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THE SENATE ARMED SERVICES COMMITTEE

STATEMENT

OF

THE HONORABLE SEAN J. STACKLEY
ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, DEVELOPMENT AND ACQUISITION)

REAR ADMIRAL DONALD E. GADDIS
PROGRAM EXECUTIVE OFFICER, TACTICAL AIRCRAFT
DEPARTMENT OF THE NAVY

REAR ADMIRAL THOMAS J. MOORE
PROGRAM EXECUTIVE OFFICER, AIRCRAFT CARRIERS
DEPARTMENT OF THE NAVY

REAR ADMIRAL MICHAEL C. MANAZIR
DIRECTOR, AIR WARFARE (OPNAV)

BEFORE THE

SENATE ARMED SERVICES COMMITTEE

ON

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

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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.

<u>CVN 78 Design and Engineering</u>

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.

<u>CVN 78 Construction</u>

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 FY 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.