78 Class aircraft carriers, a number of design changes were identified that would result in more affordable construction. Some of these design changes were derived from lessons learned in the construction of CVN–78 and others seek to further simplify the construction process and drive cost down.

The introduction of several advancements in construction tooling is yielding improved productivity in the construction trades. Examples include weld machines that operate more autonomously, pipe bending machines precisely controlled through digital data, a plate cutting and beveling machine with the capability to accommodate plate nearly twice as thick, and adaptable construction jigs and fixtures.

Additionally, the shipbuilder has created new superlifts, combining several units, lowering the number of units that need to be independently erected into the dry-dock, helping to alleviate demands on the gantry dry-dock crane and decreasing the number of times welders have to work in a constrained environment to weld construction units into the ship. Larger superlifts allow for more pre-outfitting on the final assembly platen, and shops, prior to ship erection, thereby increasing ship construction efficiency. To date, the shipbuilder has decreased the number of erectable units from CVN–78 by approximately 9 percent.

Facility Additions and Upgrades

In addition to the major focus discussed above, the shipbuilder continues to implement capital improvements to facilities that serve to reduce risk and improve productivity. Some initiatives include:

- The shipbuilder is installing large weather covers on the buffer zone and final assembly platen, as well as building a multi-bay unit outfitting hall that will increase the amount of covered workspace for the construction of CVN–79 and follow ships. This supports build strategy changes that move significant outfitting work from the ship to the final assembly platen. A recent improvement was made where the shipbuilder tripled the amount of space available for blast and coat of assembly units by building two additional blast and coat facilities.
- The shipbuilder has added a dry-dock elevator to allow easier access to dry-dock number 12. This addition was done toward the later stages of CVN–78 dry-dock construction and therefore had limited benefit for CVN–78, but is expected to increase the efficiency of movement of material into the dry-dock for CVN–79 and alleviate the bottleneck imposed by the limited number of lifting cranes. The shipbuilder is also building portable utility platforms to provide greater ease of access and support equipment for work being accomplished on the final assembly platen.

Two Phased Delivery

To enhance CVN–79 build efficiency and affordability, the Navy is implementing a two-phase delivery plan. The two-phase strategy will allow the basic ship to be constructed and tested in the most efficient manner by the shipbuilder (Phase I) while enabling select ship systems and compartments to be completed in Phase II, where the work can be completed more affordably through competition or the use of skilled installation teams.

No previous *Nimitz* or *Ford*-class construction program has utilized a two-phase delivery strategy from the start. CVN–79's circumstances are unique in that a single-phased ship construction would deliver the ship two years prior to when required as the numerical-relief for USS *Nimitz*. The two-phase delivery strategy for CVN–79 capitalizes on this schedule flexibility to deliver the ship at the lowest cost and enables the Navy to procure and install at the latest date possible shipboard electronic systems which otherwise would be subject to obsolescence prior to CVN–79's first deployment in 2027. This approach also supports the installation of the Enterprise Air Surveillance Radar (EASR) suite, a common enterprise radar solution selected for both capability and affordability in lieu of the DBR. The substitution of the EASR suite alone saves $180 million in GFE costs compared to CVN–78. Both Phase I and Phase II are funded within the CVN–79 budgeted end cost and are included within both the $11,498 million cost estimate and cost cap.

The net result of all these actions was the recent award of the CVN–79 construction contract that in conjunction with GFE procures CVN–79 at or below the $11,498 million Congressional cost cap. This contract includes a steeper shareline and a lower ceiling price than prior CVN fixed price contracts and is reflective of a shared understanding by the Navy and the shipbuilder of the costs and risks associated with building CVN–79. Importantly, this is just one step in an ongoing process that will continue to reduce the costs of future ships of the class.

VIII. CVN–80 AND FOLLOW SHIPS

The CVN–80 planning and construction will continue to leverage class lessons learned in the effort to achieve cost and risk reduction for remaining *Ford*-class ships. The CVN–80 strategy seeks to improve on CVN–79 efforts to frontload as much work as possible to the earliest phases of construction, where work is both predictable and more cost efficient. A key element in achieving continued cost reduction on CVN–80 is to provide stability in funding and construction schedules. The CVN–80 contract award for long lead material procurement and construction planning is scheduled to award November 2015 and requires the first year of advance procurement funding. A continuing resolution extending beyond November 2015 will delay the CVN–80 contract award and consequently delay material procurements, workload and layout planning, material tracking, an integrated master schedule, work packages, and other activities necessary to prepare for construction start in fiscal year 2018.

The naval nuclear component vendor industrial base is a highly specialized supply base with over 95 percent of contract value with single or sole source vendors. Naval Reactors actively manages this industrial base to minimize costs and deliver high quality products. In addition to material and labor costs, nuclear security and safety requirements are specific drivers in this specialized industrial base that Naval Reactors continuously engages with suppliers on. As a result of this comprehensive engagement, Naval Reactors is actively managing costs for these components, driving down inflation, workload and material cost impacts, across this highly specialized industrial base to minimize costs for CVN–80 and follow ships.

As part of the Navy's approach to drive affordability into CVN construction, a research and development funding stream is being pursued to accomplish design for affordability efforts similar to the ongoing efforts on the *Virginia*-class submarine program to help sustain the identification, development and implementation of cost savings initiatives on CVN–80 and follow ships. These would consist of a broad range of system and technology alternatives and continued producibility improvements.

IX. CONCLUSION

Aircraft carriers are central to the Nation's defense strategy, which calls for forward presence; the ability to simultaneously deter potential adversaries and assure our allies; and capacity to project power at sea and ashore.

While delivery of the first-of-class *Ford* has involved challenges, those challenges are being addressed and this aircraft carrier class will provide great value to our Nation with unprecedented and greatly needed warfighting capability at overall lower total ownership cost than a *Nimitz*-class CVN. The Navy has taken major steps to stem the tide of increasing costs and drive affordability into carrier acquisition. When *Ford* delivers, she will be able to meet operational challenges and those projected into the future at a savings of $4 billion per ship ($80 million per ship per year). These national assets are equally capable of providing our other core capabilities of sea control, maritime security, and humanitarian assistance and disaster relief. Our nuclear powered carriers will continue to provide our nation the ability to rapidly and decisively respond globally to crises for decades to come.

Chairman MCCAIN. Thank you.

Dr. Gilmore.

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

Dr. GILMORE. Mr. Chairman, Senator Reed, members of the committee, I'll briefly summarize my written statement.

Whether the projected quantum improvements and combat effectiveness and reductions in total ownership costs that will be realized that are associated with the new systems being incorporated in CVN–78 are not now known, the Navy indicates the reliability of the electromagnetic aircraft launch system, or EMALS, advanced arresting gear, AAG, and dual-band radar, DBR, will support initial operational test and evaluation in first deployment.

The most recent definitive data I have indicate the reliability of EMALS is below the Navy's goal by more than a factor of ten. The reliability of the DBR and redesigned AAG are unknown. We only have engineering estimates or reliability, very little test data.

Prior to its redesign, AAG reliability was a factor of 800 below its goal. Data providing a first indication of the reliability of the redesigned AAG will be available later this year as a result of ongoing testing.

In the case of EMALS, the Navy notes that reliability is above the December 2014 reliability growth curve. However, as a consequence of poor performance and tests, that growth curve was rebaselined to well below the reliability goal, and, consequently, the data we have indicate EMALS was not on a path to meet its goal.

What the effects on combat effectiveness of shortfalls, if any, in the ultimate reliability of these systems could be will not be known until developmental and operational tests that are conducting post-delivery. In particular, the specific nature of the failures encountered and their difficulty of repair will be important to understand. In that regard, the Navy has recently indicated that the EMALS installation on CVN–78 is such that failures in selected EMALS components could result in multiple catapults being down for extended periods. This is because there is no ability to read—to readily electrically isolate components permitting, as in current fleet operations, maintenance on nonoperating catapults while flight operations are performed on operating catapults. The reliability of these systems will also be a key determinant of whether projected lifecycle cost savings for the *Ford*-class will actually be realized.

The schedule of activities for CVN–78 subsequent to its delivery, including the timing for and number of independent steaming exercises, is determined primarily by the Navy's certification, safety, and training requirements. Operational testing and strike combat operations, which cannot be accomplished until carrier air wing qualifications are complete, will be conducted as part of the *Ford's* joint task force exercise, which is an integral part of the Navy's planned training evolution for the ship and her crew. The plan is to test systems realistically as early as possible, to provide feedback to the program office, and to combine training and testing. Nonetheless, the current test schedule remains, in my view, aggressive, with concurrent ship-based and land-based developmental testing, and with some developmental testing, including very important first-time integration testing, continuing past the start of operational testing.

In August, the Deputy Secretary of Defense directed the Navy to conduct a full-ship shock trial on CVN–78 before the ship's first deployment. Historical experience indicates clearly this is a key means to identify and mitigate mission-critical failures before the ship and her crew deploy into harm's way.

Finally, CVN–78 was designed to reduce manning, thereby limiting total ownership costs. However, recent Navy assessments raise concerns about manning issues on CVN–78 that would only be exacerbated by any shortfalls realized in the reliability of EMALS, AAG, and DBR. In particular, the Navy's Manning Wargame 3 states front-end analyses have not been finalized to capture the true maintenance and operational workload associated with the carrier's new and unique systems, and that won't be possible until we know more about what the reliability will actually be and what their maintainability will actually be.

Thank you.

[The prepared statement of Dr. Gilmore follows:]

PREPARED STATEMENT BY DR. J. MICHAEL GILMORE

Chairman McCain, Ranking Member Reed, and distinguished members of the Committee, thank you for the opportunity to discuss my assessment of USS *Gerald R. Ford* (CVN–78). The Navy intends to deliver CVN–78 early in calendar year 2016, and to begin initial operational test and evaluation (IOT&E) in late calendar year 2017. However, the Navy is in the process of developing a new schedule, so some dates may change. Based on the current schedule, between now and the beginning of IOT&E, the CVN–78 program is proceeding on an aggressive schedule to finish development, testing, troubleshooting, and correction of deficiencies for a number of new, complex systems critical to the warfighting capabilities of the ship. Low or unknown reliability and performance of the Advanced Arresting Gear (AAG), the Electromagnetic Aircraft Launch System (EMALS), the Dual Band Radar (DBR), and the Advanced Weapons Elevators (AWE) are significant risks to a successful IOT&E and first deployment, as well as to achieving the life-cycle cost reductions the Navy has estimated will accrue for the *Ford*-class carriers. The maturity of these systems is generally not at the level that would be desired at this stage in the program; for example, the CVN–78 test program is revealing problems with the DBR typical of discoveries in early developmental testing. Nonetheless, AAG, EMALS, DBR, and AWE equipment is being installed on CVN–78, and in some cases, is undergoing shipboard checkout. Consequently, any significant issues that testing discovers before CVN–78's schedule-driven IOT&E and deployment will be difficult, or perhaps impossible, to address.

Resolving the uncertainties in the reliability and performance of these systems is critical to CVN–78's primary function of conducting combat operations. CVN–78 has design features intended to enhance its ability to launch, recover, and service aircraft. EMALS and AAG are key systems planned to provide new capabilities for launching and recovering aircraft that are heavier and lighter than typically operated on *Nimitz*-class carriers. DBR is intended to enhance radar coverage on CVN–78 in support of air traffic control and ship self-defense. DBR is planned to reduce some of the known sensor limitations on *Nimitz*-class carriers that utilize legacy radars. The data currently available to my office indicate EMALS is unlikely to achieve the Navy's reliability requirements. (The Navy indicates EMALS reliability is above its current growth curve, which is true; however, that growth curve was revised in 2013, based on poor demonstrated performance, to achieve EMALS reliability on CVN–78 a factor of 15 below the Navy's goal.) I have no current data regarding DBR or AWE reliability, and data regarding the reliability of the re-designed AAG are also not available. (Poor AAG reliability in developmental testing led to the need to re-design components of that system.) In addition, performance problems with these systems are continuing to be discovered. If the current schedule for conducting the ship's IOT&E and first deployment remain unchanged, reliability and performance shortfalls could degrade CVN–78's ability to conduct flight operations.

Due to known problems with current aircraft carrier combat systems, there is significant risk CVN–78 will not achieve its self-defense requirements. Although the CVN–78 design incorporates several combat system improvements relative to the *Nimitz*-class, these improvements (if achieved) are unlikely to correct all of the known shortfalls. Testing on other ships with similar combat systems has highlighted deficiencies in weapon employment timelines, sensor coverage, system track management, and deficiencies with the recommended engagement tactics. Most of these limitations are likely to affect CVN–78 and I continue to view this as a significant risk to the CVN–78's ability to defend itself against attacks by the challenging anti-ship cruise missile and other threats proliferating worldwide.

The Navy's previous decision to renege on its original commitment to conduct the Full Ship Shock Trial (FSST) on CVN–78 before her first deployment would have put CVN–78 at risk in combat operations. This decision was reversed in August 2015 by the Deputy Secretary of Defense. Historically, FSSTs for new ship classes have identified for the first time numerous mission-critical failures the Navy had to address to ensure the new ships were survivable in combat. We can expect that CVN–78's FSST results will have significant and substantial implications on future carriers in the *Ford*-class and any subsequent new class of carriers.

I also have concerns with manning and berthing on CVN–78. The Navy designed CVN–78 to have reduced manning to reduce life-cycle costs, but Navy analyses of manning on CVN–78 have identified problems in manning and berthing. These problems are similar to those seen on other recent ship classes such as DDG 1000 and the Littoral Combat Ship (LCS).

AAG

AAG has undergone testing at the Navy's land-based test site in Lakehurst, New Jersey. Planned testing over the last few years has experienced delays to address problems discovered during testing. Testing has uncovered deficiencies in major components and in software that have contributed to several redesigns of the system since 2007. In July 2013, the AAG program office provided estimates of AAG reliability in the shipboard configuration.[1] At that time, the program estimated AAG reliability to be approximately 20 Mean Cycles Between Operational Mission Failure (MCBOMF) in the shipboard configuration.[2 3] That estimates was well below the Navy's goal of 16,500 MCBOMF.[4] Unless resolved, AAG's low reliability will diminish CVN–78's ability to conduct flight operations and will reduce the number of sorties per day that CVN–78 can support. In particular, a typical day of flight operations requires 100 arrested landings. If the reliability of the re-designed AAG is not substantially better than prior test results, CVN–78 likely will not be able to complete a normal day of flight operations and may need to frequently divert aircraft to other airfields due to non-availability of arresting gear.

Prior test data indicate clearly that absent significant changes in its design, AAG reliability is unlikely to achieve its goal.[5] MIL–STD–189C states that the ratio of initial reliability of a system to its reliability goal must be greater than or equal to 0.30.[6] It also notes that failure to achieve a sufficiently high initial reliability in the past has resulted in an unacceptably high percentage of the Department's developmental systems failing to meet their reliability thresholds in the IOT&E. Based on this, AAG reliability should be above 4,950 MCBOMF at this point in the development to have a reasonable chance of achieving the goal of 16,500 MCBOMF.

In a December 2014 briefing to my office, the AAG program acknowledged that the AAG design at that time did not meet service life requirements, and decided to redesign the water twister, one of three major components of AAG.[7] The redesigned water twister was installed at the Jet Car Track Site (JCTS) at Lakehurst earlier this year. The AAG program started performance testing in July to validate the new design.[8] The program does not expect to have a statistically significant number of test events for assessing performance or reliability until later this year. Consequently, I do not now have performance or reliability data on the new design, which is intalled on CVN–78. If any major issues are discovered during upcoming testing, it will be difficult if not impossible to incorporate any changes onto CVN–78.

The AAG program office also notes there is schedule risk in developing the Aircraft Recovery Bulletins (ARB) for CVN–78. The ARBs provide standardized operating procedures and technical guidance, and are required to conduct AAG flight operations. The schedule, which the program office considers to be at risk, has the first ARB delivered in June 2016, which addresses F/A–18E/F aircraft. Subsequent ARBs will cover the other aircraft in the CVN–78 air wing with the final ARB scheduled for April 2017. This is shortly before the CVN–78 IOT&E is scheduled to start in September 2017. Consequently, a delay of even a few months will affect IOT&E.

EMALS

EMALS is more mature than AAG. Over the years, technical issues with the EMALS power interface and conversion systems and other deficiencies have slowed progress. However, testing at the Navy's land-based test site in Lakehurst has demonstrated performance across the system's envelope. Testing at Lakehurst has examined EMALS performance launching F/A–18, C–2, E–2D, F–35C, and T–45 aircraft. EMALS equipment is installed on CVN–78 and has begun shipyard testing, which includes dead load testing, to check out the installed equipment.[9]

While EMALS is more mature than AAG, EMALS reliability remains a concern. In its last report to my office in December 2014, the EMALS program office esti-

[1] Testing at Lakehurst uses a system similar, but not identical, to the CVN–78 configuration. The AAG program used data from Lakehurst to estimate AAG reliability onboard CVN–78 in the shipboard configuration.

[2] The AAG estimate is based on reliability block diagrams, which model the overall system based on individual component analysis.

[3] A cycle represents the recovery of one aircraft.

[4] The Navy goal is for the AAG installation on CVN–78. An operational mission failure is a failure that reduces the number of available AAG engines below two. The Navy's original plan installed four AAG engines on CVN–78; however, it is currently expected that only three engines will be installed on CVN–78.

[5] This concern has been noted in my December 2013, Operational Assessment of USS *Gerald R. Ford* (CVN–78) Report and my fiscal year 2013 and fiscal year 2014 Annual Reports.

[6] MIL–STD–189C, Department of Defense Handbook for Reliability Growth Management," dated 14 June 2011.

[7] AAG includes three brakes for recovering aircraft, the water twister, a brake derived from the B–52 landing gear brake, and a motor-generator. The three separate brakes provide redundancy within the AAG system to ensure the safe recovery of aircraft.

[8] In JCTS testing, AAG arrests jet-propelled vehicles that travel down a railway with different loads and speeds. The AAG arrests these vehicles to test performance before transitioning to manned aircraft.

[9] Dead loads are large, wheeled steel vehicles used to simulate the weight of actual aircraft.

mated EMALS reliability to be approximately 340 Mean Cycles Between Critical Failure (MCBCF) in the shipboard configuration. [10] [11] [12] This is well below the Navy goal of 4,166 MCBCF in the shipboard configuration, although it is above a revised reliability growth curve developed by the Navy in 2013 indicating achievement on CVN–78 of EMALS reliability a factor of 15 below the Navy's goal; that revision was necessary to generate a defensible growth curve consistent with the system's low demonstrated reliability. Following MIL–STD–189C, EMALS reliability should be above 1,250 MCBCF at this point in the development to have a reasonable chance of achieving the Navy's reliability goal. As with AAG, I am concerned about EMALS reliability and the potential effect on CVN–78 flight operations.

In addition, the EMALS program is still discovering problems during testing. For example, the program discovered last year that EMALS launches of F/A–18E/F and EA–18G aircraft will overstress aircraft attachment points for wing-mounted 480-gallon external fuel tanks. Until the problem is rectified, these aircraft cannot employ external fuel tanks, which all but eliminates the organic tanking capability of the carrier strike group as well as normal flight operations. I agree with the Navy's assessment that the problem can be resolved; nonetheless, it is a concern that these types of problems are being discovered so close to the ship's delivery. Because EMALS equipment is installed on CVN–78, if upcoming testing uncovers additional problems, it will be difficult to incorporate changes onto CVN–78.

AWE

The eleven AWEs on CVN–78 move ordnance and other supplies between the magazines, the hanger, the weapons handling areas, and the flight deck. The AWEs on CVN–78 are a new design. They are high capacity rope-less elevators each utilizing four Linear Synchronous Motors (LSMs). To date, only engineering analyses of AWE reliability are available, which do not include significant test data. The early evidence from testing on CVN–78 in the shipyard raises concerns. Developmental testing on CVN–78 AWEs has required substantial contractor support suggesting that the system has poor reliability. If the AWEs on CVN–78 are unreliable, it will degrade the ship's ability to conduct combat operations.

DBR

DBR is composed of two radars, the Volume Search Radar (VSR) and the Multi-Function Radar (MFR). The DBR is currently undergoing land-based testing at Wallops Island, Virginia using a configuration that is similar to the CVN–78 shipboard configuration. However, engineering development hardware is being used in some areas instead of production hardware, shore based power and cooling are used rather than shipboard power and cooling, and the radars each have one face versus the three faces each on CVN–78. [13] Consequently, some DBR capabilities cannot be tested in a live environment until testing occurs onboard CVN–78 including, for example, the radar's ability maintain track on a target as the target transitions from one radar face to another.

The ongoing developmental testing at Wallops Island is in the problem discovery phase. Tests in the past year have revealed significant issues with tracking and supporting intercept missiles in flight, excessive numbers of clutter/false tracks, and track continuity issues. Since DBR provides CVN–78 with its ability to support air traffic control, it is noteworthy that some of the problems, such as close range clutter and dropping aircraft tracks that are in holding/marshalling patterns, critically degrade air traffic control functionality. The program is working on fixes to the problems identified so far; but, because testing is in the early stages, the program has had limited opportunity to verify the efficacy of the fixes.

The Navy is concerned about the amount of testing that remains to be completed as the DBR is integrated with the rest of the CVN–78 combat system. Consequently, the Navy has developed a plan to extend testing at Wallops Island. Under the Navy's previous plans, the MFR at Wallops Island was to be moved to the Self-

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[10] The EMALS estimate is based on reliability block diagrams, which model the overall system based on individual component analysis.

[11] A critical failure is a failure that brings the number of available catapults below three.

[12] The EMALS land-based configuration has one catapult versus the four planned for CVN–78, and it does not include the shared electrical power configuration intended for use on the ship.

[13] The VSR and MFR operate in different frequency bands. VSR has three radar faces and MFR has three radar faces, for a total of six faces.

Defense Test Ship (SDTS) in June of this year to conduct self-defense testing. The Navy's new plan leaves MFR at Wallops Island for approximately another year, providing valuable time to conduct DBR and combat system integration testing. While the new plan will have ripple effects on other testing efforts, I agree that it is necessary to extend testing at Wallops.

Unfortunately, the new plan will not relieve CVN–78's aggressive test and deployment schedule. Under the CVN–78's current program schedule, the ship will not complete its Combat System Ship Qualification Trial (CSSQT) until December 2017, which is after IOT&E begins. It is during the CSSQT that CVN–78 will fire its first missiles in self-defense scenarios and the ship's crew will first demonstrate combat system safety and crew proficiency. To have this key event ending after IOT&E begins, raises the likelihood that additional problems will be discovered during IOT&E or that problems discovered during the CSSQT affect self-defense testing during the IOT&E.

I also note that only engineering analyses of DBR reliability are currently available, which do not include significant test data. Although the Wallops Island land-based test site is not fully production representative, some reliability data are expected to be collected during testing that is currently ongoing. To date, some reliability problems have been observed at Wallops Island, for example with low voltage power supplies and with Transmit/Receive Integrated Multichannel Modules (T/RIMM) that form the radar antenna. The Navy has developed some fixes, for example, for the low voltage power supplies, but the problems with the T/RIMM modules, in particular, are a significant concern that, while progress is being made, are not fully resolved. Similar to EMALS and AAG, DBR equipment has been installed on CVN–78. Therefore, it will be difficult to correct performance or reliability problems that are discovered in upcoming testing of DBR, which is a critical system for both air traffic control and ship self-defense.

SORTIE GENERATION RATE (SGR)

One of CVN–78's Key Performance Parameters is Sortie Generation Rate (SGR), but for a variety of reasons, CVN–78 is unlikely to achieve the required SGR. SGR measures the number of aircraft that CVN–78 can launch and recover each day. The Navy designed CVN–78 to have a higher SGR than the *Nimitz*-class carriers. CVN–78 has features intended to provide this enhanced capability that include a slightly larger flight deck, dedicated weapons handling areas, and increased aircraft refueling stations. CVN–78 requirements specify an SGR of 160 sorties per day during sustained operations (12-hour flight day) and 270 sorties per day (24-hour flight day) during surge operations. In comparison, *Nimitz*-class has demonstrated an SGR of 120 sorties per day in sustained operations and 240 sorties for surge.

As described above, I have concerns related to the performance and reliability of AAG, EMALS, AWE, and DBR. These systems are critical to CVN–78 flight operations and are being tested for the first time in their shipboard configurations after they have been installed in CVN–78. I assess the poor or unknown reliability of these critical systems and the performance issues outlined above, which clearly have the potential to diminish CVN–78's SGR, as the most significant risk to CVN–78's successful completion of IOT&E.

In addition, there are also problems with the SGR requirements themselves because they are based on unrealistic assumptions. The SGR requirements are defined through a 35-day wartime scenario known as the Design Reference Mission (DRM).[14] The DRM and the CVN–78 program office SGR assessments assume fair weather and unlimited visibility and that aircraft emergencies, failures of shipboard equipment, ship maneuvers (e.g., to avoid land), and manning shortfalls will not affect flight operations. These assumptions are unrealistic and CVN–78 is unlikely to meet the SGR requirements in an operational environment where these factors do affect flight operations.

COMBAT SYSTEM PERFORMANCE

Due to known problems with current aircraft carrier combat systems, there is a substantial risk CVN–78 will not achieve its self-defense requirements. Although the CVN–78 design incorporates several combat system improvements relative to the *Nimitz*-class, these improvements are unlikely to address all of the known shortfalls. In past reports, I have noted that the "CVN–68 class continues to have several

[14] The Navy released the current version of the DRM, version 6.0, on 4 March 2015. Version 6.0 incorporates a handful of changes, including a transition from an air wing with a mix of Joint Strike Fighters and F/A–18s to an all F/A–18 air wing (plus E–2s and other aircraft).

problems that hinder it from successfully conducting ship self-defense. Specific problems include deficiencies in weapon employment timelines, sensor coverage, system track management, NATO Evolved Sea Sparrow Missile performance, as well as deficiencies with the recommended engagement tactics."[15] Most of these limitations are likely to affect CVN–78 and I continue to view these limitations as a significant risk to CVN–78's ability to defend itself.

The CVN–78 combat system for self-defense is derived from the combat system on current carriers and amphibious ships. The combat system is used for self-defense against cruise missiles, small boats, and other threats. The combat systems on aircraft carriers and amphibious ships integrates several legacy shipboard systems, as well as several major acquisition programs including Ship Self-Defense System (SSDS), Rolling Airframe Missile (RAM), Evolved Sea Sparrow Missile (ESSM), Cooperative Engagement Capability (CEC), and Surface Electronic Warfare Improvement Program (SEWIP). On CVN–78, this integration effort includes DBR. While the integration of sensor and weapon systems with the command and decision system enhances a ship's self-defense capability relative to the use of non-integrated combat systems, the Navy has not successfully demonstrated the ability to effectively complete the self-defense mission against the types of threats and threat scenarios for which the overall system was designed. These problems affect CVN–78, as well as other Navy ships.

The combat system improvements incorporated for CVN–78 should reduce some of the sensor coverage problems historically seen on carriers, but other shortfalls in combat system integration and weapon limitations will remain. The most significant improvements involve upgrades to the sensors. The Navy will replace several legacy sensors used on *Nimitz*-class carriers with the new DBR.[16] In addition, CVN–78 will receive a new SEWIP electronic warfare system, which is an upgrade from the current SLQ–32 passive radio frequency sensor. These changes should improve sensor coverage, which has been a deficiency on *Nimitz*-class carriers. To confirm these improvements, however, realistic operational testing on CVN–78 and on the Self-Defense Test Ship (SDTS) is required. (SDTS testing is required to examine CVN–78's ability to defend itself in scenarios that are unsafe to conduct on manned ships.)

Some have argued that the self-defense limitations of aircraft carriers are not important because destroyers and cruisers escort carriers in combat and will handle these threats, but this argument ignores the fact that the CVN–78 self-defense requirements assume that these escorts are present. For example, the CVN–78 requirements to defend itself against enemy cruise missile attacks assume that the escorts will defeat most of an incoming raid and that only a portion of the raid, that will nonetheless be a challenge to defeat, will leak through to the CVN–78's self-defense systems. The Navy's most recent classified analysis examined a variety of tactical scenarios and confirmed the need for CVN–78 to be able to defend itself against cruise missiles that leak through the escorts.[17]

In addition to the historic problems with carrier combat systems mentioned earlier, there are other known limitations with the CVN–78 combat system design. These limitations include disconnects between the CVN–78 requirements and current tactics for surface threats; performance limitations against surface swarm attacks; known limitations involving torpedoes and the Nixie torpedo decoy; and concerns with mine warfare and degaussing. While these problems affect many of the Navy's surface combatants, they represent risks to CVN–78's self-defense capabilities.

PROGRAM SCHEDULE AND TEST RISKS

Some have expressed concerns that the CVN–78 post-delivery program is too lengthy and comprises an excessive number of independent steaming events (ISEs) and other activities. In fact, the program of testing and other activities leading up to the ship's deployment is determined almost entirely by the Navy's own safety and training requirements. In particular, the program schedule and number of ISEs subsequent to the ship's delivery are not driven by a mandate from testers to obtain hundreds of thousands of cycles on arresting or launch equipment, which was never expected to occur prior to the ship's deployment, as all involved in the program have known for many years. The program schedule is driven by the need to complete nu-

[15] My unclassified conclusions are reported in the fiscal year 2011 through fiscal year 2014 Annual Reports, and classified conclusions are documented in the March 2011 and the November 2012 Ship Self-Defense Operational Mission Capability Assessment Reports.

[16] Legacy sensors on *Nimitz*-class carriers include SPS–48, SPS–49, SPQ–9, and Mk 9 tracking illuminator.

[17] *Surface Ship Theater Air and Missile Defense Assessment (SSTAMDA) Study Report (U),* 9 July 2008, N86/8S177518

merous training events, Aircraft Recovery Bulletins (ARBs, which provide standardized operating procedures and technical guidance for the arresting gear and are required by the Navy to conduct flight operations), and carrier flight qualifications. For example, under the Navy's own plans, CVN–78 will not complete air-wing carrier qualifications with all of the aircraft types expected on CVN–78, until the 29th ISE. Completion of the ARBs necessary to conduct air-wing qualifications has been delayed by the poor reliability and subsequent re-design of the AAG. Carrier strike operational testing, which cannot be conducted until the air-wing has finished workups and completed carrier air-wing qualification, will be conducted as part of the CVN–78's Joint Task Force Exercise (JFTX), which is an integral part of the Navy's planned training evolution for the ship and her crew. This plan was developed to enable cost-effective testing of CVN–78's new capabilities at the earliest possible times by using data from the Navy's already-planned exercises. The common theme of the test plan is to test systems as early as possible to provide early feedback to the program office, and to combine training and testing.

Nonetheless, CVN–78 currently has a post-delivery schedule driven by the ship's deployment date and leaves little time to fix problems discovered in developmental testing before IOT&E begins. The aggressive schedule has pushed significant portions of developmental testing beyond the start of the first phase of IOT&E. Developmental Test/Integrated Test-5 (DT/IT–5), a major system integration test period, overlaps the beginning of IOT&E. Major at-sea combat system developmental tests, such as Combat System Shipboard Developmental Test events, also are scheduled to occur after IOT&E begins. [18] This aggressive schedule increases the likelihood that problems will be discovered during CVN–78's IOT&E that could delay the successful completion of testing, and may delay CVN–78's first deployment.

FULL SHIP SHOCK TRIAL (FSST)

CVN–78 survivability will be assessed as part of CVN–78's Live Fire Test and Evaluation (LFT&E) program, which includes a Full Ship Shock Trial (FSST). Historically, FSSTs for each ship class have identified previously unknown mission-critical failures that the Navy had to address to ensure that the ships would be survivable in combat. I have documented these issues in classified memoranda. [19]

In combat, even momentary interruptions of critical systems can be catastrophic when those systems are crucial to defending against incoming threats. This is why the Navy has historically required mission-essential systems to remain functional before, during, and after shock. The Navy's shock qualification specification states that a momentary malfunction is acceptable only if it is automatically self-correcting and only if no consequent derangement, mal-operation, or compromise of mission essential capability is caused by the momentary malfunction. Thus, arguments made by some that deferring the shock trial presents acceptable risk because the trial will find problems that crews can fix miss the point—unanticipated failures requiring minutes, let alone hours or days to fix are unacceptable in combat, by the Navy's own admission. The Deputy Secretary of Defense directed in August 2015 that the FSST be conducted on CVN–78 prior to her maiden deployment. The FSST will provide critical information regarding CVN–78's ability to survive and continue to conduct combat operations after absorbing hits from enemy weapons: understanding these vulnerabilities is essential. Discoveries made by conducting the FSST on CVN–78 will enable timely modification of future ships of the *Ford*-class to assure their survivability.

Some have indicated that shock trials are expected on new ships, but have yet to be done on the first ship of the class, which is incorrect. History shows that shock trials have regularly been conducted on first-of-class ships including PGH 1, LCC 19, DD 963, CV 59, LHA 1, FFG 7, DDG 993, LSD 41, MCM 1, LHD 1, and MHC 1. However, on occasion, various circumstances have caused some shock trials not to be conducted on the first-of-class, with the primary reason being to ensure testing is conducted on the most representative ship of the class. For example, FSSTs will not be conducted on the first-of-class Littoral Combat Ships (LCSs) because numerous significant design changes are being incorporated in later ships. Nonetheless, the preference is to perform the FSST on the first-of-class ship, so as to identify and mitigate mission-critical failures as soon as possible.

Some have argued component-level testing and modeling and simulation are sufficient to identify and correct shock-related problems on fully-integrated ships. If that

[18] Combat System Shipboard Developmental Test (CS SBDT) #9 and #10 occur after IOT&E begins.

[19] August 2012 memorandum, *Value of Conducting Full Ship Shock Trials (FSST) (U)* and 5 May 2014 memorandum, *GERALD R. FORD Class CVN–78 Full Ship Shock Trial (FSST).*

were the case, no mission critical failures should ever occur during FSSTs, which are conducted at less than the design-level of shock; however, mission-critical failures are always observed. For CVN–78, the FSST is particularly important given the large number of critical systems that have undemonstrated shock survivability. These systems include AAG, EMALS, DBR, the 13.8 kilovolt Electrical Generation and Distribution Systems, AWE, a new reactor plant design, and a new island design and location with a unique shock environment.

It is noteworthy that the conduct of an FSST on CVN–78 prior to her first deployment had been a part of the program of record since 2004; therefore, the Navy has had ample time to plan for this event. Nonetheless, a number of claims have been and are being made regarding the potential delay in CVN–78's deployment caused by conducting the FSST prior to the ship's first deployment. These claims span months to years; however, only the former is consistent with the Navy's conduct of the FSST on CVN–71, USS *Theodore Roosevelt.* Commissioned in October 1986, CVN–71 was underway most of January and February 1987 conducting crew and flight operations as part of shakedown. From March to July 1987, CVN–71 underwent a post-shakedown availability. The month of August was used to prepare for the FSST, which was conducted during the period spanning August 31, 1987 to September 21, 1987. Upon completing the FSST, CVN–71 returned to Norfolk Naval Station for a two-week period to remove specialized trial equipment and to complete repairs to systems essential to flight operations. After completing those mission-critical repairs, CVN–71 returned to sea to conduct fleet carrier qualifications. From November 1987 to January 1988, the ship underwent a restricted availability to complete all post-FSST and other repairs. CVN–71 was then underway for most of the remainder of 1988, conducting independent steaming exercises and other activities, departing on its first deployment on December 30, 1988. The effect of conducting the FSST on CVN–71's availability for operations following the shock trial was two weeks to conduct mission-critical repairs, and the total time required to prepare for, conduct, and recover fully from the FSST was about five months, including the restricted availability.

MANNING

I recommend that manning and berthing be reexamined for the CVN–78-class so that lessons learned can be incorporated into CVN–79. To reduce total ownership costs, the CVN–78 manning requirement is 500 billets below the *Nimitz*-class.[20] This manning requirement focuses on the ship's company and does not include the carrier air wing or embarked staffs. To achieve reduced manning, the Navy has relied upon technologies that have not been fully developed, tested, or fielded and emerging Navy-wide policies for moving workload to shore support. Similar assumptions were applied to the DDG 1000 and LCS programs. For those ship classes,the Navy has increased the size of the crews beyond the original estimates. On LCS, for example, this led to significant berthing changes. Similar manning growth could occur for CVN–78 with related berthing issues.

In its manpower analyses, the Navy has highlighted several concerns:[21]

- CVN–78's manning must be supported at the 100 percent level, although that is not the Navy's standard practice on other ships and the ability of the Navy's personnel and training systems to provide 100 percent manning is unclear;
- CVN–78 is extremely sensitive to manpower fluctuations, and in several areas a shortfall of one or two crew members creates unsustainable workloads;
- Current Navy constructs for training will not work for new and unique CVN–78 systems;
- Berthing shortfalls for Chief Petty Officers (CPO) exist;
- Officer berthing is very tight and must be managed closely;
- Berthing during some training evolutions that require a significant number of evaluators and ship riders onboard CVN–78 is inadequate;[22]
- Who is in charge of managing and maintaining CVN–78's network is not defined, a network which is much more complex than historically seen on Navy ships;
- Workload estimates for AAG, EMALS, and DBR are not well-understood.

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[20] *Nimitz* is allocated 3,291 billets in the 2002 CVN–68 Draft Ship's Manning Document. The CVN–78 manning threshold is 2,791 billets.

[21] The Navy holds regular CVN–78 manpower assessments. The last, *USS Gerald R. Ford (CVN–78) War Game III,* was held 28 July – 01 August 2014.

[22] Inadequate berthing is identified as an issue for the Composite Training Exercise (COMPTUEX) integrated phase.

In addressing these concerns on CVN–78, some changes are relatively easy, others are more difficult. Addressing the CVN–78's atypical requirement for 100 percent manning and the training shortfalls for CVN–78 unique equipment will likely require changes to the Navy support structure. With respect to increasing the ship berthing, typical berthing areas on CVN–78 have berthing racks that are two bunks high; it is relatively easy to replace two-high racks with three-high racks. This has been done on other ships such as LCS. However, it is relatively hard to provide additional showers and water closets. This requires identifying additional areas for showers and water closets and significant work for plumbing. Since habitability is a major concern for Navy ships and because these factors will inevitably have an effect on CVN–78 habitability, the Navy should reexamine manning and berthing for CVN–79.

SUMMARY

There are significant risks to the successful completion of the CVN–78 IOT&E and the ship's subsequent deployment due to known performance problems and the low or unknown reliability of key systems. For AAG, EMALS, AWE and DBR, systems that are essential to the primary missions of the ship, these problems, if uncorrected, are likely to affect CVN–78's ability to conduct effective flight operations and to defend itself in combat.

The CVN–78 test schedule leaves little or no time to fix problems discovered in developmental testing before IOT&E begins that could cause program delays. In the current program schedule, major developmental test events overlap IOT&E. This overlap increases the likelihood problems will be discovered during CVN–78's IOT&E, with the attendant risk to the successful completion of that testing and to the ship's first deployment.

The inevitable lessons we will learn from the CVN–78 FSST will have significant implications for CVN–78 combat operations, as well as for the construction of future carriers incorporating the ship's advanced systems; therefore, the FSST should be conducted on CVN–78 as soon as it is feasible to do so.

Chairman MCCAIN. Mr. Francis.

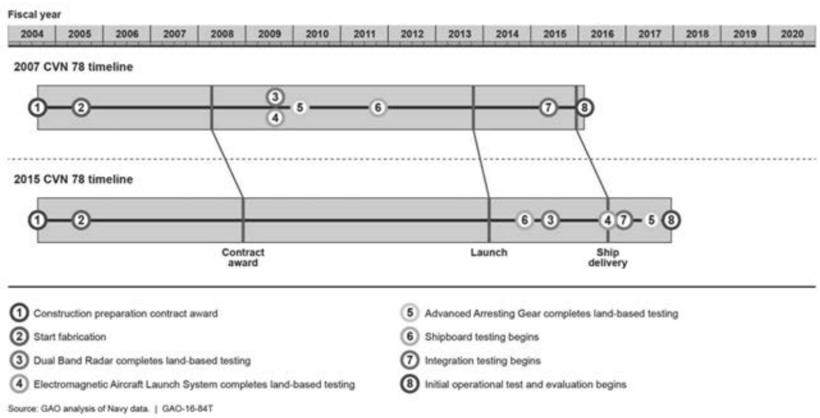
STATEMENT OF PAUL L. FRANCIS, MANAGING DIRECTOR OF ACQUISITION AND SOURCING MANAGEMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE

Mr. FRANCIS. Thank you, Mr. Chairman, Mr. Reed, members of the committee. And I appreciate the opportunity to talk about the carrier program this morning.

Let me start with the CVN–78. My bottom line on the CVN–78 is "same story, different program." In 2007, we reported that costs were likely to be underestimated by 22 percent on the construction of the ship and that the three main technologies—EMALS, AAG, and DBR—were immature, likely to slip to the right, and out of schedule margin. And we said the Navy would be faced with the decision to either push the ship to the right or push the technologies to the right.

Fast forward to today, 2015, cost increases are 22 percent. The three key technologies—I'm going to hold the slide up—but, they've slipped about 5 years. So, the decisions made to keep the ship construction schedule pretty much intact but let the technologies slip. So, that's probably hard to see. But, the top chart—we have circles here. Three, four, five, and six, those are the three key technologies in the beginning of the shipboard testing. So, the original plan on the top was clearly "fly before buy." Where we are today is, those three technologies and shipboard testing have all slid past ship launch. So, that's "buy before fly."

Delays in CVN 78 Program Events: 2007 to July 2015



Source: GAO testimony, 1 Oct 2015

So, my view at this point is, ship costs are going to continue to increase, full capability of the ship has been deferred, and right now we're looking at getting less for more. Now, why would I say that? I remember 25 years ago, I was interviewing the second Under Secretary of Defense for AT&L, John Betti. And he told me, "You know, cost estimates in the Department of Defense, it's not like they're impossible to be achieved, but they do count on hitting seven home runs in the bottom of the ninth." So, I apologize for the sports analogy, but it's not mine.

So, let's look at the home runs that the CVN–78 has to hit. And you can kind of see them bunched up here. We have to do a land-based testing, ship-based testing, integrated testing, IOT&E, all the time we're trying to complete construction. So, it's a big lift.

Let's go to the CVN–79. What are its home runs? Right now the CVN–79's cost estimate depends on reducing construction labor hours by 18 percent, 9.3 million labor hours. Never been done before. Twice of whatever's been done in the past. The dual-band radar has been removed. It'll be replaced with a radar that's to be determined. And upgrades that were planned for the ship have been postponed. And so, I think that's wringing a lot out of the program already. It's already, with all these changes, at cap, and we're 7 years from delivery. Again, I think cost increases are likely, regardless of what's reported against the cost cap.

So, I'd like to put the carrier in a little context here against acquisition. And, I think, Mr. Chairman, you brought this up, as did Mr. Reed. The CVN–78 program is a typical acquisition outcome. You know, 22-percent increase in cost, schedule delays are actually pretty typical for acquisitions. And, Mr. Chairman, I've testified before you a number of times on different things, but we can think of worse examples: JSF [Joint Strike Fighter], FCS [Future Combat Systems], F–22, LCS [Littoral Combat Ship]. So, I think what's different here is, this program—we knew all along this was going to be the case. We shouldn't be surprised by anything that's happened here, because we saw it coming. So, it's not an "I told you so" moment. It's "We all knew it."

And so, you ask yourself why does something like this happen? Best practices are pretty well known, and we can go through them. So, mature technologies before you put them on the program. Wasn't done here. Go with a realistic cost estimate, and budget to it. We've always gone with the lowest cost estimate, the Navy's estimate. And we still are. And "fly before buy." It wasn't done here.

So, you ask yourself, Why don't we do these things? And my belief is, it's the prevailing acquisition culture. It's the collective pressures that the different participants bring upon the process that create incentives for programs to overstate what they think they can do, to understate technical risk, to understate cost, and to understate schedule. That's how you get funding, that's how you get programs approved.

So, I'd just like to say, Where does this leave us today? And I'll say I know it's popular today to talk about the acquisition process being broken, but I think it's in a happy equilibrium. Well, maybe not so happy, but it's in equilibrium. It's been this way for 50 years. And I think it's going to stay this way until the incentives change. And, as the Chairman said, I've had—been in this job for 40 years. I haven't given up hope yet. And I believe that Congress is the game-changer here. I think Congress can change the incentives by reclaiming its oversight role, which I think has been diminished over the years. So, what do I mean by that? I'll cite three things:

First is, your most important oversight tool is the initial funding you provide to a program. But, you give that tool up pretty early. So, if I'm a program today and I'm at milestone B, Congress had to approve my funding 2 years ago. Information was less, optimism fills the void. There's a cardinal rule in acquisition that says, "Don't take money off the table." So, once you've approved my funding, 2 years later you've actually made the milestone B decision for me.

Second thing is, I know the committee has many, many heavy responsibilities, but one of your responsibilities is, you're the appeals court for the services. So, if OSD says something a service disagrees with—and I'm speaking broadly—if Mike Gilmore's shop says something that the—they don't agree with, if the CAPE [Office of Cost Assessment and Program Evaluation] estimate they don't like, if it's a GAO recommendation they don't like, the services come up here. You're the appeals court. And they try to strike a deal. And they get those deals.

And then, finally, a movement in the Department—and, I think, particularly with the Navy—is the bundle-up programs in multiyear procurements, block buys, and option program—or option contracts. So, not only do you give up your funding—initial funding power, you can't touch the program afterwards, because it's all locked down in a block contract.

So, I guess my appeal to you today is, let's not think of the CVN–78 program as the story, per se, but let's think about it as an object lesson in acquisition process and acquisition culture, and what the Congress can do about it, not just telling what the Department can do, but how you might do differently. Because I really think what you do with money sends messages as to what is acceptable.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Francis follows:]

United States Government Accountability Office

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FORD CLASS AIRCRAFT CARRIER

Poor Outcomes Are the Predictable Consequences of the Prevalent Acquisition Culture

Statement of Paul L. Francis, Managing Director
Acquisition and Sourcing Management

GAO-16-84T

GAO Highlights

Highlights of GAO-16-84T, a testimony before the Committee on Armed Services, U.S. Senate

October 2015

FORD CLASS AIRCRAFT CARRIER

Poor Outcomes Are the Predictable Consequences of the Prevalent Acquisition Culture

Why GAO Did This Study

The Navy set ambitious goals for the Ford-class program, including an array of new technologies and design features that were intended to improve combat capability and create operational efficiencies, all while reducing acquisition and life-cycle costs. The lead ship, CVN 78, has experienced significant cost growth with a reduced capability expected at delivery. More cost growth is likely. While CVN 78 is close to delivery, examining its acquisition history may provide an opportunity to improve outcomes for the other ships in the class and illustrate the dynamics of defense acquisition.

GAO has reported on the acquisition struggles facing the Ford-class, particularly in GAO-07-866, GAO-13-396, and GAO-15-22. This statement discusses: (1) the Navy's initial vision for CVN 78 and where the ship stands today; (2) plans for follow-on ship cost and construction; and (3) Ford-class experiences as illustrative of acquisition decision making. This statement is largely based on the three reports as well as GAO's larger work on shipbuilding and acquisition best practices, and also incorporates updated audit work where appropriate.

What GAO Recommends

GAO is not making any new recommendations in this statement but has made numerous recommendations to the Department of Defense in the past on Ford-class acquisition, including strengthening the program's business case before proceeding with acquisition decisions. While the Department has, at times, agreed with GAO's recommendations it has taken little to no action to implement them.

View GAO-16-84T. For more information, contact Paul L. Francis at (202) 512-4841 or francisp@gao.gov.

What GAO Found

The Ford-class aircraft carrier's lead ship began construction with an unrealistic business case. A sound business case balances the necessary resources and knowledge needed to transform a chosen concept into a product. Yet in 2007, GAO found that CVN 78 costs were underestimated and critical technologies were immature—key risks that would impair delivering CVN 78 at cost, on-time, and with its planned capabilities. The ship and its business case were nonetheless approved. Over the past 8 years, the business case has predictably decayed in the form of cost growth, testing delays, and reduced capability—in essence, getting less for more. Today, CVN 78 is more than $2 billion over its initial budget. Land-based tests of key technologies have been deferred by years while the ship's construction schedule has largely held fast. The CVN 78 is unlikely to achieve promised aircraft launch and recovery rates as key systems are unreliable. The ship must complete its final, more complex, construction phase concurrent with key test events. While problems are likely to be encountered, there is no margin for the unexpected. Additional costs are likely.

Similarly, the business case for CVN 79 is not realistic. The Navy recently awarded a construction contract for CVN 79 which it believes will allow the program to achieve the current $11.5 billion legislative cost cap. Clearly, CVN 79 should cost less than CVN 78, as it will incorporate lessons learned on construction sequencing and other efficiencies. While it may cost less than its predecessor, CVN 79 is likely to cost more than estimated. As GAO found in November 2014, the Navy's strategy to achieve the cost cap relies on optimistic assumptions of construction efficiencies and cost savings—including unprecedented reductions in labor hours, shifting work until after ship delivery, and delivering the ship with the same baseline capability as CVN 78 by postponing planned mission system upgrades and modernizations until future maintenance periods.

Today, with CVN 78 over 92 percent complete as it reaches delivery in May 2016, and the CVN 79 on contract, the ability to exercise oversight and make course corrections is limited. Yet, it is not too late to examine the carrier's acquisition history to illustrate the dynamics of shipbuilding—and weapon system—acquisition and the challenges they pose to acquisition reform. The carrier's problems are by no means unique; rather, they are quite typical of weapon systems. Such outcomes persist despite acquisition reforms the Department of Defense and Congress have put forward—such as realistic estimating and "fly before buy." Competition with other programs for funding creates pressures to overpromise performance at unrealistic costs and schedules. These incentives are more powerful than policies to follow best acquisition practices and oversight tools. Moreover, the budget process provides incentives for programs to be funded before sufficient knowledge is available to make key decisions. Complementing these incentives is a marketplace characterized by a single buyer, low volume, and limited number of major sources. The decades-old culture of undue optimism when starting programs is not the consequence of a broken process, but rather of a process in equilibrium that rewards unrealistic business cases and, thus, devalues sound practices.

Chairman McCain, Ranking Member Reed, and Members of the Committee:

I am pleased to be here today to discuss the Department of the Navy's Ford-class nuclear-powered aircraft carrier, the successor to the Nimitz-class aircraft carrier designed in the 1960s. The Navy set ambitious goals for the Ford-class program, designing the carrier with an array of cutting edge technologies, including an aircraft launch system that would use electromagnetics—versus steam—to propel aircraft off of the ship (EMALS), an advanced arresting gear (AAG) with an electric motor to recover aircraft, and a dual band radar (DBR) that would use two planar (stationary) radars to provide air traffic control, ship self-defense, and other capabilities. These technologies, along with new design features, like an enlarged flight deck and aft positioned island, would improve combat capability and create operational efficiencies by increasing the ship's sortie generation rate and reducing manpower—with a $4.4 billion investment needed to research and develop these improvements for the class. The Navy expected to achieve these improvements while simultaneously reducing acquisition and life cycle costs. From the outset there was inherent tension between these goals. Budgets set early in the Ford-class program were not realistically achievable and included optimistic delivery dates to the fleet. The consequences of this tension have been realized today. The costs to construct the lead ship, CVN 78, have increased by over $2 billion, with promised levels of capability potentially compromised.

Today, with CVN 78 over 92 percent complete, the ability to make course corrections is limited. Yet, it is not too late to examine the lead ship's acquisition history not only in an effort to improve the outcomes for the other ships in the class, but to illustrate the dynamics of shipbuilding—and weapon system—acquisition. Accordingly, I will discuss: (1) the initial vision for CVN 78 and where we are today; (2) plans for follow-on ship cost and construction; and (3) Ford-class experiences as illustrative of acquisition decision making.

This testimony largely leverages our past Ford-class program reports from August 2007, September 2013, and November 2014.[1] Details of the scope and methodology are available in these reports. This statement also includes updates to this information as appropriate based on program documentation and discussions with Navy officials. We also draw on some conclusions from our broader work on Navy shipbuilding and acquisition reform initiatives. We conducted this work in accordance with generally accepted government auditing standards. Those standards required that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions.

Weaknesses in CVN 78's Business Case Manifested by Less Capability at Higher Cost

In July 2007, we reported on weaknesses in the Navy's business case for the Ford-class aircraft carrier and focused mainly on the lead ship, CVN 78.[2] We noted that costs and labor hours were underestimated and critical technologies were immature. Today, all of this has come to pass in the form of cost growth, testing delays, and reduced capability—in other words, less for more. In August 2007, we also observed that in consequence of its optimistic business case, the Navy would likely face the choice of (1) keeping the ship's construction schedule intact while deferring key knowledge-building events—such as land-based tests of technologies—until later, or (2) slipping the ship's construction schedule to accommodate technology and other delays. Today, those choices have been made—the ship's construction schedule has been delayed slightly by a few months, while other events, like land-based tests for critical technologies, have slid by years. The result is a final acquisition phase in which construction and key test events are occurring concurrently, with no margin for error without giving something else up.

In its simplest form, a business case requires a balance between the concept selected to satisfy warfighter needs and the resources—

[1] GAO, *Defense Acquisitions: Navy Faces Challenges Constructing the Aircraft Carrier Gerald R. Ford within Budget*, GAO-07-866 (Washington, D.C. Aug. 23, 2007); GAO, *Ford-Class Carriers: Lead Ship Testing and Reliability Shortfalls Will Limit Initial Fleet Capabilities*, GAO-13-396 (Washington, D.C.: Sept. 5, 2013); and GAO, *Ford-Class Aircraft Carrier: Congress Should Consider Revising Cost Cap Legislation to Include All Construction Costs*, GAO-15-22 (Washington, D.C.: November 20, 2014).

[2] GAO, *Defense Acquisitions: Realistic Business Cases Needed to Execute Navy Shipbuilding Programs*, GAO-07-943T (Washington, D.C. Jul. 24, 2007).

technologies, design knowledge, funding, and time—needed to transform the concept into a product, in this case a ship. In a number of reports and assessments since 2007, we have consistently reported on concerns related to technology development, ship cost, construction issues, and overall ship capabilities. Absent a strong business case, the CVN 78 program deviated from its initial promises of cost and capability, which we discuss below.

In August 2007, before the Navy awarded a contract to construct the lead ship, we reported on key risks in the program that would impair the Navy's ability to deliver CVN 78 at cost, on time, and with its planned capabilities (as seen in table 1 below).

Table 1: Expectations for CVN 78 Program and Risks Identified by GAO in 2007

Navy Expectations in 2007	Risks Identified in 2007 GAO Report
Critical technologies	
• The Navy expected to deliver CVN 78 with increased capability over the Nimitz class. • EMALS, AAG, and DBR would all complete land-based testing before their equipment was required in the shipyard for installation.	• Delays in critical technology development and testing could increase lead ship construction costs. • Technology challenges could also lead to reductions in the ship's required capability at delivery.
Design Knowledge	
• CVN 78's design would be more complete than the previous carrier. • A new 3-dimisional design tool would help complete 75 percent of the product model by the time of construction contract award.	• While the design process was relatively sound, the design schedule may be difficult to maintain because immature technologies could require future design changes. • Design changes could also interfere with ship construction.
Cost	
• CVN 78 would cost $10.5 billion total to design and construct • The shipbuilder would use 42.7 million total labors hours to construct the ship.	• The Navy's cost estimate used to develop the CVN 78 budget was optimistic. • Costs will likely exceed budget if: • technologies or other materials are delivered late, • labor hour efficiencies are not realized, • materials are delayed, or • cost exceeds estimates.
Time	
• The Navy would deliver a complete ship by September 2015 to meet operational needs.	• Immature critical technologies and an optimistic budget could delay the CVN 78 schedule.

Source: GAO analysis of Navy data and GAO-07-866 | GAO-16-84T

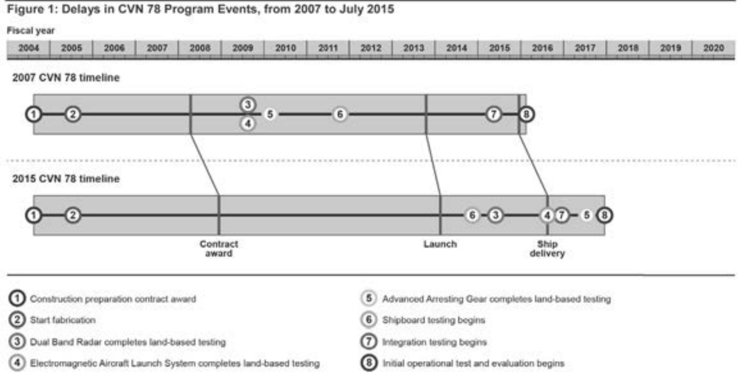
Specifically, we noted that the Navy's cost estimate of $10.5 billion and 2 million fewer labor hours made the unprecedented assumption that the CVN 78 would take fewer labor hours than its more mature predecessor—the CVN 77. The shipbuilder's estimate—22 percent higher in cost was more in line with actual historical experience. Moreover, key technologies, not part of the shipbuilder's estimates because they would be furnished by the government, were already behind and had absorbed much of their schedule margin.

Congress expressed similar concerns about Ford-class carrier costs. The John Warner National Defense Authorization Act for Fiscal Year 2007 included a provision that established (1) a procurement cost cap for CVN 78 of $10.5 billion, plus adjustments for inflation and other factors, and (2) a procurement cost cap for subsequent Ford-class carriers of $8.1 billion each, plus adjustments for inflation and other factors. The legislation in effect required the Navy to seek statutory authority from Congress in the event it determined that adjustments to the cost cap were necessary, and the reason for the adjustments was not one of six factors permitted in the law.[3]

The risks we assessed in 2007 have been realized, compounded by additional construction and technical challenges. Several critical technologies, in particular, EMALS, AAG, and DBR, encountered problems in development, which resulted in delays to land-based testing. It was important for these technologies to be thoroughly tested on land so that problems could be discovered and fixes made before installing production systems on the ship. In an effort to meet required installation dates aboard CVN 78, the Navy elected to largely preserve the construction schedule and produce some of these systems prior to demonstrating their maturity in land-based testing. This strategy resulted in significant concurrency between developmental testing and construction, as shown in figure 1 below.

[3] The 2007 legislation allowed the Navy to make adjustments to the cost cap without seeking additional statutory authority due to: 1) cost changes due to economic inflation; 2) costs attributable to compliance with changes in federal, state, or local laws; 3) outfitting and post-delivery costs; 4) cost changes related to the insertion of new technologies; 5) cost changes due to nonrecurring design and engineering; 6) costs associated with the correction of deficiencies that would affect the safety of the ship and personnel or otherwise preclude safe ship operation and crew certification. The National Defense Authorization Act for Fiscal Year 2014 expanded this list to include changes due to urgent and unforeseen requirements identified during shipboard testing. Pub. L. No. 113-66, § 121 (2013).

Figure 1: Delays in CVN 78 Program Events, from 2007 to July 2015

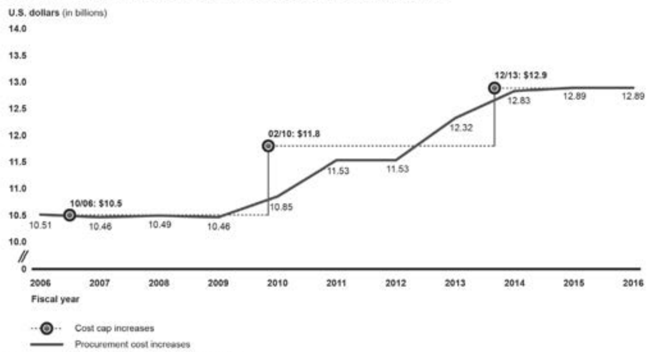


Source: GAO analysis of Navy data. | GAO-16-84T

The burden of completing technology development now falls during the most expensive phase of ship construction. I view this situation as latent concurrency in that the overlap between technology development, testing, and construction was not planned for or debated when the program was started. Rather, it emerged as a consequence of optimistic planning. Concurrency has been made more acute as the Navy has begun testing the key technologies that are already installed on the ship, even as land based testing continues. Moreover, the timeframes for post-delivery testing, i.e. the period when the ship would demonstrate many of its capabilities, are being compressed by ongoing system delays. This tight test schedule could result in deploying without fully tested systems if the Navy maintains the ship's ready-to-deploy date in 2020.

The issues described above, along with material shortfalls, engineering challenges, and delays developing and installing critical systems, drove inefficient out-of-sequence work, which resulted in significant cost increases. This, in turn, required the Navy to seek approval from Congress to raise the legislative cost cap, which it attributed to construction cost overruns and economic inflation (as shown in figure 2 below).

Figure 2: CVN 78 Procurement Costs and Congressional Cost Cap Increases



Source: GAO analysis of U.S. Navy budget data. | GAO-16-84T

Along with costs, the Navy's estimates of the number of labor hours required to construct the ship have also increased (see table 2).

Table 2: CVN 78 Planned vs. Actual Ship Construction Costs (2007-2015)

2007	2015
$10.5 billion	$12.9 billion
42.7 million labor hours estimated to complete ship	49.9 million labor hours estimated to complete ship
= Fully constructed ship at delivery	**= Incomplete ship at delivery** Work to be completed post-delivery: • 367 compartments • Correction of certain deficiencies • Installation of mission-oriented systems

Source: GAO analysis of Navy data | GAO-16-84T

Recalling that in 2007, the Navy's estimate was 2 million hours lower than the shipbuilder's, the current estimate is a big increase. On the other hand, it is more in line with a first-in-class ship like CVN 78; that is to say, it was predictable. To manage remaining program risks, the Navy deferred some construction work and installation of mission-related systems until after ship delivery. Although this strategy may provide a funding reserve in the near term, it still may not be sufficient to cover all potential cost risks. In particular, as we reported in November 2014, the schedule for completing testing of the equipment and systems aboard the ship had become increasingly compressed and continues to lag behind expectations. This is a particularly risky period for CVN 78 as the Navy will need to resolve technical deficiencies discovered through testing—for critical technologies or the ship—concurrent with latter stage ship construction activities, which is generally more complex than much of the work occurring in the earlier stages of construction.

Risks to the ship's capability we identified in our August 2007 report have also been realized. We subsequently found in September 2013 and November 2014 that challenges with technology development are now affecting planned operational capability beyond the ship's delivery (as shown in table 3).

Table 3: CVN 78 Planned vs. Actual Capabilities at Delivery (2007-2015)

2007	2015
• CVN 78 would be able to conduct full flight operations with all carrier aircraft types • The ship would conduct full operations with a reduced manning profile • Projected CVN 78 manpower would be sufficient to meet increased sortie generation rate	• CVN 78 is scheduled to begin flight operations in July 2016, according to Navy officials—4 months after delivery—with one fixed-wing aircraft type • Poor reliability of key systems, including EMALS and AAG, will likely require additional personnel • Additional personnel will be needed to meet the surge sortie generation rate

Source: GAO analysis of Navy data and prior GAO reports | GAO-16-84T

Specifically, CVN 78 will not demonstrate its increased sortie generation rate due to low reliability levels of key aircraft launch and recovery systems before it is ready to deploy to the fleet. Further, required reductions in personnel remain at risk, as immature systems may require more manpower to operate and maintain than expected. Ultimately, these limitations signal a significant compromise to the initially promised capability. The Navy believes that, despite these pressures, it will still be able to achieve the current $12.9 billion congressional cost cap. While this remains to be seen, the Navy's approach, nevertheless, results in a more expensive, yet less complete and capable ship at delivery than initially planned. Even if the cost cap is met, it will not alter the ultimate cost of the ship. Additional costs will be borne later—outside of CVN 78's acquisition costs—to account for, for example, reliability shortfalls of key systems. In such cases, the Navy will need to take costly actions to maintain operational performance by adding maintenance personnel and spare parts. Reliability shortfalls, in turn, will drive ship life cycle cost increases related to manning, repairs, and parts sparing. Deferred systems and equipment will at some point be retrofitted back onto the ship.

Business Case for Follow-On Ship Assumes Ambitious Efficiency Gains

Although increases have already been made to the CVN 79's cost cap and tradeoffs made to the ship's scope, it still has an unrealistic business case. In 2013, the Navy requested congressional approval to increase CVN 79's cost cap from $8.1 billion to $11.5 billion, citing inflation as well as cost increases based on CVN 78's performance. Since the Ford-class program's formal system development start in 2004, CVN 79's planned delivery has been delayed by 4 years and the ship will be ready for deployment 15 months later than expected in 2013.

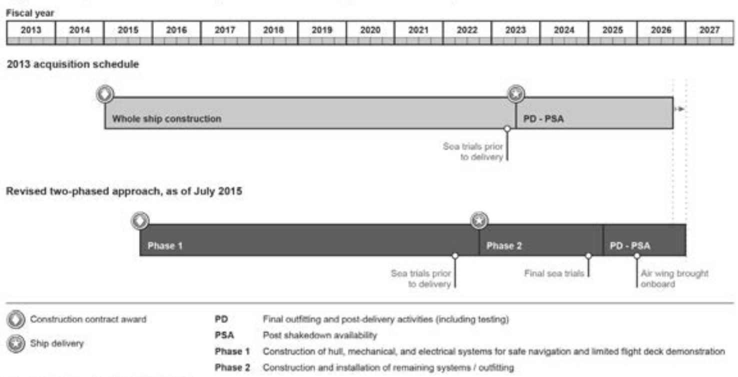
The Navy recently awarded a construction contract for CVN 79 which it believes will allow the program to achieve the current $11.5 billion legislative cost cap. Similar to the lead ship, the business case for CVN 79 is not commensurate with the costs needed to produce an operational ship. By any measure, CVN 79 should cost less than CVN 78, as it will incorporate important lessons learned on construction sequencing and other efficiencies. While it may cost less than its predecessor, CVN 79 is likely to cost more than estimated. As we reported in November 2014, the Navy's strategy to achieve the cost cap: 1) relies on optimistic assumptions of construction efficiencies and cost savings; (2) shifts work—including installation of mission systems—needed to make the ship fully operational until after ship delivery; and (3) delivers the ship with the same baseline capability as CVN 78, with the costs of a number of planned mission system upgrades and modernizations postponed until future maintenance periods. Even with ambitious assumptions and planned improvements, the Navy's current estimate for the CVN 79 stands at $11.5 billion—already at the cost cap. For perspective, the Director of the Department of Defense's (DOD) Cost Assessment and Program Evaluation office projects that the Navy will exceed the congressional cost cap by about $235 million. The Congressional Budget Office estimates for CVN 79 are even higher; at a total cost of over $12.5

billion—which, if realized, would be over $1 billion above the current congressional cost cap.

Similar to CVN 78, the Navy is assuming the shipbuilder will achieve efficiency gains that are unprecedented in aircraft carrier construction. While the shipbuilder has initiated significant revisions in its processes for building the ship that are expected to reduce labor hours, the Navy's cost estimate for CVN 79 is predicated on an over 9 million labor hour reduction compared to CVN 78. For perspective, this estimate is not only lower than the 42.7 million hours originally estimated for CVN 78, it is 10 percent lower than what was achieved on CVN 77, the last Nimitz-class carrier. Previous aircraft carrier constructions have reduced labor hours by 3.2 million hours at most. Further, the Navy estimates that it will save over $180 million by replacing the dual band radar in favor of an alternative radar system, which it expects will provide a better technological solution at a lower cost. Cost savings are assumed, in part, because the Navy expects the radar to work within the current design parameters of the ship's island. However, the Navy has not yet awarded a contract to develop the new radar solution. If design modifications are needed to the ship's island, CVN 79 costs will increase, offsetting the Navy's estimate of savings. Again for perspective, the Navy initially planned to install DBR on CVN 77 and it has taken the Navy over 10 years to develop the DBR, which is still not yet through testing.

Finally, achieving the legislative cost cap of $11.5 billion is predicated on executing a two-phased delivery strategy for CVN 79, which will shift some construction work and installation of the warfare and communications systems to after ship delivery. By design, this strategy will result in a less capable and less complete ship at delivery—the end of the first phase—as shown in figure 3 below:

Figure 3: Comparison of CVN 79's September 2013 and July 2015 Revised Acquisition Schedules



Source: GAO analysis of Navy data. | GAO-16-84T

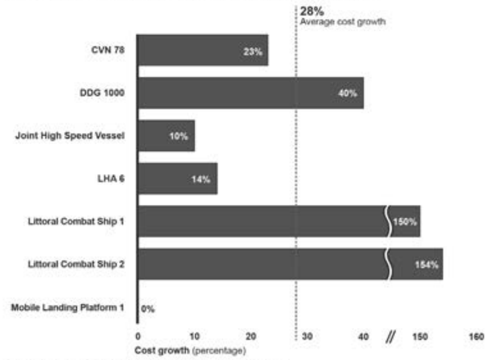
According to the Navy, delaying procurement and installation of warfare and communications systems will prevent obsolescence before the ship's first deployment in 2027 and allow the Navy to introduce competition for the ship's systems and installation work after delivery.

As we reported in November 2014, the Navy's two-phased approach transfers the costs of a number of known capability upgrades, including decoy launching systems, torpedo defense enhancements, and Joint Strike Fighter aircraft related modifications, previously in the CVN 79 baseline to other (non-CVN 79 shipbuilding) accounts, by deferring installation to future maintenance periods. While such revisions reduce the end cost of CVN 79 in the near term, they do not reduce the ultimate cost of the ship, as the costs for these upgrades will eventually need to be paid—just at a later point in the ship's life cycle.

Ford Class Program Emblematic of Incentives Which Discourage Implementing Sound Acquisition Practices

That CVN 78 will deliver at higher cost and less capability, while disconcerting, was predictable. Unfortunately, it is also unremarkable, as it is a typical outcome of the weapon system acquisition process. Along these lines, what does the CVN 78's experience say about the acquisition process and what lessons can be learned from it? In many ways, CVN 78 represents a familiar outcome in Navy shipbuilding programs. Across the shipbuilding portfolio, cost growth for recent lead ships has been on the order of 28 percent (see figure 4).

Figure 4: Cost Growth in Program Budgets for Recent Lead Ships (Authorized to Start Construction between Fiscal year 2005 to Fiscal year 2011)



Source: GAO analysis based on Navy budget documentation. | GAO-16-84T

Note: In cases where a lead and follow-on ship costs were budgeted in a single year we attributed the planning cost to the lead ship and then split the remaining costs between the two. Also, we depicted LCS 1 and LCS 2 as lead ships because each ship was constructed at a different shipyard with different designs.

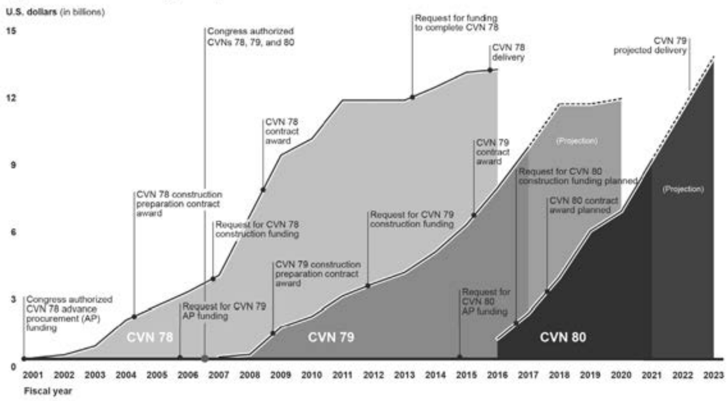
Figure 4 above further illustrates the similarity between CVN 78 and other shipbuilding programs authorized to start construction around the same time. Lead ships with the highest percentages of cost growth, such as the Littoral Combat Ships and DDG 1000, were framed by steep programmatic challenges. Similar to the CVN 78, these programs have been structured around unexecutable business cases in which ship construction begins prior to demonstrating key knowledge, resulting in costly, time-consuming, and out-of-sequence work during construction and undesired capability tradeoffs.

Such outcomes persist even though DOD and Congress have taken steps to address long-standing problems with DOD acquisitions. These reforms emphasize sound management practices—such as realistic estimating, thorough testing, and accurate reporting—and were implemented to enhance DOD's acquisition policy, which already provided a framework for managers to successfully develop and execute acquisition programs. Today these practices are well known. However, outcomes of the Ford-class program illustrate the limits of focusing on policy-and-practice related aspects of weapon system development without understanding incentives to sacrifice realism to win support for a program.

Strong incentives encourage deviations from sound acquisition practices. In the commercial marketplace, investment in a new product represents an expense. Company funds must be expended and will not provide a return until the product is developed, produced, and sold. In DOD, new products represent a revenue, in the form of a budget line. A program's return on investment occurs as soon as the funding is initiated. The budget process results in funding major program commitments before knowledge is available to support such decisions. Competition with other programs vying for funding puts pressure on program sponsors to project unprecedented levels of performance (often by counting on unproven technologies) while promising low cost and short schedules. These incentives, coupled with a marketplace that is characterized by a single buyer (DOD), low volume and limited number of major sources, create a culture in weapon system acquisition that encourages undue optimism about program risks and costs. To the extent Congress funds such programs as requested, it sanctions—and thus rewards—optimism and unexecutable business cases. To be sure, this is not to suggest that the acquisition process is foiled by bad actors. Rather, program sponsors and other participants act rationally within the system to achieve goals they believe in. Competitive pressures for funding simply favor optimism in setting cost, schedule, technical, and other estimates.

The Ford-class program illustrates the pitfalls of operating in this environment. Optimism has pervaded the program from the start. Initially, the program sought to introduce technology improvements gradually over a number of successive carriers. However, in 2002, DOD opted to forgo the program's evolutionary acquisition strategy, in favor of achieving revolutionary technological achievements on the lead ship. Expectations of a more capable ship were promised, with cost and schedule goals that were out of balance with the technical risks. Further, the dynamics of weapon system budgeting—and in particular, shipbuilding—resulted in significant commitments made well in advance of critical acquisition decisions, most notably, the authorization to start construction. Beginning in 2001, the Ford Class program began receiving advanced procurement funding to initiate design activities, procure long-lead materials, and prepare for construction, as shown in figure 5 below.

Figure 5: Ford Class Funding and Major Milestones



Source: GAO analysis of U.S. Navy budget data. | GAO-16-84T

By the time the Navy requested funding for construction of CVN 78 in 2007 it had already received $3.7 billion in advance procurement. It used some of these funds to build 13 percent of the ship's construction units.[4] Yet, at that time the program had considerable unknowns—technologies were immature and cost estimates unreliable. Similarly, in 2013, Congress had already appropriated nearly $3.3 billion in funding for CVN 79 construction. This decision was made even though the Navy's understanding of the cost required to construct and deliver the lead ship was incomplete. A similar scenario exists today, as the Navy is requesting funding for advanced procurement of CVN 80, while also constructing CVN 78 and CVN 79. While these specifics relate to the Ford-class

[4] By comparison, CVN 77 received approximately $919 million in advance procurement funding.

carrier, the principles apply to all major weapon system acquisitions. That is, commitments to provide funding in the form of budget requests, Congressional authorizations, and Congressional appropriations are made well in advance of major program commitments, such as the decision to approve the start of a program. At the time the funding commitments are made, less verifiable knowledge is available about a program's cost, schedule, and technical challenges. This creates a vacuum for optimism to fill. When the programmatic decision point arrives, money is already on the table, which creates pressure to make a "go" decision, regardless of the risks now known to be at hand.

The environment of Navy shipbuilding is unique as it is characterized by a symbiotic relationship between buyer (Navy) and builder. This is particularly true in the case of aircraft carriers, where there is only one domestic entity capable of constructing, testing, and delivering nuclear-powered aircraft carriers. Consequently, the buyer has a strong interest in sustaining the shipbuilder despite shortfalls in performance. Under such a scenario, the government has a limited ability to negotiate favorable contract terms in light of construction challenges and virtually no ability to walk away from the investment once it is underway.

Concluding Remarks

The experiences of the Ford-class program are not unique—rather, they represent a typical acquisition outcome. The cost growth and other problems seen today were known to be likely in 2007—before a contract was signed to construct the lead ship. Yet CVN 78 was funded and approved despite a knowingly deficient business case; in fact, the ship has been funded for nearly 15 years. It is too simplistic to look at the program as a product of a broken acquisition process; rather it is indicative of a process that is in equilibrium. It has worked this way for decades with similar outcomes: weapon systems that are the best in the world, but cost significantly more, take longer, and perform less than advertised. The rules and policies are clear about what to do, but other incentives force compromises of good judgment. The persistence of undesirable outcomes such as cost growth and schedule delays suggests that these are consequences that participants in the process have been willing to accept. It is not broken in the sense that it is rational; that is, program sponsors must promise more for less in order to win funding approval. This naturally leads to an unexecutable business case. Once funded and approved, reality sets in and the program must then offer less for more.

Where do we go from here? Under consideration this year are a number of acquisition reforms. While these aim to change the policies that govern weapon system acquisition, they do not sufficiently address the incentives that drive the behavior. As I described above, the acquisition culture in general rewards programs for moving forward with unrealistic business cases. Early on, it was clear that the Ford-class program faced significant risks due to the development, installation and integration of numerous technologies. Yet, these risks were taken on the unfounded hope that they were manageable and that risk mitigation plans were in place. The budget and schedule did not account for these risks. Funding approval—authorizing programs and appropriating funds are some of the most powerful oversight tools Congress has. The reality is once funding starts, other tools of oversight are relatively weak—they are no match for the incentives to over-promise. Consequently, the key is to ensure that new programs exhibit desirable principles before they are approved and funded. There is little that can be done from an oversight standpoint on the CVN 78. In fact, there is little that can be done on the CVN 79, either. Regardless of how costs will be measured against cost caps, the full cost of the ships—as yet unknown—will ultimately be borne. For example, while the Joint Precision Approach and Landing System has been deferred from the first two ships, eventually it will have to be installed on them to accept the F-35 fighter. The next real oversight opportunity is on the CVN 80, which begins funding in fiscal year 2016.

Going forward, there are two acquisition reform challenges I would like to put on the table. The first is what to do about funding. Today, DOD and Congress must approve and fund programs ahead of major decision points and key information. With money in hand, it is virtually impossible to disapprove going forward with the program. There are sound financial reasons for making sure money is available to execute programs before they are approved. But they are also a cause of oversold business cases. Second, in the numerous acquisition reform proposals made recently, there is much for DOD to do. But, Congress, too, has a role in demanding realistic business cases through the selection and timing of the programs it chooses to authorize and fund. What it does with funding sets the tone for what acquisition practices are acceptable.

Mr. Chairman and Members of the Committee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff has any questions about this statement, please contact Paul L. Francis at (202) 512-4841 or FrancisP@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. GAO staff who made key contributions to this testimony are Diana Moldafsky, Assistant Director; Charlie Shivers; Burns C. Eckert; Laura Greifner; Kelsey Hawley; Jenny Shinn; Ozzy Trevino; Abby Volk; and Alyssa Weir.

Appendix I: Prior GAO Recommendations for Ford Class Carriers and Department of Defense (DOD) Responses and Subsequent Actions

In August 2007 and, again, in September 2013, we recommended actions the Navy could take to improve CVN 78's business case. Further, in our September 2013 report, we also made recommendations to improve the Navy's management of CVN 79's costs and schedule. As shown below, few actions have been taken to address our most pressing recommendations for the lead and follow-on ship:

GAO Report	GAO Recommendations	DOD Response and actions
GAO-07-866	• Improve the realism of CVN 78's budget estimate. • Improve Navy's cost surveillance capability.	• While the department agreed with our recommendations in concept, it has not fully taken action to implement them. The CVN 78 cost estimate continues to reflect undue optimism.
GAO-13-396	• Conduct a cost-benefit analysis on required CVN 78 capabilities, namely reduced manning and the increased sortie generation rate prior to ship delivery. • Update the CVN 78 test plan before ship delivery to allot sufficient time after ship delivery for land based testing to complete prior to shipboard testing. • Adjust the CVN 78 planned post-delivery test schedule to ensure that system integration testing is completed before IOT&E. • Defer the CVN 79 detail design and construction contract until land-based testing for critical systems was complete and update the CVN 79 cost estimate on the basis of actual costs and labor hours needed to construct CVN 78 during the recommended contract deferral period of CVN 79.	• DOD agreed with the need for a cost-benefit analysis, but did not plan to fully assess CVN 78 capabilities until the completion of operational testing after ship delivery. • DOD agreed with our recommendation to update the CVN 78 test plan before delivery and has since updated the test and evaluation master plan (TEMP). However, it did not directly address our recommendation related to ensuring that sufficient time is allotted to complete land-based testing prior to beginning integrated testing. • DOD partially agreed with our recommendation to adjust the CVN 78 planned post-delivery schedule but current test plans still show significant overlap between integrated test events and operational testing. • DOD disagreed with our recommendation to defer the award of the CVN 79's detail design and construction contract. However, shortly after we issued our report, the Navy postponed the contract award citing the need to continue contract negotiations. While DOD did not agree to defer the CVN 79 contract as recommended, it did agree to update the CVN 79 cost estimate on the basis of CVN 78's actual costs and labor hours. DOD has updated CVN 79's budget estimate which we note is based on optimistic assumptions.

Source: GAO | GAO-16-84T

Chairman MCCAIN. Well, thank you, Mr. Francis.

Have you seen some of the changes we've made in acquisition in the defense bill that we passed through the Senate?

Mr. FRANCIS. I have, Mr. Chairman.

Chairman MCCAIN. Is those steps in the right direction?

Mr. FRANCIS. I think they're in the right direction, in many cases, for the Department, but I think, as you said in your opening statement, to the extent the Department comes in with a bad business case, if you still approve it and fund it, you're sanctioning it. So, with all of those improvements in acquisition reform legislation, that has to be coupled with what you do on programs. And I think a couple of good "no's" would be healthy.

Chairman McCAIN. I think Senator Reed and I realize that we're just beginning in acquisition reform. And we will continue to make it our highest priority.

Secretary McFarland or Secretary Stackley, is there anything you disagree with that Mr. Francis said?

Mr. STACKLEY. Mr. Chairman, I was paying close attention and taking notes, and if I were changing places with Paul, looking at this from his perspective, I think I'd write a very similar summary, with some edits that I don't want to quibble over right here. But, I think his summation of some of the systemic issues, I think they are—I think he is correct, on spot. And what I would suggest is that we are making some systemic changes on our side, and you, likewise, with the Congress, to try to address these issues. And I don't give up on them.

Chairman McCAIN. Secretary McFarland?

Ms. MCFARLAND. Chairman, Ranking Member, I agree with much of what Paul said. In fact, I haven't spent 40 years, but I've been spending at least 30-plus years being both a program manager and a tester in most of the functions that are performed inside of acquisition. And the challenge is the culture, and it is the people. It's the workforce, itself. I think the Department is very grateful for other committee and for the Congress for providing defense acquisition workforce development funds to help. But, inside of this culture, there needs to be a constructive change to how we work together as a team to provide these products.

Mr. STACKLEY. Sir, I'm going to buy back one moment on that, too. Paul hit a very—he hit the word "incentives." And the context that he uses that, I would make it much broader. If you look at the complexity of our acquisition system from end to end, starting with Congress, right down to the program manager and industry, the incentives across the board are not all aligned to the same outcomes. And as long as that is true, we've got forces pulling in opposite directions that are impacting program execution.

Chairman McCAIN. But, I would like to direct the witness's attention to probably one of the most egregious aspect of these cost overruns. And, of course, that's the advanced arresting gear, which, from an original estimate of $143 million is now estimate of $1 billion. It grows so much that 2 years ago, this—just this aspect of the carrier had grown so much, it hit the threshold to become a major defense acquisition program. And it continues, as we mentioned, to go up.

I understand the Navy has assessed how their contractor has performed on this program is consistently substandard. It's having significant difficulties meeting cost and schedule targets. Yet, we ask the contractor and the Department's contract management officials, they characterize this type of performance, to my staff, as typical or average.

Secretary Stackley, do you agree with the characteristic that a cost growth of 600 percent is typical or average?

Mr. STACKLEY. Absolutely not, Mr. Chairman.

Chairman McCAIN. Secretary McFarland, on page 3 of your statement, you said—acknowledging that the AAG problems have had the largest effect on construction, you stated, "These engineering design problems are now in the past." Now, that's in your statement. And yet, I have in front of me a Defense Contract Management Agency evaluation of the AAG contract performance from just this past month that directly contradicts your statement, and, in fact, expect additional delays due to issues that have not yet been resolved. Now, I understand you oversee the Defense Contract Management Agency. Tell me that—what's the disconnect here between you and the people that are making this estimate about the AAG? And can you assure this committee that this cost increase has stopped?

Ms. McFarland. Chairman, I do not believe that the cost has stopped. I do believe that the majority of the engineering aspects of this program, in terms of technological risks and development, have been retired. There is still testing to be completed. There are still opportunities for risk to be realized as part of that effort. And I do believe that there will be activities in front of us. It's essentially that we have in front of us a program that has sunk a lot of effort into getting to where it is. And to go backward with the opportunities that this system has, operationally, to provide for the carrier does not make a good business case.

Chairman McCain. Thank you.

Would you—I would just point out that, recently, the manufacturers of the new tanker experienced cost overrun. They absorbed that cost overrun within that corporation. I wonder if maybe we should make that a standard procedure here in defense contracting. I think it should be a subject of a lot of consideration.

Senator Reed.

Senator Reed. Well, thank you very much, Mr. Chairman.

And first, Dr. Gilmore, you urged that shock trials be conducted on the CVN–78. And those are not going to be done on the CVN–78, they're going to be postponed to the next ship in the class, the –79. Senator McCain and I wrote to the Navy, basically accepting your advice and your opinion. Why is it so important that these shock trials begin on CVN–78, not deferred, in your view?

Mr. Francis. Well, first of all, the—as I mentioned in my testimony, the Deputy Secretary decided to direct that the shock trial be done on the –78 before its first deployment last month. He made that decision.

It's important because history has shown clearly—the history of shock trials has shown clearly that they are the only way to discover mission-critical failures. There has been—there has been some claim that component-level shock qualification testing, which, by the way, had not been funded for the *Ford*-class—it had been defunded; now the Navy says it will do it—and modeling and simulation are sufficient. But, if those things were sufficient, we should never see any mission-critical failures when we do shock trials, which are conducted at less-than-design level of shock. But, we always do. And I think it was Captain Hontz who sent the committee a letter—he was the CO [Commanding Officer] of the Princeton when it was hit by a mine in the Persian Gulf—indicating his experience with shock trials and how they provided the key information that enabled his ship to survive and function in the Gulf after being hit.

So, the history is clear that you will not know about mission-critical failures unless you do the shock trial. And I can assume, and

I know, that the history that we presented to the Deputy Secretary and the Secretary figured in that decision.

Senator REED. Very good.

Just for the record, Secretary Stackley, we are—you're on board—no pun intended—with the shock trials for the CVN–78.

Mr. STACKLEY. Sir, we're moving out. Dr. Gilmore made reference to the component testing. The component testing was being lined up with a potential CVN–79 full-ship shock trial. We're moving that back to the left to support CVN–78.

Senator REED. Thank you.

Let me follow up, Secretary Stackley, with the—the issue of off-ramps. Particularly when this was decided, in 2002, that it would be a transformative technology and risks went significantly higher—in other cases, you have used off-ramps. I know, in—with the DDG–1000, you were able to select a different type of motor when the desired, or at least the breakthrough, technology didn't materialize. What's your position with respect to the CVN–78 and –79 EMALS and others? Do you have a backup, or are we just going to follow this down to the point at which it can't work, and then—one of the points I think Senator McCain has made very useful is that if we have a system that cannot accommodate every type of aircraft the Navy flies for all of our carriers, then we are diminishing our force projection.

Mr. STACKLEY. Yes, sir. Let me—your touching on the off-ramps is striking a chord here. The amount of risk that was stacked up on CVN–78 without adequate off-ramps put us in a—just in an untenable position when we ran into issues. I made reference to this Nunn-McCurdy-like review that we did on EMALS and AAG in the 2009 timeframe. That was with concern, cost and technical, regarding the program's performance. And, at that point in time, we had—the ship was off and running, in terms of production. And so, when we look at a potential off-ramp then, it would have caused a significant halt in production, delay, complete redesign of many of the ship's systems to bring steam back up to the flight deck to go to an alternative. So, there was no tenable off-ramp in that regard. And much of our focus then became, Will the system work? Are we confident the system will work? Can we cap the cost? And that ended up leading to a decision—and, frankly, with the CNO chairing that decision board—that we're going to press on, because of the trades in cost, one path or the other, the impact on schedule, the impact on performance if we were to, to that point in time, take an off-ramp that we had not planned.

Going back in time, if—you know, if we had the ability, we could have, in fact, laid in an off-ramp in the early design stages of the CVN–78, in the event that we determined EMALS or AAG was not mature enough.

I think this was a manifestation of what became a highly concurrent, highly compressed timeframe for development, design, production, and also decisionmaking that precluded that. Your example of the DDG–1000 going from what was going to be the permanent magnet motor, which was higher risk, it failed in test, we had a backup ready, in terms of the advanced induction motor to replace the PMM [Permanent Magnet Motor], and that—that has proven very successful, in terms of its completion of development, installation, and test on that program.

Senator REED. Just very quickly, going forward now——

Mr. STACKLEY. Going forward. Yes, sir.

Senator REED.—one of the lessons of this very expensive exercise is that, when you're doing transformative technology, very high-risk technology, will you always make it routine to have an off-ramp?

Mr. STACKLEY. Yes, sir. We—our assessment of technical risk—if we have a high-risk system that we're bringing to a production program, we've got to keep a hand on what are our alternatives, at least to a certain decision point where the confidence is compelling to go forward. You——

Senator REED. Thank you very much.

Mr. STACKLEY. You specifically asked about EMALS and AAG, going forward.

Senator REED. Yeah

Mr. STACKLEY. Sir, we have absolute confidence in EMALS at this point. We have conducted thousands of cycles on that system. We have gone through what we refer to as high-cycle fatigue testing, highly accelerate lifetime testing. We've got a system at Lakehurst that, in fact, is demonstrating the performance that we need.

AAG is behind where it needs to be. All the data that Dr. Gilmore referred to, in terms of reliability, that's not because it's poorly designed, that's because we're behind where we need to be, in terms of time to demonstrate reliability—test, fix, test, fix. So, we have that—a merge between development and production. Going forward, in terms of an off-ramp, first question that—every AAG meeting I have, I start with, "Is the system going to work?"—to make sure there's no doubt, no question, or, if there is, that we're addressing it.

The Chairman described how there was a plan to backfit AAG on all the *Nimitz*-class carriers. And that's proven to be not affordable. That's not affordable as much because of the impact of a carrier than the cost of the AAG system, itself. But, if we had to, we could.

Senator REED. Thank you.

Chairman MCCAIN. How many years have we been seeing that? It's a remarkable record.

Senator Ernst.

Senator ERNST. Thank you, Mr. Chair.

Secretary McFarland, gentlemen, thanks for being with us today.

Secretary Stackley, "test, fix, test, fix." How long are we going to continue to do that?

Mr. STACKLEY. Ma'am, when it comes to—every developmental system—we are still doing test and fix on the DDG–51 Aegis weapon system that's been in the fleet for 30 years. So, there's going to be a continual test-and-fix as you bring in upgrades and added performance improvements. On the specific systems that we're delivering to the CVN–78, we'll be in a test-and-fix mode right through operational testing. We'll identify some further issues in operational testing, just like we do with every major weapon system that we bring to the fleet. And we'll continue to fix those.

Today, test-and-fix primarily—primarily is software- related—software, not hardware.

Senator ERNST. And where is this carrier right now?

Mr. STACKLEY. CVN–78 is about 95 percent complete at the piers at Newport News Shipbuilding in Hampton Roads.

Senator ERNST. It's sitting in a shipyard, correct?

Mr. STACKLEY. Yes. Yes, ma'am.

Senator ERNST. Okay. Well, Iowa, we don't have shipyards. The only time it matters to the folks back home, for me, is when they are actually out there operating. Now, across the military services, I have been told the 90 percent solution on time is better than the 100-percent solution too late. And at some point, this is going to be too late. And we are rapidly approaching that.

Now, you have been the Assistant Secretary of the Navy for Research, Development, and Acquisition since 2008. And that was the same year the CVN–78 procurement was authorized. Have you ever received adverse action by the Navy or DOD due to the delays and the $2.4 billion in program cost growth?

Mr. STACKLEY. No, ma'am.

Senator ERNST. Has anybody within your chain, your structure, have they ever received adverse action for this?

Mr. STACKLEY. In the chain, yes, ma'am.

Senator ERNST. And can you describe those actions to me, please?

Mr. STACKLEY. There was a program manager associated with the aircraft launch and recovery equipment who was relieved of his responsibilities.

Senator ERNST. And at what level was he? Can you give me a rank, please?

Mr. STACKLEY. Program manager, a captain in the United States Navy.

Senator ERNST. Okay.

And, Secretary McFarland also, have you received adverse action?

Ms. MCFARLAND. No, ma'am.

Senator ERNST. Has anybody within your structure been——

Ms. MCFARLAND. Not to my knowledge.

Senator ERNST.—reprimanded? Not to your knowledge.

Folks, this is—I can tell you, a lot of folks have been let go for a lot less. I—and you can tell, I am extremely frustrated with the cost overruns, not being on time. There's no excuse. You can talk about all the gee- whiz gadgets that you want. That's fantastic. But, I will tell you that this is affecting all of the other services, as well.

I still serve in the National Guard. You know, I'm a ground-pounder. Great. Good for me. We are losing in the National Guard, with this new NDAA, 8,200 National Guard soldiers. We're being cut 1100 dual-status technicians. We're losing 800 Active, Guard, and Reserve members. We're being cut forces. And at some point, this is going to hit the Navy, too. If we keep spending money on gee-whiz gadgets that are sitting in a shipyard, someday you may not have the sailors to get that thing out of port. It's affecting everyone. And our taxpayers are going to hold everyone accountable for this. Everyone.

I am really upset, because I have been working very hard—early hours, early months of my work here in the Senate, in this committee and on Homeland Security—trying to restore the program management process. And I had a bill pass unanimously out of HSGAC [the Homeland Security and Government Affairs Committee] on the program management. And I tried to get something into the NDAA, specifically for the Department of Defense. But, unfortunately, it didn't survive the conference. And I'm baffled—I am baffled why we're not focusing on program management and cost overruns. This is an epidemic, and we've got to do something about it.

I'm sorry I'm on a soapbox, but you can tell that I'm upset. The folks back home are upset. And it doesn't do us any good unless it's actually out there, providing protections for the United States. And if we keep sitting on it, not moving forward in a timely manner, it doesn't do us any good.

So, I'd like to hear a response. Just when are we going to get this done?

Anybody. Anybody, please.

Mr. STACKLEY. Let me specifically address CVN–78, in terms of when she will deliver to the Navy. The CVN–78, at one point in time, was going to be a 2006 procurement. It was delayed to 2007, delayed to 2008, for budget purposes. As was described earlier, she was tied to being—to maintaining an 11-carrier Navy. Today, we're at 10 carriers. The requirement is for 11.

Since the ship was put under construction, there was a 4-month delay to launching the ship. And that was associated with getting completion levels to a higher level to ensure that we could control the costs going forward on the program. Since that time, there was a 6- to 8-week delay, that we announced a couple of weeks ago, which is tagged to ensuring that we maintain the discipline and cost in executing the balance of the test program. We have not moved the delivery date. We have changed the trials date. So, today we are still targeting an April, could go into May, delivery date for CVN–78. All of that lines up to get the ship on its scheduled deployment in 2019.

Senator ERNST. I appreciate the response. I hope everybody understands my frustration, as well as the other members on the committee. This has got to be corrected, and somebody needs to be held accountable.

Thank you, Mr. Chairman.

Mr. FRANCIS. Senator Ernst, I—may I make a comment?

Senator ERNST. Absolutely.

Mr. FRANCIS. I think your concerns about, you know, the budget are well founded, and how those bills are going to be paid. I think, if you look at the CBO's [the Congressional Budget Office] analysis of the Navy's shipbuilding plan, if it's executed as it's currently planned, the Navy will need a 30-percent bigger budget than it's historically gotten. So, that's on the Navy side.

On the Air Force side, we have the tanker, we have the JSF, and the Long-Range Strike is coming. And, at the same time, the Army is shrinking.

So, those bills are going to have to be paid somewhere. And then, if they're higher than even we think now, we're going to be in real trouble.

And on the program managers, I remember we were at a hearing a few months ago, and you had asked me a question about that. One thing I wanted to bring up which I didn't then is, we really put program managers in terrible positions. So, when we create business cases where a program's underestimated and there isn't enough schedule to get things done, and technology's immature, we put a program manager in that position. And they have to do two things. They have to manage the program and impart discipline; at the same time, they have to defend the program. So, what we do with our program managers is not what industry does, and we grind really good people up. It's a wonder they take the jobs.

Senator ERNST. Exactly. Thank you so much. I appreciate it.

Admiral MANAZIR. Senator Ernst, may I make an operational comment?

Senator ERNST. Yes, absolutely, Admiral.

Admiral MANAZIR. Captain John Meier and his crew have moved aboard *Ford*. They're in the galley aboard *Ford*. They're operating almost 50 percent of the systems, and the crew is extraordinarily happy with the ship at this point. Secretary Stackley has already outlined the retirement of risk in the timeline, and we'll have to do that, but the warfighter does need this ship. And we're pleased with the fact that the crew likes the capability that we're delivering there, and the statement referred to that capability. Yes, ma'am, absolutely, costs more and is taking longer, but we will have that ship delivered with that higher capability by the time it deploys. And I'd just like to note for the record that the crew is very happy with the technology we're delivering to the warfighter.

Senator ERNST. And thank you, Admiral.

I'll make a closing comment. I have gone way over my time, but I will tell you, $2.4 billion is a lot of up-armor that could help the guys on the ground, as well. We could have saved a lot of arms, a lot of legs, a lot of lives if we had had that money allocated in our budget, as well.

Thank you.

Senator REED [presiding]. Thank you.

On behalf of the Chairman, let me recognize Senator Manchin.

Senator MANCHIN. Thank you, Mr. Chairman.

Let me just say that it's just that it's unbelievable to sit here and listen to this. And I'm reminded—in a 1961 farewell speech of then-President Eisenhower, "In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military industrial complex."

Mr. Francis, I don't know how—I'd like to know how you're able to do this job and be—keep from being so frustrated, seeing the recommendations, seeing the forecast that you've put out in all these years, and knowing that the deficiencies will happen. So, what I would ask—Has anyone followed those people who have left? I think someone mentioned, here, how many of—people that were in charge, whether it be from the Secretary on down—how many have left during the process of some of these acquisitions, and where they had—where they have gone to work afterwards?

Mr. FRANCIS. I don't know if—that there's a comprehensive study. I think——

Senator MANCHIN. Back home, we always say, "Follow the money," and you can usually figure out what the problem is.

Mr. FRANCIS. Yes. I think there's a fair amount of, you know, government personnel retiring and moving to industry.

Senator MANCHIN. Do they move to the same industry that—basically, that they were in charge of overseeing?

Mr. FRANCIS. Well, there are laws about conflict of interest, and they apply to different levels. So, they have to abide by that. But, many of them do eventually do that.

Senator MANCHIN. What I'm understanding, in listening to the testimony, sir, that there's no repercussion whatsoever. I think this—the last statement was made, Mr.—Secretary Stackley—nobody at a higher level has ever been reprimanded, relieved, or whatever, for incompetency, but someone at a lower level has been. One person was mentioned. You know, in the private—back home in West Virginia, if we build a home and it goes over budget, and then let's say later on they build another home, you would learn from the first one. You know. And the definition of "insanity" is continue to do the same thing and think you'll get a different result. You would think that sooner or later we would learn.

Mr. FRANCIS. Well, I think Sean made a very good point when he went through why these programs take so long. The leadership changes, at every level, so many times that, you know, we're starting over again. And the people who are in the position now don't remember what happened then.

I'll also say, I don't think this is a case of bad actors. I think these are people trying to act rationally in the environment——

Senator MANCHIN. I'm not accusing anybody——

Mr. FRANCIS. Yeah.

Senator MANCHIN.—of being——

Mr. FRANCIS. Yeah

Senator MANCHIN.—intentionally a bad actor. I'm accusing probably the system, the way it's evolved over the years.

President Eisenhower saw something coming. There is something that got his attention for him to make this statement in his farewell speech. And, being a military person, if we had operated in World War II, probably, he was thinking, the way he saw the evolution of the industrial complex, military, God help us in World War II, probably what—I'm saying something stoked his interest to say, "We've got a problem. Be careful." And you're telling me this has evolved for 50 years.

Mr. FRANCIS. Yes.

Senator MANCHIN. So, he had tremendous vision back then, knowing that we were going down a slippery path.

I'm just saying—I was looking at what Russia—I mean, what China's able to do. And if you look at how they're able to advance and jump in very quickly. I'm sure there's other—they've had other ways of acquiring the information they're getting, and we have suspicion about that. But, still yet, there is a process, a move that they're able to do things in a much quicker timeframe.

What would—what recommendation would you make to us as—of all of us here, and people that make decisions, and people that maybe can change the law or create laws that would help us or prevent this from continuing? GAO, we pay no attention to you all. It's a shame. There should be a law that, when GAO basically makes a recommendation, we should at least owe it to the American people to give you an answer back why we accepted your recommendation or why we don't accept your recommendation. It's very simple. And myself and a—former Senator Coburn tried to get that done. Someone has to answer to what you're seeing and we're not doing. What's your recommendation for us to fix this system?

Mr. FRANCIS. I actually don't think it's a matter of law or regulation or telling the Department to do anything. I think it's—when you're making—your biggest opportunity is when you're approving a new program and you really have to scrutinize that program for what principles it embodies. So, if you really believe in "mature technologies before you put them in a program," if you really believe in "fly before buy," if you really believe in "realistic estimating and scheduling," and a program comes up that doesn't measure up, you've got to say no.

Senator MANCHIN. Mr. Francis, if I may—and I'm reading—"The GAO found"—this is in 2007; you mentioned this—"the *Ford*-class aircraft carrier's lead ship began construction with an unrealistic business case."

Mr. FRANCIS. Yes.

Senator MANCHIN. You identified that. Didn't anybody here, or whoever was there at the time, did they talk to you? Did you give them that information, what you saw in evaluation?

Mr. FRANCIS. Wow. I'll tell—yes, in terms of the report. But, I believe this is the first hearing on the carrier where outside witnesses have been invited. I think that's right.

Senator MANCHIN. Well, I thank the Chairman for that, because he's had some great hearings for us learn a little bit more about. I just—sir, I—I mean, I appreciate all your services.

Ladies and gentlemen, we've got to change. $18 trillion of debt and the way we're climbing, and our military is under-funded from the standpoint—or less—or lack of direction.

But, Mr. Francis, thank you. And I'd love to meet with you later on, sir.

Mr. FRANCIS. I'd like that.

Senator MANCHIN. Thank you.

Chairman MCCAIN [presiding]. I thank the Senator from West Virginia for his involvement and his commitment on this issue.

Senator Tillis.

Senator TILLIS. Thank you, Mr. Chair.

Mr. Francis, I think you opened up your statement by saying "the same story, different program." And you also commented, in your opening statement, about the—this committee and the Senate—or Congress as a whole, playing a more aggressive oversight role than we have over recent years. So, can you give me some sense of how much of that is going forward with new programs, how much of that should be applied retroactively to this subject or any of the other major projects that we have. What are your recommendations to this committee for what, specifically, we should do, say, in the next committee meeting or over the course of the year?

Mr. FRANCIS. I would say, right now we're kind of in a period where there aren't as many big, new programs coming down the pike. And that's really your opportunity. I don't know how much you can do on a program that's already through the milestone and under contract without making more of a mess of it.

Senator TILLIS. Well, what—maybe just going back, I think you used the analogy of seven home runs in the bottom of the ninth with respect to this graphic, here. To what extent do we need to go back and say, "We know"—I think maybe the Twins did it to the Tigers this season, but it's very uncommon. It was widely reported, as a result. So, what do we need to do, with respect to this timeline, about being realistic that we're going to have a timeline that we're going to achieve? What do we need to do here to at least just not come back and have the same frustrations that Senator Ernst has about—we see it, we know it's not likely to happen; therefore, what should we be doing to set realistic expectations about what's already in the pipeline?

Mr. FRANCIS. So, for something like this, I would say—and I think the Navy has moved the schedule out a little bit so far on integration testing—I think you have to make it okay for the Navy to come up and say, "We need to move this schedule, and it's going to cost more." That has to be okay. And right now we sort of play this—we're on eggshells, because, you know, the Navy might not want to come in and say that, because they're going to take a beating over increased cost. So, we kind of play——

Senator TILLIS. Not wait until it happens.

Mr. FRANCIS. Wait until it happens.

Senator TILLIS. Yeah. And I will tell you, as somebody who's been in long—you know, has been responsible for long-term, complex projects, that's when people lose their jobs. I think that the thing that we ought to put on the table now is, if you come back and you explain to us why you're going to miss your dates, that becomes our problem, it becomes senior leadership's problem in the Department. If you wait, and ultimately realize or come to us and actually say, "Well, you know, we were wrong," then somebody else needs to lose their job. It's a matter of whose problem it is. I can—and I'm not citing any one person, but it seems like it's obvious that we're going to have to pull a rabbit out of the hat to achieve these dates. Somebody owns the responsibility to speak honestly about that and set the right expectations. And if they don't, then they need to own it. And I think—I don't think you disagree with me.

Mr. FRANCIS. No.

Senator TILLIS. I think, going forward, because you said it's the same story, different program, we do need to come up with some sort of findings of fact before we approve future programs so that we can really have people own this, going forward, instead of having it, as Senator Manchin said, be the insanity that seems to be driving a lot of these large, complex programs.

For the admirals, I'm going to ask you just a general question. First off, with respect to China, I know we spend a lot of time trying to take the edge off of our quantitative disadvantage with, say, a country like China that's churning out a lot of ships by the qualitative advantage. But, as Admiral Harris said, quantity has a quality of its own. At some point, we just—our capabilities may end up being matched by the sheer quantity that some of our potential adversaries are building up.

What was so important, in terms of some of the unproven capabilities that are going onto these ships—what sort of leap in capabilities justified the cost overruns and the—and the basis of the discussion we're having today? And I'll open it up to any of the admirals. And, in advance, thank you for your service.

Admiral MANAZIR. Senator, as the Director of Air Warfare, I'm responsible for stability of requirements that go into our acquisition programs. When you have stable requirements, you control cost, or at least that's one aspect of controlling costs. When we developed the *Ford*-class carrier, starting in the mid-'90s, with a—actually before that—a look at the future of aircraft carriers, we don't look at only one country, sir, we look around the world at potential conflicts. And we take the conflicts from relatively low-end conflict, like you're seeing in the north Arabian Gulf, with the carriers that are operating over the top of northern Iraq and Syria, and we look at higher-end conflicts against countries who can, through technology, attempt to match our capabilities. We do campaign modeling. We actually have names for them, like Thunder and Storm, and they are joint campaign models using U.S. Air Force, U.S. Navy, U.S. Army, and other military assets to effect that campaign.

As has already been stated by Secretary Stackley, the United States Navy nuclear-powered, the largest place of an aircraft carrier is a chess piece in our Navy. Those chess pieces are a critical factor on the campaign plans that we bring forward. When we looked at the future and the way that the threats around the world were going, we devised the *Ford*-class, with 33-percent greater sortie generation capability, with enhanced technology and an electric capacity, and, with the EMALS and AAG, an ability to increase getting airplanes on and off the ship, and other technologies around the ship. That campaign model, sir, looking at threats around the world, is what delivered the requirements base that resulted in the *Ford* design you see today. When we stabilize those requirements, sir, that is one aspect of stabilizing the cost and schedule.

Admiral MOORE. Sir, if I may, from a pure acquisition standpoint, the other reason from—that we built the *Ford*-class is, the *Nimitz*-class was starting to reach the end of its useful service life. Technology does change. We have to keep up with that technology. But, the other thing is that the *Nimitz*-class was built in an era where people were relatively inexpensive. And so, from a total lifecycle cost perspective, the *Nimitz*-class is very expensive. People make up 40 percent of the cost of that ship over its 50-year service life. So, it was pretty clear, as we went forward, not only did we need the warfighting capability, but we had to drive long-term affordability into the ship over the 50 years, and the most important thing we could do in that respect was to get people off the ship. That required a complete redesign of the ship. Some of the things you're seeing with the new technology—EMALS and AAG, for instance—not only do they provide operational capability, but they also provide a significant reduction in the people on the ship.

So, we're going to take 663 sailors off of *Ford,* compared to *Nimitz*, about 1,200, when you compare the air wing. The net result is, over 50 years, the cost to buy that ship, own it, operate it, and maintain it would be about $4 billion less than a *Nimitz*-class carrier today.

Chairman MCCAIN. Well, I must say, all those things that both admirals pointed out are undeniably accurate, but those numbers there are totally unacceptable. And I hope you realize that.

I'd like to point out that Senator Kaine has been more involved in this situation in regard to this carrier than any member of this committee. He has been very constructive. He's been incredibly helpful in informing this committee. And he is a strong advocate for the men and women who are doing great work in the construction of this—of these aircraft carriers in arguably one of the finest shipyards in the world.

Senator Kaine.

Senator KAINE. Thank you, Mr. Chair. And thanks for your comments about the shipyard. I'm proud to represent the thousands of shipbuilders who manufacture the largest and most complicated items on the Planet Earth, nuclear aircraft carriers and subs, many from North Carolina and Virginia, who work at the shipyard. And they didn't make the decision about putting all the new technologies on the first in class of the *Ford*-class. They also didn't develop the weapon systems that have—and the AAG and EMALS systems that have been complicated. Those were developed elsewhere, and they're working to install them. But, I've been on the ship many times, and seen the work that's underway. I saw the core inserted into the ship one day. I've seen the Navy take control of the ship in recent months, and they are very excited about it. But, a couple of items:

Cost overruns. And I agree that there's very systemic issues that are demonstrated that we need to tackle them. Cost overruns, I would say that a lot of this is less an overrun than poor cost estimation. And I think you unpack what cost overruns are: poor cost estimation.

Before 2010, when the Navy was talking about their cost estimate on this project, to this committee and others, repeatedly the Navy said that their confidence level in the cost estimate was less than 50 percent, or even, in some cases, less than 40 percent. Isn't that correct?

Mr. STACKLEY. Yes, sir.

Senator KAINE. And I gather that that was because first in class and the addition of all these untried technological systems, as mandated by a previous SECDEF [Secretary of Defense], that was one of the reasons that the confidence level was low. Is that right?

Mr. STACKLEY. Yes, sir.

Senator KAINE. Now, let me talk about first-in-class history, because, Mr. Francis, you talked about, you know, this is a similar problem, but just a new example. I think it was Eric Labs who did the CBO study this summer, where he basically looked at Navy acquisition programs. And he looked at first in class over a variety of programs. And he basically concluded, I think, that, as a general matter, first-in-class acquisitions in shipbuilding tend to be 30 or

40 percent higher than the estimate that the Navy has begun with. Isn't that essentially true?

Mr. FRANCIS. Yes, Senator. I think in my statement we have listed the most recent, the first in class, and the average cost increase is 28 percent. So——

Senator KAINE. So, I'm not going to defend 23 percent as a—as better than an average, but, to put it in context, this isn't that unusual. But, maybe the thing that is more important is what happens after first in class. So, first in class on the *Ticonderoga*-class cruiser, there was a lot of problems, "An obese $1 billion walrus of the high seas with potentially dangerous stability problems." That was the assessment of the first-in-class by Defense Week in 1982. That program ended up being significantly improved as it moved along. The Arleigh Burke destroyer, it was called "the Navy's billion-dollar hole in the water, another example of the Navy driving itself to the poorhouse in a Cadillac." That was the Washington Post in 1986. But, generally, that acquisition program significantly improved after the first in class.

One that I really love from our shipyard is the *Virginia*-class submarine that's done in tandem between the shipyard in Newport News and Electric Boat. That's turned into a very successful acquisition program. But, wouldn't you agree the first-in-class of that had some significant challenge and cost overruns or cost estimation problems? Have I basically given the history correct on these three, the Ticonderoga, the Arleigh Burke, and the *Virginia*-class?

Mr. STACKLEY. Sir, you're absolutely correct.

One important thing to keep sight of is, in each case, unlike other major weapon systems programs, there is not a prototype——

Senator KAINE. Right.

Mr. STACKLEY.—ship.

Senator KAINE. Right.

Mr. STACKLEY. The lead ship is the prototype. It is the first opportunity you get to bring these complex systems together, integrate, test. And there are uncertainties, unknowables, and risks that get brought to that ship, in production, when it is most costly to find and fix those issues.

Senator KAINE. I love the "try it and buy it." For some weapon systems, that's really what you do. You prototype it and try it and then you buy it. But, for a ship of this size, the prototype is the actual. And that's why you often see difference between first-in-class and the subsequent history.

You talked, Secretary Stackley, about the changing in the contracting mechanism between –78 as a cost-plus to –79 as a fixed cost. And I'm assuming –80 will be fixed-cost, as well.

Mr. STACKLEY. Yes, sir. Both –79 and –80 will be fixed-price contracts.

Senator KAINE. And then, finally, on just the—Senator Tillis asked the question about the O&S savings. Actually, for as much we talk about the cost of constructing, actually the cost of operating is even larger on platforms such as this, because they have such a long life. And I gather that one of the main design features of this is to put in physical design to dramatically reduce the number of sailors and then drop the personnel cost by about $4 billion. Now, I credit—it was either Dr. Gilmore or Mr. Francis who said yes, there's a projected savings in personnel cost, but we haven't achieved it yet. We—you know, we have to see whether that's accurate. There may be some challenges that would reduce that. But, I do know that those—bringing down the number of personnel is one of the main advances over the *Nimitz* design that's part of this *Ford*-class. And obviously, I think the committee should stay very much on y'all. We should all stay on it to make sure that that's actually achieved.

I strongly support the Chair's acquisition reform strategy. What we did in this year's NDAA was important. But, I think, Mr. Chair, I certainly see that as just a downpayment on what we will be doing, going forward. And I think it's important that we do it.

Mr. FRANCIS. Senator Kaine, can I make a——

Senator KAINE. Please.

Mr. FRANCIS.—a couple of comments?

Senator KAINE. Please.

Mr. FRANCIS. First, on the contract for the CVN–79. The current contract is fixed price. That covers about 45 percent of the construction cost. Fifty-five percent has already been paid for under a cost-plus contract. So, just keep that in mind.

And then, I think you're exactly right on—the first- of-class of any weapon system, we seem to have a lot of trouble with. And then, later on, we kind of get comfortable with the fact that we've worked out the problems and everything looks good. And it creates a little complacency. So, I think a challenge for us, if we're repeatedly having trouble with first article—and it's not just Navy—what is it we can do, in terms of estimating and risk analysis, so we're not making those same estimating errors every time?

Senator KAINE. Good point.

Ms. MCFARLAND. Could I add to that, Senator? I think it's important this committee has actually received from the Director of CAPE a information package that showed that, since the implementation of WSARA [Weapon System Acquisition Reform Act of 2008], that the cost estimating techniques were improved because we were given access to information and data right directly from contractors. And it shows that the disparate distance between the service cost positions and the independent cost positions has gone at a median from over 6 percent to less than 2 percent and 3 percent, which is in the margin of error.

So, over the last period of time, what the Senate points out is exactly what needs to be done to improve our future understanding of how costs are gone.

Chairman MCCAIN. But, isn't it also true that the delays in CVN–78 have had a significant effect on the cost of CVN–79?

Ms. MCFARLAND. Go ahead.

Mr. STACKLEY. Yes, sir, there's—the program plan for the carrier, CVN–78, –79, and –80 has been stretched out, programatically and budgetarily. So, as I described earlier, 78 was originally going to be an '06 carrier that became '07, then'08. In the 2008 NDAA, the Navy was authorized to procure the –78, –79, and –80 on 4-year centers, which was consistent with 12-carrier Navy. The decision was subsequently made by the Department of Defense that we're going to stretch that out to 5-year centers, so now the CVN–79, which was going to be an earlier carrier, is not put under contract until 2013 budget, and then the –80 was bumped further. So, the program has been stretched out, and that's brought, frankly, more cost to the program just associated with costs that run with time.

Chairman MCCAIN. Senator Ayotte.

Senator AYOTTE. Thank you, Chairman.

I want to thank all of you.

I just wanted to say that I think one of the challenges—Mr. Francis, you referenced this in your testimony—is, here we sit here today, billions of dollars of overrun, and people are very frustrated by it. And you cited also that the JSF program, the F–22, the Littoral Combat Ship, they were actually worse, and that this is a typical acquisition outcome.

So, here's the challenge. We've got to change this dynamic, because we've had the leaders of all of our military rightly come in here and testify about the impact of sequestration and the fact that we're going to diminish the size of our fleet, that we need more ships, more attack submarines, more ground troops, obviously more fighters and making sure that we also have the training, of course, for our men and women in uniform. And then my constituents look at these billions of dollars of overruns that have been multiple examples of it, and look at us and say, "Why aren't you dealing with that? If we're going to give you more money, then we need you to deal with that." So, all of us who care very deeply about making sure that we do what needs to be done to defend this great Nation, this is an issue that we've—it's got to go from being the bottom priority to a top priority.

So, one question I'd ask all of you, whoever is the best—Secretary Stackley, Secretary McFarland, if you're—Mr. Francis—who is best to answer this—you mentioned aligning responsibility, accountability, and decisionmaking. How are we rewarding good acquisition behavior within the Pentagon? In other words, if you are doing a good job, how are you rewarded? And, in turn, I think one of the questions you're hearing from all of us is, How are those being held accountable, not just at the captain level that we've heard about today, but at the highest levels that this has to be a priority for all of us if we want to make sure that our men and women in uniform have what they need and that we can make this case to the American people about how important this is?

So, whoever is best to field that. But, I think that's the big question here. We're clearly not aligned in accountability priority and how we're rewarding the people who are doing a good job and also holding accountable the people who aren't doing a good job. And I'm sure that's demoralizing to the people who are doing a good job.

Ms. MCFARLAND. Senator, I think your points are very well made. I'm not sure we reward our program managers very well. I think the only thing that I could see from my experience is, you promote them.

In terms of holding folks accountable, when we see a clear connection between what they did and their outcome, we do retire them or move them, both civilian and military. Beyond that, the incentive structure that you're referring to is not clear, and it's not adequate, and it ties to what the earlier—Chairman and the Ranking Member talked about is, where those decisions are made. And what Paul talked about, in terms of, How is it that the culture and how the decisions are directed into a program manager relates to their ability to perform.

Senator AYOTTE. Well, one thing I would say is that also, as leaders, if you've got someone you've got to let go at the captain level, the leader needs to be held accountable also, because any one of us, if our team does something, we're ultimately responsible, right, as the leaders? And I think that coming from the top is so critical of making this a priority.

I had a specific question also about what Senator McCain referenced, Mr. Francis mentioning the KC–46 program and how the contractors absorb the cost overruns. Wouldn't it make sense for all major defense acquisition production programs to be designed so that the contractor absorbs the cost overruns for production?

Ms. MCFARLAND. If I could, Senator.

Senator AYOTTE. Yes.

Ms. MCFARLAND. I think it's important to understand the risks. Sometimes the threat drives us to take risks because we need to. And when the risks aren't clear, that cost-sharing between us and the contractor has to be considered. When we ask for a fixed-price contract when the risks are high, the contractor, in order to get their corporate headquarters to agree upon working in that contract, they add that risk related to costs.

Senator AYOTTE. So, I understand that issue with regard to R&D [research and development], but what I'm talking about is production costs.

Ms. MCFARLAND. I agree with you in production.

Senator AYOTTE. So, are we doing that consistently across the board on production?

Ms. MCFARLAND. We took a look at our contracts across all the enterprise, across the services, and, indeed, yes.

Mr. STACKLEY. Let me make one point regarding that. And we talk about shipbuilding, the lead shipping of prototype. Historically, the lead ship of a new class has been a cost-plus ship, with the follow ships being production. Over the last—frankly, since I've been in this office, we've been trying to drive down the number of cost-plus ships in our program. And today, across the Department of the Navy, we have two cost-plus ships in production, one of those is the CVN–78.

Senator AYOTTE. My time is up, but I also will submit a question for the record that concerns me. As we looked at the CVN–78 cost growth, I'd like to understand, as we look at the *Ohio*-class submarine replacement program, what lessons we've learned from this so that we don't go down the same road with the *Ohio*-class, which is obviously very important to our Nation. So, I'll submit that for the record.

[The information referred to follows:]

The Navy recognizes the critical national importance of the *Ohio* Replacement (OR) program and is taking proactive steps to ensure that the program is successfully executed. Program measures include tight control over requirements, high degree of design completion prior to construction, maximum practical critical technology reuse, aggressive design for affordability program, detailed risk management program, extensive employment of engineering development models to retire risk, and continuous active review of program cost to enable timely course correction, if required. This will provide the Navy, the Department of Defense and the Nation confidence in long-term successful program execution.

The OR program commenced with significant effort to establish the right warfighting requirements for the program. In June 2015 the Chief of Naval Operations approved OR's Capabilities Development Document (CDD) defining the authoritative, measurable, and testable capabilities needed to perform the mission and in August 2015 the Joint Requirements Oversight Council validated OR's CDD. The program completed the Navy's Gate 4 in November 2015 to confirm that the proper requirements have been established for the technical baseline for steady design maturity. The OR program has instituted formal and rigorous change control to manage the program's technical baseline and ensure the requirements are maintained and controlled at the appropriate level.

Maximizing design maturity at the start of platform construction is a critical lesson learned from other shipbuilding programs. Increased design maturity will limit many of the complications that negatively impact both cost and schedule resulting from simultaneous design and production. To illustrate the effect of design maturity (i.e., drawings released to the shipbuilder) on various programs, the lead *Seawolf*-class submarine achieved design maturity of 6 percent, and the lead *Virginia*-class submarine reached approximately 43 percent at construction start. The target design maturity for OR is 83 percent at start of construction.

Technical maturity is another major focus area for the OR program and will reuse many of the proven technologies from both the *Virginia* and *Ohio*-class programs. It will also re-host the Trident D5 Strategic Weapon System, limiting the potential impact that immature transformational technologies could have on the program. The reuse of proven technologies mitigates technical risk and ensures a credible and survivable sea-based strategic deterrent.

To ensure maximum cost and schedule savings, the OR program has initiated prototyping and pre-construction testing of key systems. These efforts are critical to address potential technical risks and include the Strategic Weapons System Ashore in Cape Canaveral, Launcher Test Facility at China Lake, and the Compatibility Test Facility in Philadelphia for propulsion system testing. Manufacturing risk reduction prototyping, including the Missile Tube and its outfitting, Quad Pack of Missile Tubes and Missile Tube Module (MTM), is also in process.

The OR program will also leverage *Virginia's* extensive experience with modular construction. The *Virginia* program successfully improved schedule through modifying construction plans by using super-lifts, reducing 10 modules into 4. OR will implement a six super-module build plan based off the *Virginia* program to significantly reduce construction schedule and costs. The government, design yard, and shipbuilder are working together conducting detailed construction planning efforts to determine the optimal build sequence. The program is also continuing to identify opportunities to further acquisition efficiency, reduce schedule risk, and improve program affordability.

Credible detailed cost estimates are critical to the OR program's success to achieve the appropriate cost targets. The program established an initial lead ship cost estimate and affordability targets for follow-on ships in December 2010 in support of the Milestone A. An updated cost estimate, largely based on actual data from the *Ohio* and *Virginia*-class programs, will be done to support the program's Milestone B decision in August 2016. The updated cost estimate will incorporate all cost reduction initiatives to date and adjust affordability targets if necessary.

The Navy is committed to recapitalize the nation's sea-based strategic deterrent by ensuring the right requirements are established and implemented, design maturity is maximized and the technical baseline is strictly managed. The program's incorporation of mature and proven technologies, prototyping initiatives, and focus on affordability, are integral to successful execution. These efforts will ensure the OR program is successful, assure our Nation's strategic deterrence and ensure best value for the American taxpayers.

Senator AYOTTE. Thank you all.

Mr. FRANCIS. Senator, can I jump in on the time you don't have left?

[Laughter.]

Senator AYOTTE. Of course. With the Chairman's latitude. How's that?

Mr. FRANCIS. Thank you.

I—on—you're right, on production contracts. They should be fixed price. But, there are still times—ships aside, there are still some contracts that are cost-plus going into low-rate production. And you do have to match the risks you're taking with the contract.

So, a good contract can't save a bad program. So, if the risks are high, I don't necessarily fault the contract type. I raise the question, Why are we going into production if we're not done with development yet?

Senator AYOTTE. Well, if it's a bad program, we shouldn't be investing in it in the first place. Isn't that the fundamental question?

Mr. FRANCIS. Yes. Or if it's just not ready to take the next step.

And then, on your first point, on program managers and people held accountable, I think it's a really good philosophical question about: Accountable for what? What constitutes success? So, if I'm a program manager and I'm trying to get my program through the next milestone, and I do that, and then there's a cost increase, what am I going to be rated on? Getting it through the next milestone or the cost increase? And it's going to be the former. If you can support the program and get it moving, that's your—that's what you're mainly accountable for.

Senator AYOTTE. Well, that's a problem——

Mr. FRANCIS. Yes.

Senator AYOTTE.—because if it costs you a lot more and you're putting it through, but you get it on time, that's not meeting your target. And so, people need to be held accountable for both. Otherwise, this is where we end up, with the billions of dollars in overruns.

Thank you.

Chairman MCCAIN. Senator Hirono.

Senator HIRONO. Thank you, Mr. Chairman.

I know that the Department has—undertaking headquarters reductions, and Congress has reiterated the need to look at reducing headquarters positions for efficiencies and other savings. And, while we all want to reduce waste and inefficiency, I would urge the Department to look at possible headquarters reduction targets on a case-by-case basis and to make informed decisions, keeping in mind that cuts today can come back to cost much more in the long term than we get in the short-term savings.

The acquisition workforce is vital to ensuring that our acquisition programs, such as the *Ford*-class carrier, are managed and lead to successful outcomes so that our men and women in uniform are given the tools that they need to effectively carry out their missions. We have to ensure that we are able to recruit and retain a quality acquisition workforce if we are to be successful in defense acquisitions. And if we have acquisition teams that are understaffed, undertrained, or too inexperienced, we cannot expect to have good results in our acquisition programs.

As described in Secretary McFarland's testimony today, we cut the DOD acquisition workforce by roughly 57 percent during economy drives of the late 1990s and early 2000s. I believe that these deep reductions contributed directly to a large number of the problems that DOD has had in major acquisition programs over other last two decades. And I agree that Congress has an important oversight role to play on acquisitions. However, at the start, I want to know that our acquisition workforce can perform and that we can rely on the analyses and processes of our acquisition team before a program is recommended.

Therefore, when we look to implement mandatory cuts to headquarters, we should be—we should consider the potential long-term effects on our acquisition programs among, of course, other programs.

So, for Secretary McFarland, what is your assessment of the health of the acquisition workforce——

Ms. MCFARLAND. Senator——

Senator HIRONO.—especially as we deal with these very complicated acquisitions that we are—such as the *Ford*-class?

Ms. MCFARLAND. Senator, first, thank you. This is such a human endeavor. That is the principal understanding of the underlying problems that we have inside of acquisition, is to ensure that our workforce is appropriately trained and experienced to do these jobs.

In 1986, we had 622,000 core acquisition people. By the timeframe of this program, in -78 was conceived, in '96 through 2002, we had reduced that workforce to less than 300,000 people.

This committee and Congress in general has provided us the Defense Acquisition Workforce Development Fund that has allowed us to regrow, retrain, and reeducate about 8- to 10,000 people to bring abroad since then. That has been a critical improvement to where we are. The majority of our workforce is imminent to retirement. The workforce that we do have is predominantly younger and not necessarily in age, but rather in experience. And this program and these capabilities that we're discussing were inherently bred by people that may not have the adequate acquisition experience or understanding of the business case that needed to be executed here.

So, I would say that we're very fragile right now, is the best way I could say it. These people are working very hard, they're very loyal, they're patriotic people, they don't get very well paid, they get a lot of abuse in the press. There is also an opportunity to forget what they have done that is done well, like the JLTV [Joint Light Tactical Vehicle] program that's actually been put together under the principles of WSARA and the better buying-power initiatives. And I can really commend the services—the Navy, the Marine Corps, and the Army—for that program and others that are doing much better by having that disciplined approach.

The only way we're going to protect our future is to invest and protect that core capability.

Senator HIRONO. Secretary Stackley, would you like to comment also?

Mr. STACKLEY. Ma'am, I think I'll add just one comment.

Back in May of 2014, Chairman McCain and Senator Levin signed out a letter soliciting inputs from a number of individuals and organizations regarding, What do we need to do to improve this acquisition system? And I was fortunate enough to have the opportunity to respond. After giving it much thought, first and foremost my concern and conclusion was: programs that succeed succeed because you've got a highly talented, experienced team in place, that is able to overcome work through, in, and around this very dense, difficult system that we've got and, at the same time, master the technical details and programmatic oversight to deliver complex weapon systems; programs that fail quite often fail because of not having the same attributes, in terms of the acquisition workforce team. And so, first and foremost, we've got to give us the tools to attract, train, and retain those professionals to get the job done.

Senator HIRONO. I emphasize how important it is to have an acquisition team that we can rely upon, because these are very complicated systems and programs, and it would be very difficult for Congress to be the first line, in terms of analyzing the efficacies and the reliability, et cetera, of these programs, so I expect our acquisition people to do that. And therefore, you know, thank you very much.

Mr. Chairman.

Chairman MCCAIN. At Secretary Carter's hearing for confirmation, I showed a chart, $40 billion that was spent on programs that never became reality. That is not an acceptable system or situation. We value the men and women who work in this business, but these problems are of such magnitude, in the view of most members of this committee, that we can't lose sight of the fact that the system is badly broken.

Senator Sullivan.

Senator SULLIVAN. Thank you, Mr. Chair. And thank you for your leadership on this issue, in terms of oversight. Critically important function of this committee.

You know, I'm not sure the question has been asked, but maybe I'll just ask it. Pretty simple. Secretary Stackley, Secretary McFarland, who is responsible? Who's responsible? Who's kind of raised their hand and said, "This cost overrun is my responsibility. I accept it"?

Mr. STACKLEY. Sir, I will tell you that, today, I'm responsible. You see the gentlemen here at the table that are responsible for elements of the program that all come together to the—for the carrier. But, as the service acquisition executive, as I stated in my opening remarks, I assume responsibility for this program and the decisions that I have the opportunity to make as we execute.

Senator SULLIVAN. Secretary McFarland?

Ms. MCFARLAND. Sir, the Navy is responsible——

Senator SULLIVAN. No, no, I'm not talking about an organization. That's very amorphous. I'm talking about people, individuals.

Ms. MCFARLAND. Sir, I believe we could have done much better in preparing and advocating for the right aspects of this program to be conducted at the beginning and throughout its execution.

Senator SULLIVAN. So, who's responsible, in your view?

Ms. MCFARLAND. The Department. Not a good answer, not something that——

Senator SULLIVAN. No, it's a ridiculous answer. Okay?

Ms. MCFARLAND. Yes, sir.

Senator SULLIVAN. So, who—in your view, who is responsible? Part of the issue here is that the responsibility seems to be placed in a——

I mean, Secretary Stackley, I appreciate your statement. Right? That's up front.

Secretary McFarland, I'm just asking the same question to you. Who is responsible? I'm talking about individuals. That's how we fix it. We can't blame it on "the Navy."

Ms. MCFARLAND. Sir, I will take absolute responsibility for not having done the correct things, in terms of helping this program along.

Senator SULLIVAN. So, who's responsible?

Ms. MCFARLAND. Then I would say myself, sir.

Senator SULLIVAN. Okay.

Admiral Moore, Admiral Gaddis, I—you know, looking at your bios, very impressive, in terms of your military careers. When you get assigned to be the billet of a program manager, as a senior flag officer in the United States Navy, is that something that, when that happened, you celebrated? Is that something you were, like, "Oh, geez"? I mean, how is your job, as uniformed military officers, viewed in the Navy? And is that part of the issue, here?

Admiral MOORE. Well, other than I got to spend my 16th consecutive year in Washington, D.C., if I had taken a job, yeah—no, it's——

Senator SULLIVAN. I feel for you.

Admiral MOORE.—it's an honor. I—you know, when——

Senator SULLIVAN. But, I mean, is that a career enhancer, to successfully complete a tour that's obviously filled with landmines, or is that something you try to avoid? What I'm getting at is, Do we have our most ambitious, top-rated officers trying to get these jobs, or are they trying to avoid them? And is that part of a problem?

Admiral MOORE. Sir, I believe, you know, this is the best job in the Navy. I was honored to be asked by Secretary Stackley to take the job. I think most of us sitting at—or anybody sitting at this table at our level will tell you that we want the challenges and we're not going to shy away from the responsibilities that go with the job. I'm ultimately accountable for this program with Secretary Stackley. I accept that responsibility. I want the tough jobs. I was glad to take it. I think we've made strides on -78. We're—nobody is happy with the cost overruns we've had on -78. I think we've done significantly better on -79, and I think we're on a good path, going forward.

But, to the—to your basic question, good people want these jobs. They're tough jobs, and I think you're going to continue to get the right people in these jobs, going forward.

Senator SULLIVAN. So, I—and I know you see the frustration from the committee. I think Senator Ernst did a very good job of articulating that, in terms of—you know, we talk about dollar costs, but what we're really talking about is opportunity costs with regard to the defense of our Nation. So, just one of these cost overruns on one of these carriers could fund a brigade combat team in the Army for 10 years. That's a really important issue. And the Army wants to cut 40,000 troops right now. And so, strategically, it just doesn't seem to make sense.

Let me ask a quick question, following up on Senator Ayotte's comments. Do we need—do you need statutory authority to have the responsibility of cost overruns be borne by the contractor and not the American taxpayer, or can you do that now, presently?

Admiral MOORE. Sir, we have the authority, when we contract with the contractors, to put contracts in place that hold them accountable.

Senator SULLIVAN. And so, you—we're making that, from a production standpoint, regular part of our contracting work right now?

Admiral MOORE. Yes, sir, absolutely.

Senator SULLIVAN. Thank you, Mr. Chairman.

Chairman MCCAIN. Senator King.

Senator KING. Mr. Chairman, first I want to thank you for your interest in this topic. I think it's one of the most important responsibilities that we have. And—but, I do think, in terms of the—today's discussion, that there needs to be some context.

I suspect the first Macintosh computer cost a million dollars, in terms of the work. I've read about the work that they went through to develop that computer. But, then they made them by the thousands or millions, and they went down to—the price went down to $1,000. I think one of the problems here—Mr. Francis, you identified it, and I think this is where we really need to focus our attention—is that we're dealing with first-in-class products. We're dealing with new products. And you mentioned two terms, "fly before you buy" and "mature technologies." And I understand that. But, the problem is, we're building a product, here, that's supposed to have a 50-year life. And if we build it with "fully mature" and "fly before you buy" technologies, it's going to be obsolete the day it enters the water. And we're talking about a qualitative technological edge.

So, I really think we—and as Senator Kaine pointed out, we're essentially building prototypes. There's no way to do a prototype—that first Macintosh, you know, was a prototype that we could sit on this desk, but a build—you can't build a prototype of a—of an aircraft carrier.

So, I think the problem—and you identified it, Mr. Francis—how do we deal with the first-in-class issue? And maybe it's more realistic estimates at the beginning. Maybe it's more realistic estimates of the time. But, it—to simply say there's an overrun here, as Senator Kaine pointed out, if the estimates in the beginning had been more realistic, there would be no overrun, it would have been what was estimated.

So, Mr. Francis, how do we deal with this—it's a risk-and-cost balance, it seems to me. And, in order to build the highest technology, most advanced weapon system, we're going to have to take risks, in terms of being sure that that technology is the most advanced possible when that ship launches. Talk to me about what you identified, I think, properly. This isn't an overall procurement problem of the—all of the military, but the fact that it seems to happen in every branch, on every weapon system, when—the first—whether it's the F–35 or this or other ships or other weapon systems—tanks, you name it—how do we deal with this first-in-class issue?

Mr. FRANCIS. Well, Senator, I think there's a way to take risks, so we need to take them. Our position has been, let's take more risks in science and technology before we get into acquisition. That takes money. And we're kind of stingy about money before we get into a program.

Senator KING. Would it be accurate to say that some of these ships are—that some of these systems—this is an R&D project. This——

Mr. FRANCIS. Yes.

Senator KING.—is R&D on the hoof.

Mr. FRANCIS. Yes. And so—we talked earlier about off-ramps. I think Sean talked about them. If you're going to take a risk, I think we should say—let's say we're taking a risk, and we've got an off-ramp, so if this doesn't work out, we've got a Plan B. We tend not to do that. We tend to bet that this is going to come out just the way we say.

And if you look at the original plan for the CVN–78, these systems were going to get wrung out in land-based testing before they got on the ship, but we were too optimistic about the schedule for that—taking that risk. So, they slid onto the ship.

So, myself, personally, I don't—I'm not terribly concerned about the types of problems we're having on those systems. It's when and where we're discovering them. That's the problem. So, I think there's a way to take risk, to take it more intelligently.

Again, I come back to the acquisition culture. The culture here is to say there is no risk, that we can do it for low cost. If you come in and say it's going to cost 13 billion, maybe you'll get told no. And so, you can't put that on the table. So, somehow our culture has to change so we can say, "It's okay to take a risk, and here's how we're going to do it."

Senator KING. And, of course, one of the problems here is that we're talking about a class of ships—we're building three of them. So, you don't have 50 or 60 to spread those, essentially, R&D costs over. The DDG-51, I think, is an example of that. It's now cheaper than it was when it was first—in real dollars—than it was—I believe, than it was back in 1986. It had a whole lot of problems, and now it's the mainstay of the Navy.

So, we—I think we—again, I think this is a very important subject. I don't mean to sugar-coat it. And I think we need to focus on it. But, I think we need to understand the context somewhat and really focus on the real problem, which seems to be, How do we deal with the quantitative risk? I spent 2 hours, not long ago, in a classified briefing on the new bomber. Same kinds of issues, and trying to hammer about, How do we do the contracts? Who takes the risk?—whether it's the contractor or the government. And—but, this is a tough problem when you're talking about trying to build the most technically advanced weapon system in the world. And Senator Manchin mentioned the Chinese. They're doing pretty well by stealing our intellectual property, he alleged. I alleged.

[Laughter.]

Senator KING. But, you know, that's one way to shorten—short-circuit the R&D. But, I hope you all—and, Madam Secretary and Secretary Stackley, you've done a lot of thinking about this. I think it would be very helpful to present us with some thinking about how we deal with the first-in-class problem, because that's what we're talking about, across the government.

Admiral?

Admiral MANAZIR. Senator King, if I can offer—this is more complex, from the technology risk perspective, than just whitewashing first-of-class. And that is, What technologies do you choose to put into the first-of-class? Secretary Stackley and others have said in their statements the original plan with CVN–77 had part of it, CVNX–1 had part of it, CVNX–2 had part of it, all pushed into one class. We talked about—I think Ranking Member Reed talked about the Enterprise Air Surveillance Radar Project that we're putting in the CVN–79 to replace the dual-band radar. That's a management of risk, because that radar is a non-developmental solution. We have created requirement sets that looks at what industry has now to reduce the risk of technology and development on time and schedule. The P–8 program—brand new antisubmarine warfare aircraft was put on a COTS commercial system. That's the Boeing 737 aircraft. We reduced the risk of integration into an airframe by using something that was already proven, and we're realizing that risk. Several of our weapons programs, we use the back-end motor with a brand new seeker on the front. Very, very capable. When the seeker is good, we do the back-end motor later on.

So, the type of risk that you take on, sir, in the first-of-class is key. If we choose to do a full developmental first-of-class, like the Joint Strike Fighter, that is a revolutionary weapon system that is better than any aircraft in the world. There's a lot of risk there, sir, and we're realizing that risk now. We've talked about the *Ford.* That was revolutionary between the *Nimitz* and the *Ford.*

So, I would submit, sir, that Mr. Francis's comments are exactly on the mark. We have to look clearly at the risks that we have. If your first-in-class is revolutionary, and you don't do the things that you're talking about for technology, you're going to have a cost-delivery mismatch that you're going to have to deal with later on, sir. And we look at that risk.

Senator KING. Well——

Mr. STACKLEY. If I may just add, because Senator Ayotte brought up the *Ohio.* You're asking a very—you're just spot-on questioned an issue that we wrestle with continuously. *Ohio* is the next big thing coming our way in the Department of the Navy, in terms of a first-of-class. We're talking about a program that will be providing reliable, secure, certain sea-based strategic deterrence until the 2080s. So, how do you design and develop the capabilities that are going to go on that boat on the front end, deliver on schedule so that she can be on deployment, as scheduled, in 2031, certainly, and then, throughout its life, remain that secure sea-based strategic deterrent.

Senator KING. Still be an effective weapon 50 years from now.

Mr. STACKLEY. Yes, sir. So, we're not going to go big-bang. We've been working this. We look at, What do we need to do on the *Ohio* replacement that we don't already do on the *Ohio*? Well, right now we have a very effective high- performing strategic program, in terms of the weapon system, itself. We're not going to develop a new weapon system. We're going to port over the existing weapon system, in its current state of technology at the right time, onto the *Ohio* replacement hull.

The *Virginia*-class, very effective combat systems, sensors, communication platform. We're going to port over that technologies onto the *Ohio* replacement hull. The advances that we need to make are in terms of stealth and survivability of the *Ohio* replacement hull for the next half-century. And that's where our focus is, in terms of development and design. And the way we're going about this is, we are challenging the requirements. You've got to get the requirements right, up front. And getting them right doesn't just mean, What does the operator need? But, what are the—what is technically feasible? What are the risks that you carry in there? When you identify those, make sure that you've got a development program that works those risks so everybody understands, as you're making progress before you're cutting steel, and then have the off-ramps that we discussed. And so, in fact, we've got that laid out. That's a 2019 boat that we're sitting here today doing those developments, managing—2021, excuse me—2019 advanced procurement—that we're managing closely today, and then assessing the risk each step along the way, visibly, for the Congress, for the Department of Defense, with industry, to ensure that each step along the way, we have—we're making the right decisions, and we don't find ourselves where we are today, with delay and the cost growth that we're seeing on CVN–78.

Chairman MCCAIN. Admiral, when—your time is expired—when you use the Joint Strike Fighter as a success story, sir, you have lost the connection between the military and this committee. The most expensive, longest cost—largest cost overrun, first trillion-dollar weapon system in history, and you're using that as a success story? Sir, you have lost connection with the members of this committee and those of us who have been involved in this fiasco for a decade.

Mr. Francis, you've got to respond to some of this. We are now being painted pictures, everything is fine.

Mr. FRANCIS. I think that this is the byproduct, again, of culture and the long timeline. So, when programs get through their problems, we fall back on, "Wow, but so much better than what we have." But, we've forgotten the cost and the opportunity cost it took to get there. So, I think we could agree that the system produces tremendous weapon systems, but they cost way more and they take much longer. And we're giving things up along the way, but we don't know what those things are. And that's not a pattern we want to repeat. We want to get it right the first time.

Chairman MCCAIN. Senator Cotton.

Admiral MANAZIR. Mr. Chairman, just for the record, sir, I did not intend to use the Joint Strike Fighter as a success story, sir, as much as illustrate that innovative technology, such as Secretary Stackley said, is a challenge, sir. So——

Chairman MCCAIN. Innovative technologies in Silicon Valley reduce costs. Innovative technologies, apparently, in the Department of Defense increase costs.

Senator Cotton.

Senator COTTON. Thank you.

I know that we've gone over a lot of the details of this program, so I won't rehash those, but I do, in the spirit of inquiry and problem-solving, moving ahead in the future, have a couple of simple questions that I want to ask.

Mr. Francis, I'll start with you. Has the Navy ever delivered a ship under budget and on time?

Mr. FRANCIS. I don't know if I can answer that for history. I want to say, in the recent ones that we've looked at, that hasn't happened. But, probably Mr. Stackley has better data on that.

Senator COTTON. You——

Mr. FRANCIS. The ones we've looked at, I haven't seen it.

Mr. STACKLEY. Yes, sir. First off, you said "a ship." And the answer is, absolutely yes, we do it consistently. I think what you wanted to get at is a lead ship, since we've spent so much of our time discussing lead ships. And the answer, again, is yes, we have. And that's when we have been very measured, in terms of the risk that we've carried into those lead ships. And, as we look forward, I—talking about the higher importing over technologies—when we look at the lead ships coming our way right now, the first one is going to be the TAO(X) [the oiler replacement shipbuilding program], which is in the 2016 budget. We're going to leverage existing technologies and design to minimize the risk on that. And that'll be a fixed-price program.

The next one after that is going to be the next amphib program, what we refer to as the LX(R). We have made the decision to mitigate—minimize those risks to ensure that we deliver the capability that the warfighter needs at a cost we can both afford and rely upon when it delivers. We're going to reuse the LPD–17 hull form, which is technology and capability that we understand and supports the mission, and then we're just going to deal with those changes to the mission that are necessary for the changes to that platform's requirements.

Senator COTTON. So, those are ships in the future, though, retrospectively. What is the lead ship that——

Mr. STACKLEY. The——

Senator COTTON.—the Navy delivered under budget and on time?

Mr. STACKLEY. I don't want to oversimplify this, but the last lead ship that we delivered was the Mobile Landing Platform. That delivered on schedule, under budget.

Senator COTTON. Okay.

Secretary McFarland, do you have anything to add to this question?

Ms. MCFARLAND. No, sir.

I would add one thing different, though. I think the underlying premise, in terms of what we're having as a discussion, doesn't go specific to the ship for the first-in-class, but to that culture that we discussed earlier.

Senator COTTON. And to be clear, I'm asking this not just about the *Ford*-class carrier, but all these major capital investments that, in particular, our Navy and our Air Force have to make. If the Air Force were in front of me, I'd ask them the same thing about airplanes. But, you know, we have to replace our ballistic missile submarines, and Air Force is on the verge of replacing its long-range strike bomber.

So, the reason I asked the question is, I want to know if we've done it in the past, even if it's been rarer than over-budget and delayed programs, what are the features or the best practices or the cultural conditions that allowed a program to be delivered on time and under budget?

Ms. MCFARLAND. Senator, I would like to bring forward a list of programs that have come in on schedule and performance. And also, in terms of the culture, I think that was adequately discussed by the Chairman and Ranking Member, and I think the table here.

There are thing is that can be done to improve things, like bureaucracy and things like overhead.

I think the other piece that you're getting at, in terms of, What have we learned?—one of the attributes of our new implementation of WSARA and the better buying powers is taking lessons that come from GAO, from the DOD IG [Inspector General], from DOT&E, and incorporate it in very stepwise and disciplined into the system to work to see these improvements inculturated into our workforce for the long term. We've seen, as part of the performance of the acquisition systems reports that we started 3 years ago, a moderate improvement, a decrease of the Nunn-McCurdys, an increase of performance of our contracting, although we can improve an incentive. We have been trying to measure what we do, and find those faults, whether they trace to acquisition reform, policies, statute, regulation, to work, as we had done, with Congress for these upcoming NDAAs and legislation. We believe we need to get to the heart of the matter, which is the data that points us to what we can do to improve.

Senator COTTON. Mr. Francis, do you have any——

Mr. FRANCIS. Yes, Senator. One of the classic cases of a success story is the F–16 fighter. And I know that's—it's old, but the story—the lessons are still applicable. So, that was a low-cost alternative to the F–15. So, the requirements were kept low. We had five international partners, and they all had to agree to any requirements changes, which had the effect of keeping the requirements down. And we had a contractor at the time that was in very difficult financial straits, so they couldn't underbid and hope to get well later So, that combination of things had the effect of changing the culture for that program.

There are some other examples. I'm trying to think of—the Shadow UAV [unmanned aerial vehicle] that the Army developed also went quite well. And again, in that case, it—we had both the head of requirements in the Army and the head of acquisition actually drove that program and kept it in check.

So, I—I'm—my experience suggests that the success stories have been the byproduct of exceptional circumstances and not the result of normal circumstances. So, the takeaway here is how to replicate that, how to make those circumstances, that culture, normal for most acquisitions.

Senator COTTON. Would the uniformed officers have anything to add?

Admiral GADDIS. Yes, sir. I was PMA–265. I was the Hornet, Super Hornet, and Growler program manager. And, at my change of command, I said that I thought Super Hornet was the most successful program in the history of DOD.

Two years later, I found that I was wrong, because the 18G Growler beat the E/F Super Hornet. And I would argue that that's normal acquisition, and what you see is an aberration.

That, over there, is an aberration. I have a $47 billion portfolio with those platforms, and it includes E2D Advanced Hawkeye, it includes the next-generation Jammer. Very successful programs. That, right there, is the unfolding of one agonizing technical discovery after another. And at its root, since Senator McCain asked that question, is—we didn't do it—an adequate TD [technical development]. In fact, let me give you some examples. EMALS—we did a risk- reduction effort before signing the production contract, and we spent $322 billion. WSARA Act is passed in 2009. For next-generation Jammer, before we go to milestone B, the Department of Defense will have spent $622 million for tech- mat development and tech development for next-generation Jammer. What that means is, you're going to have a solid technical baseline and a solid technical—or cost estimate going into milestone B. I feel pretty confident about those—execution of those programs.

AAG, we spent a $29 million. We could have discovered—everything that we discovered then we could have discovered it a lot sooner. But, we're at a point in the program where we're beating back all the discovery, we're beating back all the design changes, we're into test. And, as Secretary Stackley said before, we're now into software and tweaking the software. But, that's where we're at with AAG.

I wish we had done TD like we did next-generation Jammer as a result of WSARA Act and what we did with EMALS. We just didn't do it. And in 2004, by the way, normal acquisition, we did propose that. We did propose a 5-year component advanced development program followed by a 5-year development program. And it was deemed as too costly and too lengthy. Well, here we are. We should have done that in the first place, but the leadership said no, because we were into transformation pushing technology to the left. But, that's the consequences of those decisions that were made back in 2004, which, by the way, is all documented in the 2004 acquisition strategy.

Thank you.

Senator COTTON. Well, thank you, Admiral Gaddis, for that perspective.

I would, if you could, follow up on providing examples of where systems have succeeded. They've been a success story, they come in under budget, they come on time. The headline grabbers are the lines, like this one or like the Joint Strike Fighter, that don't do that. But, I do think that we have a lot of lessons to learn, not just on oversight of current or past products, but what's going to happen in the future for the platforms and the weapon systems that our sailors, soldiers, and airmen, marines, need to fight and win our wars for the future. So, that would be very helpful for me and for the rest of this committee, I'm sure.

Thank you very much.

[The information referred to follows:]

F/A–18E/F & EA–18G ACQUISITION PROGRAMS

Arguably the Navy's most successful acquisition when it was procured, the F/A–18E/F Super Hornet is a tremendous success story that was followed by an even greater success story, the EA–18G *Growler*®. Understanding the success of these acquisitions requires a look at the history of the platforms, and knowing the process/organizational construct used by the program office to achieve success. Several highlights from this success are listed here. Leveraging technology from the legacy F/A–18A–D platform produced a "worksharing" capability on the F/A–18E/F Program that programs like the F/A–22 and F–35 did not have the luxury of using. "Worksharing" was also an advantage for the *Growler*® as the EA–18G combined the best of two proven weapons systems, that of the F/A–18E/F and the repackaged Improved Capability (ICAP) III (from the EA–6B) into the Super Hornet envelope, thus creating the *Growler*®. The Integrated Test Team (ITT) and Integrated Product Team (IPT) structure implemented by the program office was groundbreaking in fostering the interoperability of government employees and contractors. Lessons learned from the cancelation of the A–12 Program enabled managers and contractors to make better decisions. An additional very important reason for the success of both of these acquisition programs was the ability of the program office to obtain the best people from both Government and industry. For the most part, these people remained on the program throughout the entire development and test periods up to Initial Operating Capability.

A key lesson learned that was incorporated on both programs was the building in of schedule margins to account for unplanned or unknown complications during development and test efforts. While only minimal amounts of these margins were used to solve unknowns, the remaining time was capitalized by closing out minor test issues and resulted in the program being better postured for success in operational testing.

F/A–18E/F

The F/A–18 E/F Super Hornet acquisition program was an unparalleled success. The aircraft emerged from Engineering, and Manufacturing Development (E&MD) meeting all of its performance requirements on cost, on schedule and 400 pounds under weight. All of this was verified in Operational Testing, the final exam, passing with flying colors and receiving the highest possible endorsement.

The forward fuselage was essentially unchanged from the F/A–18C/D Hornet, but the remainder of the aircraft shares little with earlier F/A–18C/D models. The fuselage was stretched by 34 inches to make room for fuel and future avionics upgrades and increased the wing area by 25 percent. However, the Super Hornet has 42 percent fewer structural parts than the original Hornet design, which means fewer maintenance requirements than the legacy aircraft. The F/A–18E/F added two additional wing weapons stations, a higher capacity hydraulic system, environmental control system improvements and a new engine – the F414, which included innovative blisk technology in the first three compressor stages. These enhancements allowed for increased range, on station time, weapons carriage and bringback capability. The process of acquiring new weapon platforms requires substantial time and money in development, testing, and production. The Navy's F/A–18E/F illustrates the difficulties and successes of this process.

The plans to develop this aircraft began in the early 1980s. The Navy considered several options to meet this requirement. Taking lessons from the cancelled A–12 program, program managers and contractors ultimately decided to modify the existing F/A–18C/D design.

The program office established a system for closely monitoring the contractor's cost and schedule performance. The program office sought to work closely with the contractors and did so by setting up a routine of daily phone calls between the Navy program manager and contractor counterparts. The extensive use of Earned Value Management (EVM) throughout the development program provided the government/contractor team with near real-time data. EVM updates were presented to the senior leadership team on a weekly basis. This practice allowed for timely adjustments in program execution.

The technology requirements for the aircraft were deliberately crafted to control technological risk and constrain costs. The Navy directed McDonnell Douglas (now Boeing) to undertake further risk-reduction studies throughout the early 1990's, resulting in the rejection of some of the more radical contractor design modification proposals. This produced a formal request to modify the F/A–18C/D variant versus a new program start. Although the new F/A–18E/F design entailed major airframe modifications, the Navy intended to incorporate existing F/A–18C/D avionics and a derivative of the existing engine. While all new, the airframe design for the F/A–18E/F was aerodynamically similar to the F/A–18C/D.

The F/A–18E/F Program employed a key acquisition reform concept later formalized as Cost as an Independent Variable (CAIV). By early 1992, senior Navy leadership had made it clear that the F/A–18E/F Program would not proceed unless the cost estimates for the development program and for average unit flyaway costs remained under strict ceilings dictated by likely funding realities. The F/A–18E/F program developed a "worksharing" agreement based on F/A–18A–D development and production. McDonnell Douglas was the prime contractor, and Northrop (now Northrop Grumman) was a major subcontractor on the effort. The F/A–18E/F contractor team of McDonnell Douglas and Northrop had substantial involvement on the F/A–18A–D. Both contractors had knowledgeable design teams in place and drew heavily from existing suppliers and industrial base. This workshare arrangement allowed the contractors to concentrate on their specialties from the predecessor program and to use their existing subcontractor industrial base. Similar to the F/A–18A–D, Northrop remained responsible for the aft fuselage section of the aircraft while the ultimate responsibility to integrate the entire weapon system rested on McDonnell Douglas.

While the F/A–18E/F Program was not free from serious technological and programmatic challenges, it progressed closely in accordance with its original schedule estimates. One reason was that the program office adopted a variety of new acquisition reform strategies that promoted program stability and close cooperation between the Navy program office and the contractor team.

One such strategy was the use of Integrated Product Teams (IPT) that formed the Integrated Test Team (ITT). The ITT concept was one of the key enablers in breaking through organizational barriers that had traditionally plagued past developmental efforts. Using the ITT/IPT concept, the team moved away from functional "stovepipes" toward a product orientation approach, which fully integrated functional areas, including both government and industry sides. The F/A–18E/F Program took the use of ITT/IPTs to a higher level by assigning government and industry co-leads for each team. The co-leads were interchangeable with each other and were authorized to officially accept the team's work, regardless of whether they were government or contractor employees. To emphasize and legitimize this construct, the co-leads jointly briefed at every program event including major milestones such as Preliminary Design Reviews and Critical Design Reviews. Many observers believe effective use of the ITT/IPT approach was one of the most important management initiatives promoting stability and effective management of programmatic and technological challenges throughout the F/A–18E/F development and test effort.

Numerous technical challenges were identified during developmental flight testing, but none led to major restructuring of the program or significant cost growth. The first F/A–18E/F test aircraft flew in November 1995, 32 days ahead of schedule. The second test aircraft flew one month later. The formal developmental flight test program began early the following year at the Naval Air Station (NAS) Patuxent River, Maryland. One problem that attracted considerable public attention was the "wing drop" problem, discovered in 1996. During certain maneuvers, one wing of the aircraft would unexpectedly stall or dip, causing the aircraft to roll. The Navy and contractors worked together closely to develop and implement fixes. This type of problem is not uncommon during the development of a new airframe.

Other technical and performance areas that caused some controversy during development included combat range and survivability. Most of these problems were either successfully resolved or dealt with by other adjustments. Thus, with more limited technical objectives, tighter management controls, and continuing success in maintaining cost and schedule performance, the F/A–18E/F progressed through E&MD with minimal interruptions.

EA–18G GROWLER®

Considering the benefits gained from the "worksharing" concept, the same concept can be applied to the EA–18G aircraft using much of the F/A–18E/F airframe. The predecessors of Hornet/Super Hornet and *Growler®* and their commonalities provided the groundwork for reduced development, procurement and support costs, and overlap in training and logistics infrastructure. The U.S. Navy awarded a 5-year system development and demonstration (SDD) contract in December 2003. A contract for the first four production aircraft was signed in July 2006.

Over the course of development and production, momentum was gained as multiple partners joined forces to share technology. In 2005, Boeing's work with EA–18G paralleled that of Northrop Grumman's work on the EA–6B Prowler ICAP–III and the two companies coordinated to join forces and moved the program forward as an Electronic Attack platform. The EA–18G positively benefitted from a significant amount of pre-SDD (System Design and Development) work that Boeing had done in their St. Louis simulation facility to evaluate the operational impacts of moving to a two-person aircrew from the Prowler's four-person layout. This new crew concept was one of the higher risk program areas and the efforts to resolve issues were supported by government developmental and operational test engineers working alongside their industry counterparts. Boeing and the government team also collaborated on pre-SDD efforts to define the optimum shape for the ALQ–218 wingtip pods and the effects of carriage of ALQ–99 pods on underwing weapons stations.

NGC was responsible for development of the Airborne Electronic Attack (AEA) suite. Via an Associate Contracting Agreement, Boeing and NGC worked together to integrate the ICAP–III capabilities into the *Growler®* AEA weapons system. Continuing with the joint government/industry philosophy, there was a large amount of government presence and oversight from both hardware and software engineering and test personnel throughout the integration.

The EA–18G ITT was organized somewhat differently than what was in place for the F/A–18E/F Program. While the Super Hornet ITT was primarily sited at NAS Patuxent River, Maryland, the *Growler®* ITT had a large presence at China Lake and Pt. Mugu, California. This geographic spread was dictated by the software intensive development effort and the need to utilize facilities, capabilities and ranges on both coasts near-simultaneously.

The *Growler®* aircraft's first test flight was successfully completed in August 2006. This was followed by delivery of the first two test aircraft to the U.S. Navy in September and November 2006. The first production aircraft was delivered to the U.S. Navy in September 2007. The first operational aircraft was delivered to NAS Whidbey Island in June 2008 and operational evaluation began in October 2008 onboard the USS *John C. Stennis* (CVN–74) aircraft carrier.

In 2009, the Operational Evaluation Report was released and stated that the EA–18G "demonstrated the ability to conduct representative missions covering all seven of the mission areas defined for the EA–18G utilizing all four typical mission profiles." The only exception to operational effectiveness was for those requiring a full escort mission profile against an active air defense system. This exception was due to the excessive amount of time the displays exhibited when providing data for situational awareness and the AEA suite's lengthy response time for making reactive jamming assignments. Performance deficiencies of the legacy ALQ–99 jamming pods also contributed to the noted exception.

In 2010, before the deficiencies were resolved the EA–18G was approved for full rate production. The aircraft was found to be operationally ready and Boeing would later state that a majority of the deficiencies were resolved through a previously planned software update.

A 2012 Aviation Week Program Excellence Initiative cited coordination across programs, immediate mitigation of production delays and prioritized subcontract workloads and deliveries as the framework which allowed for successful contract delivery.

Senator REED [presiding]. Thank you, Senator Cardin.

On behalf of the Chairman, let me recognize Senator Kaine. He has one question.

Senator KAINE. Thank you. Thank you, Mr. Chair.

And super questions by Senator Cotton.

In this program, going back to a point I asked earlier—and I'm—I want to get your opinions on the role we should play in, sort of, oversight. In this program, the cost estimates before 2010 were coming with a confidence factor of less than 50 percent or, in one instances, less than 40 percent. If we're being asked to make a decision about a significant acquisition, and we're given a cost estimate, but the Navy, or whatever the service branch, says, "And our confidence on this cost is less than 50," to me that suggests probably some questionable confidence on cost, but also even on operational risk, because the reason you have a question about cost often then connects to an operational uncertainty, as well. Should we just say, "Come back to us when you're at 75, or come back to us when you're at 60?" If there's that much uncertainty about a cost estimate, should we, basically, push you to do more work before we give a green light?

Mr. STACKLEY. Sir, I spend a lot of time with the cost estimators and a lot of time with the program managers, and I explained the cost estimate is not the answer. The cost estimate is information. And you hit on two things: the cost estimate and the percent confidence. In fact, the estimators come up with a range of things that could influence the final cost. What I want the program management team and the cost estimators to do is, in that, understand what are the risks. If today the confidence is 40 percent, what are the risks that we have to drive out of the program to get it up to the level that we're ready to put budget down on, ready to go to contract, ready to cut steel. And so, it's not just the cost estimate, it's the next two or three layers below that that the estimators are pointing at that identify the risks that we need to retire, just like we're been discussing here, all the parts of the carrier program, that we need to retire before we go to contract, before we go to Congress and say, "We need authorization and appropriation to go forward on this major program."

Mr. FRANCIS. Senator Kaine, I would say, for you, you have to start your work earlier. So, when you come up to a milestone, and the cost estimate's done, and the program's acquisition strategy is laid out, there's very little you can do. But, I think, with Congress and this committee, by getting invested in programs earlier, say 3 years before that milestone, you create the expectation that you want that to come in at a high confidence level, you want the risks identified, and you're willing to either, one, pay for the risk reduction, like Admiral Gaddis talked about, or you're willing to offload some of the requirements to bring the system down. But, the work would have to start earlier to position it for success.

Senator REED. Well, thank you very much.

Thank you for your extraordinarily interesting and insightful testimony, and for your service to the Nation.

On behalf of Chairman McCain, I'll adjourn the hearing.

Thank you.

[Whereupon, at 11:41 a.m., the hearing was adjourned.]

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR JOHN MCCAIN

FOLLOW-ON SHIPS AND THE COST CAP

1. Senator MCCAIN. Will you deliver CVN–79 within the cost cap? Please elaborate on your response.

Secretary MCFARLAND. The Navy is committed to building the *John F. Kennedy* (CVN–79) at the lowest possible cost and under the $11.498 billion Congressional Cost Cap. The CVN–79 Detail Design and Construction contract is a fixed-price incentive type contract and offers the Navy the most favorable cost sharing arrangement on any CVN construction contract to date. The combination of target fee, sharelines, and ceiling price are a testament to both the Navy's and the shipbuilder's confidence in the producibility of this design and ability to meet the cost target for the ship. This contract is the result of a dedicated effort over the past three years by the Navy and shipbuilder team to drive affordability into the *Ford*-class and commitment to delivering the ship within the $11.498 billion Congressional Cost Cap. Importantly, this is also just the first step in continuing to reduce the costs of future ships of the class.

Secretary STACKLEY. Yes, the Navy will deliver *John F. Kennedy* (CVN–79) within the Congressional cost cap.

Applying CVN–78 lessons learned, the Navy has significantly reduced the CVN–78 baseline cost and eliminated technical risks for follow-on ships. To deliver CVN–79 at the lowest possible cost, the Navy conducted an extensive affordability review of carrier construction, enacting significant changes focused on eliminating the largest impacts to cost performance (as identified during CVN–78 construction) and furthering improvements in future carrier construction. The Navy outlined these cost savings initiatives in its May 2013 Report to Congress and execution is proceeding as planned.

Additionally, the Navy and shipbuilder have applied numerous cost reducing design changes based upon CVN–78 lessons learned. These include the introduction of tooling advancements such as more autonomous welding machines, adaptable construction jigs/fixtures, and pipe bending machines that yield construction productivity improvements. The shipbuilder has also created new superlifts to lower the number of units independently erected in the drydock, alleviating gantry drydock crane demand and improving welding flexibility. Larger superlifts have enabled greater pre-outfitting in the shop and on the final assembly platen prior to ship erection, increasing construction efficiency and comparatively decreasing the number of costly erectable units by approximately nine percent.

Overall design completion and stability enabled the shipbuilder to fully understand the CVN–79 "whole ship" bill of materials and more effectively manage procurement using knowledge of CVN–78 construction material lead times and qualified sources. As a result, the shipbuilder has capitalized on ship-set material quantity orders and attendant cost benefits to ensure timely delivery. These efforts have reduced material cost and increased material availability in support of an optimized construction schedule. At the time of the CVN–78 Detail Design and Construction (DD&C) contract award, 44 percent of direct-buy material was contracted with 83 percent material availability. Comparatively, the same CVN–79 milestone yielded 95 percent contracted direct-buy material with 97 percent material availability. Higher material availability enables the Navy and shipbuilder to provide stable, predictable material requirements; maintain efficient construction sequencing; increase pre-outfitting earlier in the construction process; and avoid costly construction and engineering re-work.

The Navy has also implemented a two-phase delivery plan to deliver CVN–79 at the lowest possible cost. The two-phase strategy will allow the basic ship to be constructed and tested in the most efficient manner by the shipbuilder (Phase I) while enabling select ship systems and compartments to be completed in Phase II, where the work can be completed more affordably through competition or the use of skilled installation teams. Likewise, the strategy allows the Navy to procure and install at the latest possible date, shipboard electronic systems that otherwise would be subject to obsolescence prior to the first CVN–79 deployment in 2027. Additionally, the two-phase acquisition strategy allows the Navy to install the Enterprise Air Surveillance Radar (EASR), a more cost effective radar than Dual Band Radar (DBR), on CVN–79 in the Phase II availability. The substitution of the EASR suite alone is projected to save $180 million in government furnished equipment cost compared to the DBR installed on CVN–78.

The Navy's current estimate to deliver CVN–79, as reported in quarterly Reports to Congress, is $11,498 million. Strict cost control measures across all aspects of the program and further enhanced oversight of Government Furnished Equipment (GFE) are being used to lower the Navy's $11,498 million estimate. This governance process includes Program Executive Officer (PEO) approval prior to release of GFE funds and routine reviews with the Chief of Naval Operations (CNO) and Assistant Secretary of the Navy (Research Development and Acquisition).

The Navy will deliver the *John F. Kennedy* (CVN–79) within the Congressional cost cap and continues to investigate other sources of potential savings. The aforementioned actions have driven down and stabilized CVN–79 construction cost and will allow *Ford*-class follow-on ships to project world leading capability with improved affordability and reduced total ownership cost into the 22nd Century.

PERFORMANCE OF THE ADVANCED ARRESTING GEAR

2. Senator MCCAIN. Who made the decision to proceed with simultaneous design and production of the AAG even though problems with the water twister were discovered late in the development process? Who, if anyone, was held accountable for incurring the additional risk?

Admiral GADDIS. Authorization to conduct concurrent development and production of AAG was provided by then Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN RDA) with the Milestone B Acquisition Decision Memorandum (ADM) signed on February 10, 2005. The Milestone B ADM authorized not only the start of the development of AAG as an ACAT II program, but also authorized the procurement of five low rate initial production systems. At that time, the risk of concurrent development and production was assessed as low, and was authorized in order to meet shipyard installation schedules as delineated in the Acquisition Strategy of 2004. The ASN RDA decision to execute the firm fixed price production contract of AAG in support of CVN–78 in 2009 was made after the AAG Critical Design Review. Since then, AAG has been the subject of multiple Navy reviews across all levels of Navy leadership.

The water twister failure occurred at the Jet Car Track Site in February 2012. The risk presented by future component failures and re-designs that occurred, was unknown at the time of production contract award in 2009. These failures are largely attributable to inadequate risk-reduction activities associated with AAG design. Unlike EMALS, which invested over $300 million in full scale development, AAG only invested $23 million toward risk-reduction prior to engineering and manufacturing development.

3. Senator MCCAIN. Why was the AAG program not designated as a program of special interest, given its criticality to meeting approved carrier requirements? Who made that decision?

Secretary STACKLEY. The original cost and schedule estimates for AAG did not support designation as a program of special interest during ASN(RD&A)'s Milestone B decision in 2005. However, the oversight of AAG has been similar to that of a special interest program since 2009 because of delays in the land based test program, cost increases, and its association with the CVN–78 program. This level of oversight included a "Nunn-McCurdy-like" focused review which evaluated component re-design, test progress, and projected component delivery relative to shipbuilder need dates. The review also scrutinized continued delays in testing and the associated programmatic risk of performing concurrent development, test, and ship integration events. As a result, increased oversight has continued through today.

4. Senator MCCAIN. It's my understanding that AT&L has decided to designate AAG as an MDAP category 1C, in which the Navy retains decision authority for the program, vs. 1D, where AT&L takes over. Given the Navy's track record managing this program to date, are you confident this is the right decision? Please elaborate on your response.

Secretary MCFARLAND. Yes. The development problems that led to the Advanced Arresting Gear (AAG) program migrating up to a Major Defense Acquisition Program (MDAP) have been appropriately addressed. USD(AT&L) decided to designate the AAG program as an MDAP category IC program because the program has demonstrated the requisite design maturity. USD(AT&L) maintains oversight of the AAG program through the Defense Acquisition Executive Summary (DAES) process and will continue to monitor the program during annual Defense Acquisition Board (DAB) reviews of the CVN–78 program.

GAPS IN CARRIER FLEET ARRESTING CAPABILITY

5. Senator MCCAIN. At what point did the Navy decide not to backfit *Nimitz*-class aircraft carriers and why was this decision made?

Admiral MOORE and Admiral GADDIS. The Navy has not implemented the backfit plan due to challenges in design development, system maturation and cost that drove the proposed *Nimitz*-class backfit opportunities out of sync with planned ship maintenance cycles. The initial AAG backfit installation requirement was planned to be accomplished within the time constraints of an Aircraft Carrier Docking Planned Incremental Availability (DPIA). Upon further analysis, and in advance of the 2009 AAG production contract award, the Navy determined that backfit could not be accomplished within the constraints of a DPIA period and required a mid-life Refueling and Complex Overhaul (RCOH) schedule to complete the task, thus eliminating CVN–68–71 since these hulls had already completed or were already in RCOH. In 2010, due to system immaturity and the unknown cost of procurement and installation, the backfit installation in USS *Abraham Lincoln* (CVN–72) was considered too high a risk to ship schedule and delivery and was not incorporated into the RCOH modernization plan. In the summer of 2012, the backfit for USS *George Washington* (CVN–73) RCOH was not incorporated for the same reason. Backfit options for the *Nimitz*-class is currently under review as part of an on-going study expected to complete in October 2016.

6. Senator MCCAIN. What are the Navy's updated plans to address limitations to the *Nimitz*-class arresting capability that led it to be part of the AAG business case to begin with, and what costs do we expect to see for this?

Admiral MANAZIR and Admiral GADDIS. The service began an Analysis of Alternatives study in August 2015, with the goal of providing potential arresting gear solutions that could be acted upon in POM 19. This study is looking for both materiel and non-materiel solutions to address the capability concerns within the MK–7 system. Estimated costs will be included when the study is completed.

TRANSFORMATIONAL TECHNOLOGIES

7. Senator MCCAIN. In executing the *Ford*-class program, describe the major decision milestones were there and the extent to which the Navy and OSD jointly made key decisions? Specifically describe the Navy and OSD decision-making process when it was clear (1) there was significant cost growth in construction of CVN–78,

(2) that EMALS was not developing at the expected pace, and (3) that development cost of AAG had grown so much that it had become a Major program.

Secretary McFarland. OSD and Navy jointly executed the Defense Acquisition System with a series of major milestone reviews that resulted in decision memoranda as follows:

- A Milestone 0 Acquisition Decision Memorandum (ADM) dated March 29, 1996, based on a review held on March 28, 1996, that approved entry into concept exploration including the guidance for conducting an analysis of alternatives, the exit criteria for Milestone I, and the documentation requirements for Milestone I.
- A Milestone I ADM dated June 15, 2000, based on a review held on May 31, 2000, that approved program initiation for the CVNX program, including the Phase I exit criteria.
- A Milestone B ADM dated April 26, 2004, based on a review held on April 2, 2004, that approved funding for the construction preparation contract for the lead ship, the Acquisition Program Baseline, and the exit criteria for Milestone B.

In addition, the Navy provided additional status and sought OSD approval through the Defense Acquisition Board (DAB) at the following decisions:

- An ADM dated August 6, 2008, based on a review held on July 23, 2008, that approved entry into the production phase and obligation of funding for the lead ship, CVN–78, and entry into the construction preparation phase for the second ship, CVN–79.
- An ADM dated June 3, 2015, based on a review held on April 28, 2015, that approved entry into the detail design and construction phase for the second ship, CVN–79, proceeding with advance procurement for the third ship, CVN–80, and the entrance criteria for the fiscal year 2017 program review for construction of CVN–80.

OSD used the Defense Acquisition Executive Summary (DAES) process to formally monitor progress of the program between these decision meetings. The program briefed USD(AT&L) on program progress in October 2009, August 2010, April 2012, June 2013, and March 2014. During each of these meetings, cost growth issues in the construction of CVN–78 were presented and OSD and the Navy jointly agreed on the way ahead for the program. As CVN–78 construction costs continued to grow, the ASN(RDA) implemented regular monthly meetings with the shipbuilder to evaluate progress of CVN–78. OSD representatives attended these meetings. DAES reports and OSD reviews will continue as the program proceeds through CVN–79 and CVN–80 construction. USD(AT&L) will also conduct annual reviews of the CVN–78 program by the Defense Acquisition Board.

EMALS development issues were being monitored by OSD in a similar manner, as EMALS was an integral part of the CVN–78 program. Approval of the CVN–78 Class Milestone B was contingent on award of the EMALS System Development and Demonstration contract. When EMALS development became an issue in August 2008, USD(AT&L) directed an independent OSD review of its development. The OSD review concluded that:

- The critical EMALS component technologies were developed and demonstrated.
- The principal challenge involved full-system and ship integration in a program with concurrent system acquisition, testing and ship construction.
- Changes and configuration management would be critical as EMALS continued development.
- The design for reliability and reliability growth remained to be demonstrated.
- The current high-level Navy and contractor management focus must be sustained and that program leadership was key to the success of EMALS development.
- Navy should implement eight key findings to reduce schedule risk. [Navy did implement all eight key findings.]
- EMALS development should continue.

In accordance with Section 221 of the National Defense Authorization Act for Fiscal Year 2012, EMALS was designated as a major subprogram of the CVN–78 program on August 24, 2012. The revised CVN–78 APB established the EMALS subprogram baseline. Since that time, EMALS cost, schedule and performance status have been reported in all subsequent DAES reports and Selected Acquisition Reports.

AAG was originally an Acquisition Category II program with ASN(RDA) as the Milestone Decision Authority (MDA). AAG development was also monitored as a key aspect of the CVN–78 program in each program review described above. The AAG development and cost issues were recognized well ahead of the Navy formally notifying OSD that the development cost of AAG had crossed the threshold as an MDAP. Once AAG became an MDAP, OSD reviewed options for continued oversight of the program and decided to keep AAG as a separate MDAP rather than making it a sub-program of the already large and complex CVN–78 program. This decision avoided introducing programmatic inefficiencies and maintained formal oversight of AAG.

Secretary STACKLEY. Oversight and decision making for the CVN–78 Class aircraft carrier program reside within the Office of the Secretary of Defense (OSD) and the Navy. Milestone decisions and monthly Defense Acquisition Executive Summary (DAES), Selected Acquisition Reports (SARs), as part of annual budget submissions, and Defense Acquisition Board (DAB) reviews enable OSD to oversee while the Navy manages the CVN–78 Class acquisition. The Navy, with OSD attendance, further manages the CVN–78 Class with quarterly program reviews and annual Navy Gate reviews, which cover program cost, schedule, and performance, as well as periodic Naval Sea Systems Command (NAVSEA) and Naval Air Systems Command (NAVAIR) reviews.

The Navy is responsible to ensure the CVN–78 Class program meets milestone entrance criteria and readiness to proceed into the next acquisition phase of the program. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)), the Milestone Decision Authority (MDA), ensures entrance criteria is met and authorizes entry of the CVN–78 Class program into each phase of the acquisition process. USD(AT&L) and the Navy coordinated the CVN–78 Class strategies and oversight, including acquisition phase content, the timing and scope of decision reviews, and decision thresholds. The CVN–78 Class program initiated at Milestone 0 in March 1996, received Milestone 1 approval in June 2000, and Milestone B approval in April 2004. The CVN–78 Class received USD(AT&L) approval to proceed into CVN–78 Detail Design and Construction (DD&C) in July 2008 and CVN–79 (DD&C) and CVN–80 advance procurement in June 2015. Upon completion of each milestone, the Navy and OSD update the acquisition program baseline.

Development of EMALS has been integral to the overall development of CVN–78. Approval of the CVN–78 Class Milestone B was contingent on award of the EMALS development contract. The CVN–78 Class Milestone B Acquisition Program Baseline included costs for EMALS based on known and projected risks. In 2008 when EMALS development became an issue, USD(AT&L) directed an independent Defense Support Team (DST) to assess the development of EMALS and the program's ability to support the CVN–78 schedule. The Navy expanded the scope of the DST and imposed "Nunn-McCurdy-like" criteria on this assessment due to major increases in EMALS design and procurement costs and schedule delays. In February 2009, the DST recommended that the Navy continue with the development of EMALS for CVN–78 and future carriers and address findings of the DST to reduce schedule risk since no viable alternative to EMALS was available. In June 2009, after full deliberation by the requirements and acquisition chains of command, the Navy decided to continue with EMALS for the CVN–78-class and take actions to address the DST findings. To enhance cost visibility and comply with the fiscal year (FY) 2012 National Defense Authorization Act (NDAA), USD(AT&L) designated EMALS as a major CVN–78 subprogram. Since that time, EMALS cost, schedule and performance status have been reported in all subsequent DAES reports and SARs.

AAG was originally an Acquisition Category (ACAT) II program. Over the past 10 years, the AAG program experienced Research, Development, Test and Evaluation (RDT&E) cost growth, largely associated with the 2002 decision to accelerate AAG from CVN–79 to CVN–78 and the subsequent underestimate of the development required and design changes identified in land-based testing subsequent to the Critical Design Review. System re-design led to schedule delays and further cost increases. The Navy completed an AAG "Nunn-McCurdy-like" focused review in 2011 to reevaluate component redesign, test progress, and projected component delivery relative to shipbuilder need dates. The magnitude of the RDT&E cost increase required to complete system development exceeded the ACAT 1 threshold in 2014. To increase oversight and visibility of AAG progress and issues, rather than making it a sub-program to the CVN–78 program, USD(AT&L) reclassified the AAG program to an ACAT 1C program in July 2015. Subsequent to the reclassification, AAG will submit an initial selected SAR and begin DAES reporting.

8. Senator MCCAIN. It took almost 2 years after breaking the MDAP threshold for AAG to be elevated to the Under Secretary of Defense for Acquisition. When did

you each become aware of the nature and extent of cost growth and schedule delay on AAG, such that it was approaching MDAP status?

Secretary STACKLEY, Admiral MOORE and Admiral GADDIS. In April 2011, two schedule deviations from the 2009 AAG Acquisition Program Baseline (APB) were reported by the Program Manager in a Program Deviation Report (PDR): (1) the threshold for the conclusion of testing at the Jet Car Test Site (JCTS) was breached, and (2) the conclusion of testing at the Runway Arrested Landing Site (RALS) threshold would also be breached. JCTS testing delays were caused by issues experienced during System Development and Demonstration (SDD) hardware integration and commissioning due to hardware non-conformances and test incidents/failures. The Program Manager reported in the same PDR that the potential existed for a cost breach to occur as a direct result of the JCTS and RALS testing delays and was directed to identify measures to be taken to address the testing delays and to offset the cost risks. The magnitude of the cost growth was unknown at that time. Throughout 2012 and 2013, the program continued to experience schedule delays, while also working on cost containment.

Following the Water Twister failure in February 2012, an extensive, seven-month technical re-baseline of the program was completed in November 2013. At that time, estimated expenditures were projected to approach the MDAP level in 2015. With the extent of the recovery actions not immediately understood, the Navy considered multiple courses of action, including deferring scope to a future integrated test and evaluation period. Following completion of the Over Target Baseline/Over Target Schedule process and an updated Estimate At Completion in 2014, ASN(RD&A) concluded on February 27, 2015, that AAG had defaulted to a stand-alone ACAT I program. The ACAT reclassification request followed from the Program Office on March 12, 2015.

9. Senator MCCAIN. Do you believe that AAG should be designated a sub-program—as EMALS was, in order to facilitate better oversight? Please elaborate on your response.

Secretary MCFARLAND. No. USD(AT&L) could have designated AAG as a sub-program of the CVN–78 program when AAG migrated up to the MDAP level, and this was an option considered at the time. It was rejected in favor of keeping the AAG program as a separate MDAP from CVN–78 because combining the two complex programs would have induced programmatic inefficiencies and reduced visibility.

COST GROWTH ON CVN–79

10. Senator MCCAIN. Can you explain why CVN–79 experienced a $3.1 billion increase, a 38 percent growth in the estimated cost, to account for changes in inflation assumptions, when inflation (as measured by the Consumer Price Index) was ~2 percent per year from 2007 to 2014?

Secretary STACKLEY. The CVN–79 *cost estimate* has not increased $3.1 billion because of inflation. The $3.1 billion increase is the portion of the CVN–78 Class follow ship *cost cap* adjustment in the fiscal year (FY) 2014 National Defense Authorization Act (NDAA) due to economic inflation.

The FY 2007 NDAA established the *Gerald R Ford*-class lead and follow ship cost caps and allowable adjustments. The follow ship cost cap, based on the lead ship less nonrecurring design/engineering (NRE) costs, was set at $8.1 billion in fiscal year 2006 dollars; however, this figure did not account for the inflation that would occur between 2006 and the 2013 CVN–79 procurement. The FY 2014 NDAA revised the FY 2007 NDAA cost cap by $3,073 million to account for post-September 2006 economic inflation and changes in the phasing of funding, and by $325 million for NRE, bringing the cost cap total to $11,498 million. Further detail is provided below.

Inflation: Of the $3,073 million economic adjustment to the follow ship cost cap, $2,535 million is associated with the adjustment from the original fiscal year 2006 dollars to fiscal year 2013 dollars (the authorization year for CVN–79) and updates to the annual inflation rates. During the aforementioned timeframe, the inflation rate averaged 3.96 percent per year based on the Navy process for assessing and forecasting shipbuilding inflation. This rate differs from the national average of 2 percent associated with the behavior of the U.S. economy because U.S. naval shipbuilding is a very small and specialized subcomponent of the economy. The nuclear shipbuilding market structure is constrained by the effects of a single or limited source procurement supplier base and limited access to the low-cost foreign sources from which other segments of the U.S. economy benefit. The Navy develops specialized cost escalation indices for shipbuilding programs.

Funding Phase Changes: Of the $3,073 million economic adjustment to the follow ship cost cap, $538 million is associated with changes in how the follow ship funding and outlays are phased as compared to the lead ship at the time the cost cap was established. The changes in the CVN–79 funding profile are a result of shifting the ship from a fiscal year 2012 start and fiscal year 2019 delivery to a fiscal year 2013 start and fiscal year 2024 delivery, which incurred an attendant inflationary impact.

These adjustments created a total economic inflation adjustment of $3,073 million in the follow ship cost cap and are not reflective of a $3.1 billion increase in the cost estimate for CVN–79.

QUESTIONS SUBMITTED BY SENATOR ROGER WICKER

TOOLS NEEDED FOR IMPROVED PERFORMANCE

From my visits to Electric Boat and my recent visit with Senator Kaine to Newport News, I've learned that the *Virginia*-class submarine program is one of the navy's highest performing ship programs.

11. Senator WICKER. What lessons from the *Virginia*-class program can we apply to the USS *John F Kennedy* and follow-on ships in the carrier program? Following on to the cost reduction initiatives and lessons of the *Virginia*-class program, is a multi-ship procurement an efficient cost reduction option for carriers? Please explain.

Secretary STACKLEY. Lessons learned from the *Virginia*-class program and CVN–78, the lead ship of the *Gerald R Ford*-class, are being incorporated into the *John F Kennedy* (CVN–79) construction and subsequent follow-on ships in the aircraft carrier program. The Navy is using a complete and mature design along with a full bill of materials for stable construction. The Navy and shipbuilder have identified critical components, qualified supply vendors, and an optimal material procurement strategy to reduce material cost. A strong specification has been developed with early technical baseline lockdown and the Navy has enacted a rigorous change control process, mitigating costly changes during construction. The Navy is implementing design improvements and design for affordability initiatives to optimize and simplify ship's construction. The Navy and shipbuilder have optimized the CVN–79 build plan, including moving work earlier into fabrication shops in the overall construction to reduce the construction schedule and associated costs. Finally, the Navy is reducing developmental systems and concurrent integration risk as critical technologies mature on CVN–78 to reduce cost, technical, and schedule risk.

Based on *Nimitz*-class procurement experience, two-ship buys have resulted in the least procurement costs and man-hours. For example, procurement of CVN–72 and CVN–73 together reduced the man-hours for these ships to the lowest of any *Nimitz*-class construction. Two-ship buys create major perturbations in the overall Navy shipbuilding account. Therefore, other actions to achieve similar benefits are being pursued by Navy for the CVN–78-class.

The Navy is investigating multi-ship material buys to leverage economic pricing. The Navy and shipbuilders are investigating opportunities to procure parts common to multiple ship programs (e.g. CVN–79, CVN–80, *Virginia*-class submarines, *Ohio* Replacement submarines, *Nimitz*-class Refueling and Complex Overhaul) in a grouped manner to leverage better pricing for all programs.

12. Senator WICKER. What are the lessons learned from the USS *Gerald R. Ford* and other first-in-class ships that could help inform future acquisition reform plans?

Secretary MCFARLAND. In our efforts to keep CVN–79 within the current cost cap, we are working to avoid the first-of-class problems that led to the cost growth on CVN–78. The lessons learned from the CVN–78 experience were tied to these primary factors:

- Concurrency of development and construction. In June 2000, the DOD approved three ship evolutionary path recognized the significant risk of concurrency and sought to limit it by transitioning new technologies over the three ships, CVN–77, CVN–78, and CVN–79. In 2002, DOD leadership directed a transformational leap, inserting all technology developments into the CVN–78 lead ship. This led to a major redesign to accommodate all new technologies in that ship, compressing the technology development period while accepting the high risk of concurrency. The original government cost estimates for major sub-systems including the Electromagnetic Aircraft Launch System (EMALS) and the Advanced Arresting Gear (AAG), and the application of the DDG 1000 developed

Dual Band Radar (DBR), which became a first-of-class installation when it was removed from DDG 1000 as a cost reduction measure, became unachievable as development issues emerged. Cost increases in ship construction mounted as the shipbuilder had to make allowances in the construction sequence to contend with late design products and work-arounds for late delivery of some components.

- Late material deliveries. The original shipbuilder construction cost estimate was based on a design and build schedule predicated on the on-time arrival of both government and shipbuilder-ordered material and technical information to support the design and construction schedule. Late deliveries were also attributed to insufficient vendor capacity and late material procurements.
- Unplanned and unbudgeted work. Changes in the hull structural design to regain service life weight margin resulted in the use of thinner steel plating in many areas more than was used in the *Nimitz*-class hull structure. The shipbuilder required unplanned temporary bracing to complete construction of these structural units.

As we look across lessons learned from other shipbuilding programs, those lessons can be rolled up into the following major elements that should inform future shipbuilding acquisition planning:

- Before the shipbuilding program begins, ensure there is a balance between the program requirements, such as schedule, warfighting capabilities, and threat demands; the technology demands; and the expected cost.
- Use the process of "should cost" versus "will cost" to drive down cost during program execution. Do not assign "cost challenges" to the program managers, expecting them to manage their way out of the challenges from the start.
- Before beginning the detail design and construction phase of the lead ship, ensure that:
  - o All critical technologies were developed into prototypes and then successfully demonstrated in an appropriate environment.
  - o The technical risks are identified and a management plan is in place.
  - o There are no gaps remaining in the design requirements.
  - o The technical information for vendor supplied material needed to support the design is on hand.
  - o The detail design tools are adequate and proven to support the development of the product model.
  - o The shipbuilder fully understands the technical specifications that will guide the design and construction of the ship.
- Before starting construction of the lead ship, ensure that:
  - o The ship design is stable.
  - o The product model is completed to support work package development as the optimized build schedule demands.
  - o The build processes are proven.
  - o The material delivery dates remain supportive of the build plan.

ADVANCED ARRESTING GEAR (AAG)

On the topic of delays associated with the AAG, I share Chairman McCain's overall concerns about the cost and schedule risks associated with concurrency – which is when program testing and evaluation runs concurrently with the beginning of production.

13. Senator WICKER. Is it correct to say that as of right now AAG is on track to support a delivery timeline consistent with Navy expectations?

Admiral GADDIS and Admiral MANAZIR. Navy expectations are that AAG installation will be complete at ship delivery, and that shipboard testing will complete in time to support scheduled flight operations in the fall of 2016. AAG is on track to meet these expectations.

14. Senator WICKER. What steps has the Navy taken thus far to further reduce risk associated with program concurrency?

Admiral GADDIS and Admiral MANAZIR. The Navy established extensive land based test facilities in order to test and qualify AAG software and hardware as a risk-reduction mechanism prior to commencing the shipboard test program. We have retired the majority of our concurrency risks within re-designed hardware that has been tested at the Jet Car Track Site prior to delivery and installation on CVN–78. Those components that were not available prior to installation have been tested and will be incorporated into the hardware installed on the ship via a Field Change

Work Package process. The configuration baseline for CVN–79 incorporates all AAG improvements to date.

15. Senator WICKER. I understand that General Atomics' AAG contract is a firm fixed-price contract.

Can you elaborate on the benefits for the Navy of pursuing firm fixed-price contracts?

Secretary STACKLEY. Firm-fixed-price contracts apply most appropriately where the costs and requirements are well understood, well defined and stable. Well defined and stable requirements allow industry to more accurately understand Department of the Navy (DoN) requirements and produce cost-effective proposals. Performing to a stable plan (stable requirements, designs and budgets) translates into predictable, reliable performance, unit cost reduction, improved material purchasing and workforce planning, retention of skilled labor and the ability for industry to invest in facility improvements resulting in more efficient production and a more affordable program, all of which are beneficial to the DoN. Further, firm-fixed-price contracts are most appropriate when technical, business and economic risks can be reasonably identified with predictable costs included in the price. DoN programs are committed to competition and the basic principles to get the requirements right, perform to a stable plan and make every dollar count, including use of firm-fixed-price contracts where appropriate.