Senator John McCain Presents

INDEFENSIBLE

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CAPSIZING THE DEFENSE BUDGET: $4.7 BILLION WASTED ON COST OVERRUNS FOR THE NAVY'S FIRST TWO NEW FORD-CLASS AIRCRAFT CARRIERS

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 the Arabian 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.

The *USS Gerald R. Ford*, or CVN 78, was supposed to be the first in a class of "transformational" aircraft carriers that would replace and improve upon the Navy's current fleet of *Nimitz*-class carriers. In 2002, the Office of the Secretary of Defense and the Navy decided to use the *Nimitz*-class carrier as a baseline design for CVN 78, but added more than a dozen new advanced features, including an entirely new nuclear reactor plant, a new electrical distribution system, a new and enlarged flight deck, a new electromagnetic catapult system to launch aircraft, and a new Advanced Arresting Gear that could be used to recover aircraft on both the *Nimitz* and *Ford*-class carriers. These transformational technologies were envisioned to generate more aircraft sorties per day, produce more electrical power for supporting ship systems, and allow the ships to be operated with several hundred fewer sailors than the *Nimitz*-class. But the decision to develop concurrently and integrate onto one ship, a host of advanced--and entirely unproven-- technologies all at once, has proven to be the failure of this program.

The *Ford*-class program is currently estimated to be more than $6 billion over budget. On the lead ship CVN 78 alone, costs have grown by $2.4 billion or around 23 percent since procurement of the ship was authorized in 2008, with follow-on carriers projected to see similar increases. Despite the recent announcement of a two-month delay, the first ship is scheduled for delivery next year. The second ship, however, is five years behind schedule. Significant questions still remain about the capability and reliability of the core systems of these aircraft carriers.

The business case for CVN 78 was initially sound, but it has deteriorated in the face of persistent technology immaturity that led to concurrency in system development, construction, and testing; all made worse by cost and schedule estimates that had little margin for error.

Anatomy of an Acquisition Debacle

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.

Case Study: The Advanced Arresting Gear

One of the most egregious examples of acquisition gone awry on the ***Ford****-class is the* ***Advanced Arresting Gear.*** *Now a whopping $1 billion, it's over budget by 600 percent and taking twice as long to develop.* *See p. 9 for the case study with more details.*

What's more, the *Ford*-class program exemplifies the misalignment of accountability and responsibility in our defense acquisition system. Not a single senior official has been held accountable for the failures of this program to date. This is due in no small part to a diffusion of authority across multiple offices and program acquisition managers – blurred lines of accountability that allow the leaders of our defense acquisition system to evade responsibility for results.

Given the level of investment and risk, the Department designated the *Ford*-class carrier program an acquisition category (ACAT) 1D, which means the Under Secretary of Acquisition, Technology, and Logistics (AT&L) is the milestone decision authority to approve program decisions. The Navy can be faulted for excessive optimism and deficient realism, but AT&L was either complacent or complicit. While the Navy and the contractors deserve much of the blame, AT&L was responsible for determining if the program had a sound business case, and for approving the start of development and production. Indeed, AT&L authorized the Navy to start construction of CVN 78 when only 27 percent of the ship was designed and just five of its 13 new systems were mature. Despite ten 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 while congressional oversight has helped to control cost and improve the program, Congress should have intervened more forcefully and demanded more from the Department of Defense.

Program Cost Overruns: Key Factors

When the Department asked Congress to fund the *Ford*-class aircraft carrier program in 2007, it estimated the cost of CVN 78 at $10.5 billion, with delivery expected in 2015. The Department's estimated cost for the next ship in the class – the USS John F. Kennedy, or CVN 79 – was $9.2 billion, with delivery slated for 2019. But the Navy now plans to invest over $43 billion to develop, design, construct, and test its three *Ford*-class carriers. The Navy's fiscal year 2016 budget request estimates the cost of CVN 78 at approximately $12.9 billion, a $2.4 billion or 23 percent increase. Construction of CVN 78, the lead ship, is currently 93 percent complete, with delivery now slated for May 2016.

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. The Navy's fiscal year 2016 budget request estimates the cost of CVN 79 at approximately $11.4 billion—a $2.3 billion, or 25 percent, increase since 2008. And the ship has been delayed five years, to 2024. Construction of CVN 80 has not begun, though the Navy's fiscal year 2016 budget request includes $875 million in advance procurement funding and estimates the cost of CVN 80 at approximately $13.5 billion.

Figure 1: Ford-class Key Budgeting and Funding Decisions

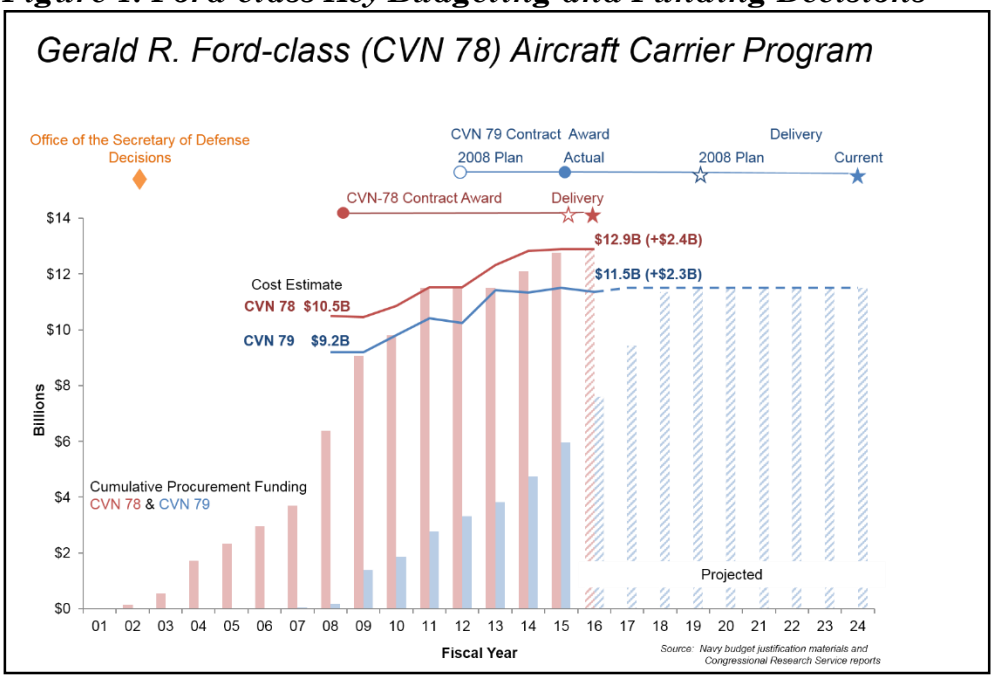
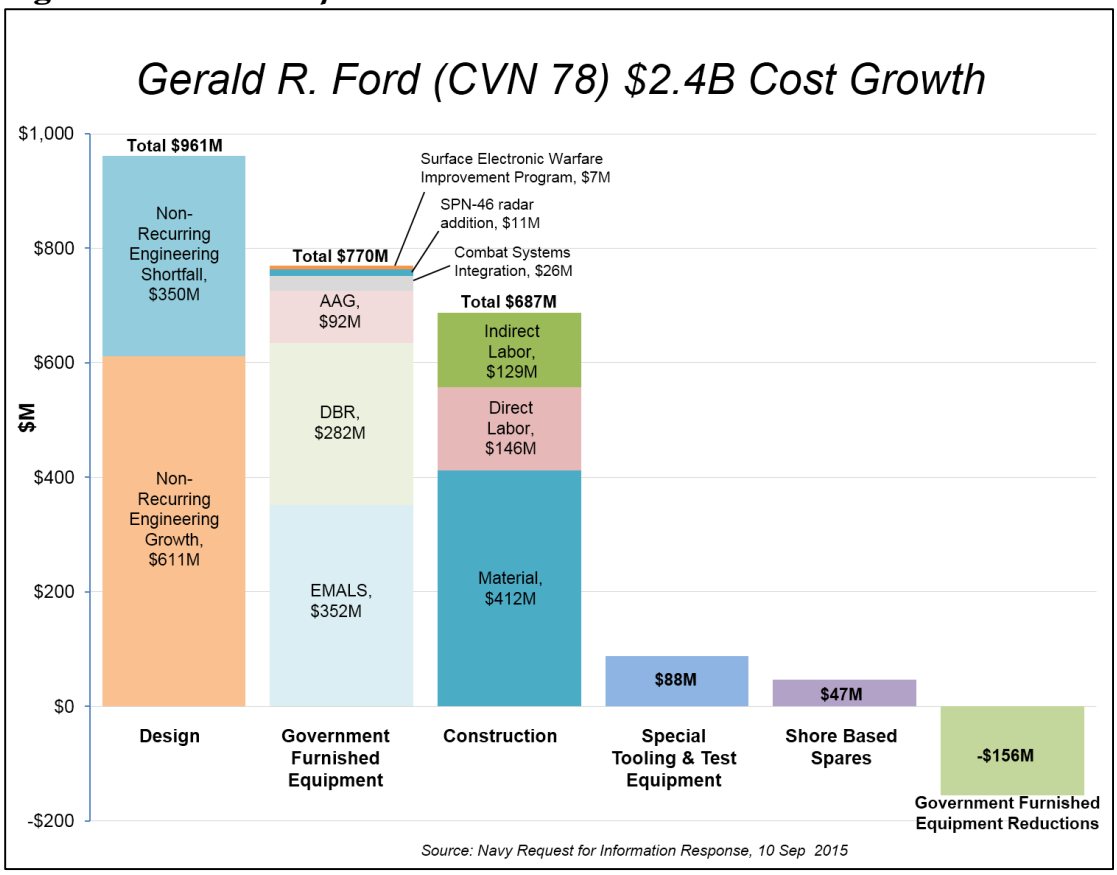


Table 1: Total Ship Estimates, *Ford*-Class Aircraft Carrier Program		
	Fiscal Year 2008 Budget	Fiscal Year 2016 Budget
CVN 78	**$10.5B**	**$12.9B**
$/% increase		+$2.4B / 23%
CVN 79	**$9.2B**	**$11.5B***
$/% increase		+$2.3B / 25%
CVN 80	**$10.7B**	**$13.5B**
$/% increase		+$2.8B / 26%

* The Navy's cost estimate of $11.348B for CVN 79 in the FY16 budget has since been revised to $11.498B.

Much of the cost growth and schedule 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. Indeed, the Navy attributes the cost and labor-hour increases to the immaturity of the ship's technologies and design when the construction contract was awarded. Program officials also cited problems such as late material deliveries, an unexpected need for more structural support to achieve a thinner deck structure, and material deficiencies on developmental components such as valves.[1]

Figure 2: Elements of Cost Growth on CVN 78



On September 22nd, 2015, the Navy announced the delivery of CVN 78 would be delayed by at least 6 to 8 weeks, until May 2016, due to delays in the shipboard test program. While the Navy has said this delay will not result in a new cost overrun on CVN 78, if sea trials reveals unanticipated issues, additional cost growth and schedule delays are likely. Significant questions still remain about the capability and reliability of the core systems of these aircraft carriers. For example, the Advanced Arresting Gear, or AAG, was billed as a more efficient and effective way to recover a wider variety of aircraft on the carrier deck. However, AAG's development costs have increased 600 percent, and it is expected 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 problems 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.

In the fiscal year 2008 budget request, CVN 79 was a fiscal year 2012 start /2019 delivery, the CVN 80 was a fiscal year 2016 start /2023 delivery, and the cost growth on the CVN 78 was not yet realized. As a result, the fiscal year 2008 budget request underestimated the cost to build CVN 78, CVN 79, and CVN 80 as well as the cost to procure developmental systems, such as EMALS and AAG. By the fiscal year 2016 budget request, the CVN 79 schedule had shifted to a fiscal year 2013 start /2024 delivery and the CVN 80 to a fiscal year 2018 start /2027 delivery.

Plans costs are allocated to perform detailed planning, material sourcing, engineering, and program management necessary for construction of each aircraft carrier. This includes the resolution of supplier-based obsolescence issues associated with the long period of time between aircraft carrier builds, and the identification and execution of alternative methods of construction to reduce construction man-hours. All of the CVN 79 plans costs will be executed by Newport News Shipbuilding.[2]

The Navy contends the $78 million change in the CVN 79 plans budget between the fiscal year 2013 and 2016 requests are associated with development and implementation of cost reduction initiatives, effects of schedule changes, and associated revisions to the ship's build sequence and planning products.

Table 2: Plans Cost, *Ford*-Class Aircraft Carrier Program		
		Fiscal Year 2016 Budget
CVN 78	**$2.3B (**FY08 Budget)	**$3.3B**
$/% increase		+$1.0B / 43%
CVN 79	**$802M (**FY13 Budget)	**$880M**
$/% increase		+$78M / 10%

The Navy has attributed 90 percent of CVN 79 cost growth to economic inflation, which is comprised of actual inflation realized to date, and updated projections of future inflation based on Navy shipbuilding inflation indices. The Navy attributes the remaining 10 percent to nonrecurring engineering cost growth, which includes incorporating lessons learned from the first-of-class construction of CVN 78 and other design changes to improve affordability. However, attributing the majority of this growth to economic inflation ignores causes of cost growth rooted in the Department's development and acquisition practices.

Over the past decade, the Government Accountability Office (GAO) and the DOD Director, Operational Test and Evaluation (DOT&E) have identified and reported upon a number of factors that have driven up the costs of the *Ford*-class program.[3] These include:

- *Technology immaturity and design instability*.
- *Poor cost estimating and accounting/surveillance.* GAO has consistently found that costs were likely to exceed budget due to an optimistic cost estimate-especially for ship construction, and that there had been ineffective cost surveillance. The shipbuilder has not consistently produced high quality cost data, and the Navy has not effectively used earned value management data captured in shipbuilder's cost performance reports.[4]
- *Schedule delays, including replans/phasing construction, and descope and deferral of work*. Continuing delays in development of EMALS, DBR, and AAG increased risk to overall construction and delivery schedule.
- *Contracting practices that increase risk to the government*. Increased use of fixed-price contracting requires that technologies be demonstrated early, the design stabilized before construction begins, and realistic estimates for cost and schedule be made.
- *Excessive concurrency between development, design, construction, and testing activities*.
- *Absence of competition in carrier construction*.

Testing and Evaluation

Questions over testing the AAG point to broader questions about testing other new systems in the *Ford*-class that are critical, as well as a Full Ship Shock Trial (FSST) that evaluates the ship's structural strength and survivability of its systems by setting off explosions next to it in the water.

From 2004 to 2011, the Navy planned to conduct FSST on CVN 78 prior to the ship's first deployment. In 2011, the Navy proposed deferring FSST to the next ship, CVN 79, in part to save costs. DOT&E did not support this approach and elevated its significant concerns about the implications: a five to seven year delay in obtaining data critical to evaluating the survivability of CVN 78 and that it would preclude the timely modification of follow-on ships.[5] Following concerns raised by

the DOT&E and Congress, in August 2015, the Office of the Secretary of Defense announced the Department's decision to conduct the Full Ship Shock Trial on CVN 78 prior to the ship's first deployment.[6]

Systems critical to the *Ford*-class aircraft carrier's operations—the Advanced Arresting Gear, Electromagnetic Aircraft Launch System, and the Dual Band Radar— face consistent challenges in demonstrating performance and reliability through testing. It is also unclear how these systems will perform together in realistic conditions, which begs the question of how the Navy plans to test them in preparation for CVN 78's delivery and the subsequent construction of other *Ford*-class carriers. Systems and areas of testing of interest include:

- *Advanced Arresting Gear (AAG).* The AAG's performance and reliability are unknown, following a significant redesign to address reliability problems discovered in earlier testing. In July 2013, AAG reliability was assessed to be approximately 20 Mean Cycles Between Operational Mission Failures (MCBOMF) in the shipboard configuration – meaning that on average the AAG was able to perform 20 launch and recovery cycles of aircraft before failing, which is far below the target of 16,500 MCBOMF.[7] Reliability testing of the new design commenced this past summer, but the testing schedule is aggressive and no new reliability data has been provided to date. The first Aircraft Recovery Bulletin (ARB) – the settings and instructions for the AAG to recover aircraft – required to conduct flight operations is likely to be delayed past the current estimate of June 2016, which is already past the scheduled delivery date of May 2016. The final ARB is scheduled for April 2017, which is shortly before Initial Operational Test & Evaluation (IOT&E) on CVN 78 is scheduled to begin. If the ARBs are delayed, development testing (and discovery of new issues) would delay the CVN 78 IOT&E and could delay the ship's first deployment.[8]

- *Electromagnetic Aircraft Launch System (EMALS).* This launch system – designed to replace the steam catapult used on carriers – has been demonstrated across its performance envelope at a land-based test site. However EMALS has demonstrated low reliability. Last December, the Navy estimated approximately 340 Mean Cycles Between Critical Failure (MCBCF) in the shipboard configuration, well below the target of 4,166 MCBCF.[9] Additionally, EMALS testing in 2014 of F/A-18E/F and EA-18G catapult launches with wing-mounted 480-gallon external fuel tanks attached revealed unanticipated issues that are not scheduled to be corrected until fiscal year 2016. Until corrected, this issue precludes the EMALS launch of aircraft with external fuel tanks.[10]

- *Dual Band Radar (DBR).* Testing of the dual band radar – an array of volume search and multifunction radars, which is the primary air search radar on CVN 78 – has also identified problems with the reliability of the technology and its integration into CVN 78. The radar may not be mature enough to support the

planned Initial Operational Test and Evaluation (IOT&E) and planned CVN 78 deployment. Developmental testing at the Wallops Island test facility is in the early problem discovery phase of testing. Testing this year has identified problems with clutter, losing tracked targets when aircraft are in holding patterns, an inability to pick up outbound targets, and numerous dual tracks, which raise concerns that CVN 78 will not be able to conduct effective air traffic control. The DBR test schedule remains aggressive, however, with testing continuing as part of the combat system ship qualification test scheduled to end after CVN 78 IOT&E begins.[11]

Conclusion

Since the Second World War, the aircraft carrier has been the centerpiece of our Navy's fleet. But the decisions made on the CVN 78 program now threaten to end that legacy.

We simply cannot afford to pay $12.9 billion for a single ship. The combined $4.7 billion in cost growth on these first two ships has already not only eroded the buying power for remaining ships in the *Ford*-class, as it leaves less available for well as other critical military capabilities. In a time of budget constraints in which every defense dollar is precious, this is simply unacceptable. If the costs on CVN 78 cannot be controlled, we must be willing to pursue alternatives, including 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.

The Department must take action to execute a realistic Test and Evaluation plan for CVN 78 that delivers the capability promised to our warfighters. And it must commit to delivering a fully capable CVN 79 within the cost cap, without using funding gimmicks in an attempt to hide the true cost of the program from American taxpayers. It must identify how it plans to fill the gap in aircraft arresting capability on *Nimitz*-class carriers. Finally, the Department must study alternatives to the aircraft carrier to ensure we are getting the best capability while most effectively allocating our scarce resources.

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[1] GAO-12-400SP Assessments of Selected Weapon Programs, March 2012.
[2] Navy RFI response to SASC, March 2015.
[3] See a complete listing of relevant GAO and DOT&E reports at the end of this report.
[4] GAO-07-866 Defense Acquisitions: Navy Faces Challenges Constructing the Aircraft Carrier *Gerald R. Ford* within Budget. P. 26. Washington, D.C. August 2007. Also GAO-07-943T. Earned value management is a tool that provides the government and contractors with insight into technical, cost, and schedule progress on their contracts.
[5] The Office of the Director, Operational Test and Evaluation, Department of Defense, *FY 2013 Annual Report*, January 2014, accessed at http://www.dote.osd.mil/pub/reports/Fiscal Year2013/pdf/other/2013DOTEAnnualReport.pdf.
[6] Memorandum from Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) Frank Kendall to Navy Secretary Ray Mabus, 07 August 2015.
[7] See Glossary.
[8] Prepared testimony of J. Michael Gilmore, Director of Operational & Test Evaluation, before the Senate Armed Services Committee on 01 October 2015.
[9] Ibid.
[10] This information comes from a meeting between Senate Armed Services Committee (SASC) staff and carrier program officials, September 22, 2015.
[11] Prepared testimony of J. Michael Gilmore, Director of Operational & Test Evaluation, before the Senate Armed Services Committee on 01 October 2015.

Case Study: The Advanced Arresting Gear

Among more than a dozen new technologies intended to improve carrier performance, one of the most troubling examples of development cost growth is the Advanced Arresting Gear (AAG) —the system that allows various aircraft to land on the ship. AAG is critical for increasing the carrier's sortie generation rates and reducing manpower, enabling a less physically stressful and more versatile approach for landing aircraft. The *Nimitz*-class's MK-7 arresting gear uses a mechanical hydraulic engine to reel out the cable that aircraft catch as they land on the deck and uses tension to slow aircraft to a halt. The AAG on the *Ford*-class improves braking by using water twisters paired with a large electric motor controlled by software. Unlike the MK-7, the AAG would entail fewer maintenance, reliability, and safety questions because it does not use hydraulic fluid, and would be easier to control and reset via the electric engine, thus allowing a variety of aircraft to land on the *Ford*-class. The primary contractor on AAG is General Atomics.

Development costs on the AAG have more than *quadrupled* and time to develop the system has more than *doubled*. To date, the system has been tested using only dead loads, rather than aircraft. [1] Table 3 below provides a comparison of initial plans for the AAG and its current status.

Table 1: Initial Plans for AAG vs. Current Status

	Initial Plan/Estimate	**Current Status 2015**
Program Acquisition category (ACAT)[2]	ACAT II (non-major program)[3]	ACAT II – despite that it exceeded lower threshold for becoming an ACAT I (major program) in 2013.
Development Cost	$143 million	$1 billion
Procurement Cost	$75 million	$167 million
Configuration /quantity[4]	3 wire - 4 engine pairs	3 wire - 3 engine pairs
Time to develop	6 years	15 years
Technology Maturity[5]	Level 5[6]	Level 6[7]
Development Approach[8]	Development, testing, production, and installation to occur in sequential fashion prior to ship delivery	Development concurrent with testing, production, and installation/upgrade, some occurring after ship delivery
Expected Capability[9]	All *Ford*-class carriers 8 back-fitted *Nimitz*-class carriers	Only *Ford*-class carriers

[1] See Glossary for definition of dead load testing.
[2] See Glossary for definition of Acquisition Category.
[3] ACAT II programs have an estimated total cost of more than $185 million for RDT&E or more than $835 million for procurement in fiscal year 2014 constant dollars.
[4] GAO-15-22 *Ford*-Class Aircraft Carrier: Congress Should Consider Revising Cost Cap Legislation to Include All Construction Costs.
[5] See Glossary for definitions of these terms.
[6] GAO-13-396 *Ford*-Class Carriers: Lead Ship Testing and Reliability Shortfalls Will Limit Initial Fleet Capabilities. P. 14. Washington, D.C. September 2013.
[7] NAVAIR response to SASC April 29 2015 request for information on TRL.
President's Budget J-books for Fiscal Year 2004 – Fiscal Year 2016 comparison of R-4 Schedule profiles and also GAO annual assessments of *Ford*-class 2005-2015.
[9] GAO-07-866 Defense Acquisitions: Navy Faces Challenges Constructing the Aircraft Carrier *Gerald R. Ford* within Budget. P. 26. Washington, D.C. August 2007.

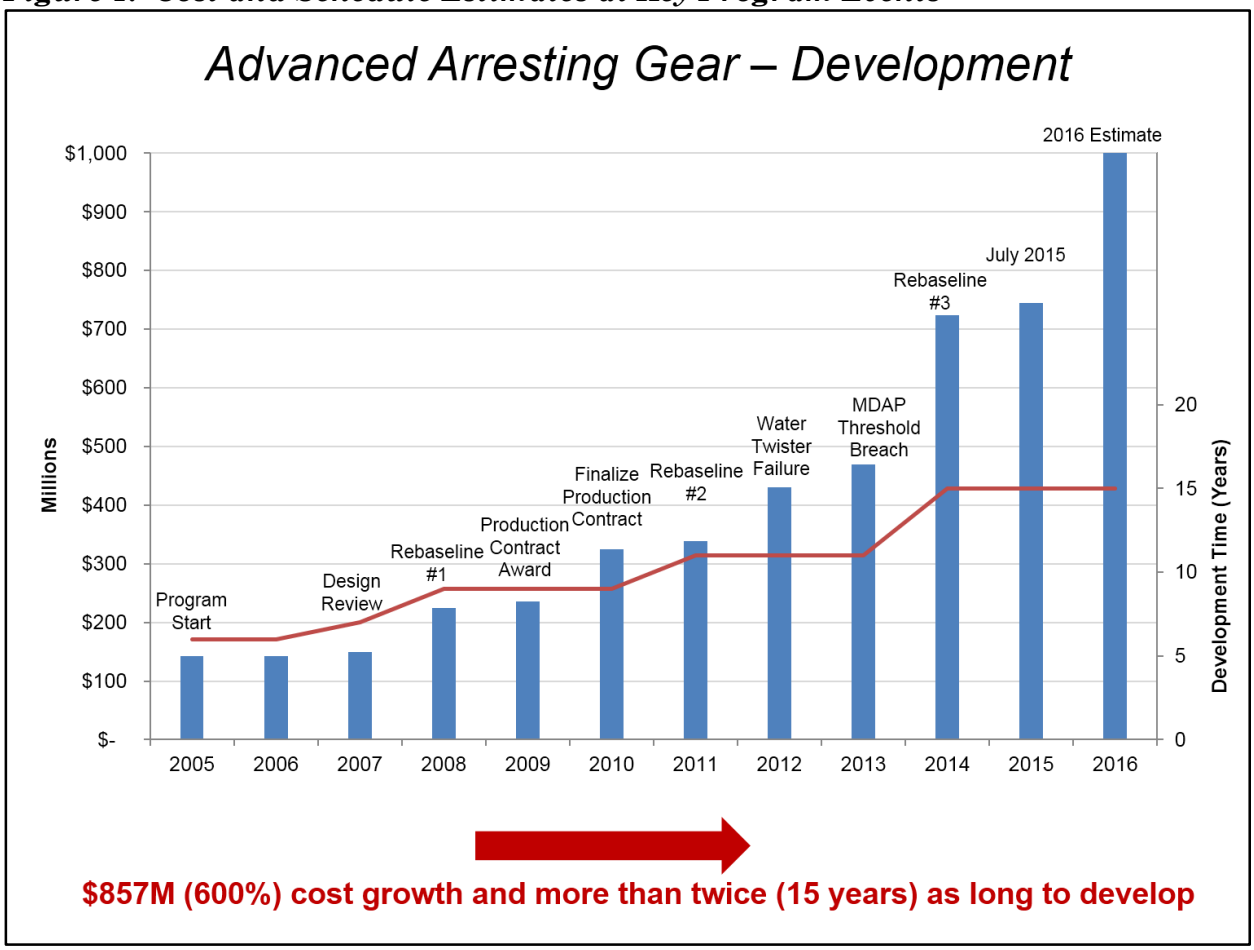
Case Study: The Advanced Arresting Gear

NAVAIR's[10] delays developing AAG have critically restricted the Navy's previous plan to demonstrate that AAG could reliably land all variants of aircraft ahead of deploying CVN 78. NAVAIR has already installed AAG on the CVN 78, and will have to modify it again after completing development of AAG.

Cost Growth and Schedule Delay

The cost to develop AAG has increased 420 percent, or more than 6 times the original cost, from $143 million at Milestone B in 2005 to $1 billion.[11] Cost to procure AAG was estimated at $75 million in February 2007, and has since grown to $167 million, an increase of 123 percent, or more than double the original.[12] At Milestone B in 2005 the development of AAG was estimated to take 6 years; now it will be 15 years, more than twice the amount of time.[13]

Figure 1: Cost and Schedule Estimates at Key Program Events



[10] NAVAIR is the Naval Air Systems Command, which provides lifecycle support of naval aviation aircraft, weapons and systems, including research, development, and acquisition.

[11] President's Budget J-books for Fiscal Year 2006 (year of Milestone B/program start) and meeting with Navy officials September 22, 2015. Figures are in then-year dollars.

[12] President's Budget J-books for Fiscal Year 2008 (year CVN 78 authorized) and Fiscal Year 2016. Figures are in then-year dollars.

[13] President's Budget J-books for Fiscal Year 2004 – Fiscal Year 2016 comparison of R-4 Schedule profiles and also GAO annual assessments of *Ford*-class 2005-2015.

Case Study: The Advanced Arresting Gear

Program Management and Contract Oversight

NAVAIR and contractor General Atomics have not been able to ensure development of AAG is timely or cost-effective. The AAG development contract with General Atomics is a cost-plus-fees type of contract. No incentive fee has been paid to the contractor since 2008, and the contractor has forfeited the opportunity to earn additional fee. The program has been re-baselined 3 times due to poor system development/redesign, cost and schedule overruns. The Defense Contract Management Agency (DCMA) and Defense Contract Audit Agency (DCAA) have documented a pattern of problems with contractor performance on the AAG.[14]

DOD originally designated AAG as an ACAT II, or 'non-major' program, however development cost growth led it to breach the lower threshold for ACAT I/MDAP in November 2013.[15] It has taken almost 2 years for the Navy to report this up to the Under Secretary of Defense for Acquisition, Technology, and Logistics, who just designated AAG as a MDAP in July 2015. Redesignation requires the Navy to prepare a new program baseline this Fall, to include a full accounting of cost growth an updated cost estimate that will allow an enhanced level of oversight on cost and schedule going forward.[16]

Technology Development

Contrary to reflecting a best practice of starting program development with mature technologies, in 2005 when it began development, AAG's critical technologies were quite immature. AAG is only now approaching maturity that it should have had when the Navy made a commitment to developing it for the carrier. Despite these issues, carrier program leadership chose to buy the AAG shipset for CVN 78 in 2009, and began installing it in 2012 in an effort to maintain the construction schedule that supported ship delivery in 2014. In 2012, testing revealed problems with the water twister, which set the program back, requiring many engineering changes, and has further disrupted production of the AAG, testing to demonstrate its performance, as well as construction of the ship.

> Water Twister. The AAG's water twister was adapted from a technology that is already fielded, operational on expeditionary airfields and is manufactured by ESCO.
> Key aspects of the water twister design for AAG relative to the expeditionary airfield operational configuration[17]. For example, the AAG water twister design configuration is vertical, while the expeditionary airfield configuration is horizontal. Also, the length of an aircraft carrier flight deck is different from an expeditionary airfield runway overrun. In 2012, the water twister failed in testing. ESCO had been a subcontractor to General Atomics under the AAG development contract, responsible for delivering the water twister.
> Finally, because NAVAIR was executing a concurrent develop, test, and production strategy for AAG, General Atomics had already produced the water twisters for the whole carrier program.

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[14] In executing its contract administration responsibilities for the Navy's AAG and EMALs contracts with GA, DCMA is issuing contract modifications, performing production and engineering surveillance, ensuring compliance with contract requirements and produces monthly Program Assessment Reports. Both DCMA and DCAA assess and report on the adequacy of contractors' business systems (accounting, estimating, purchasing, material, and earned value management). There are more than 20 DCMA and DCAA reports with findings in these areas.

[15] GAO-15-188. Defense Acquisitions: Better Approach Needed to Account for Number, Cost, and Performance of Non-Major Programs. P. 25-26. Washington, D.C. March 2015.

[16] MDAP/ACAT I programs, require more documentation and analysis to support program decisions and have to regularly report to Congress on their cost, schedule, and technical performance as compared to program baselines established at the beginning.

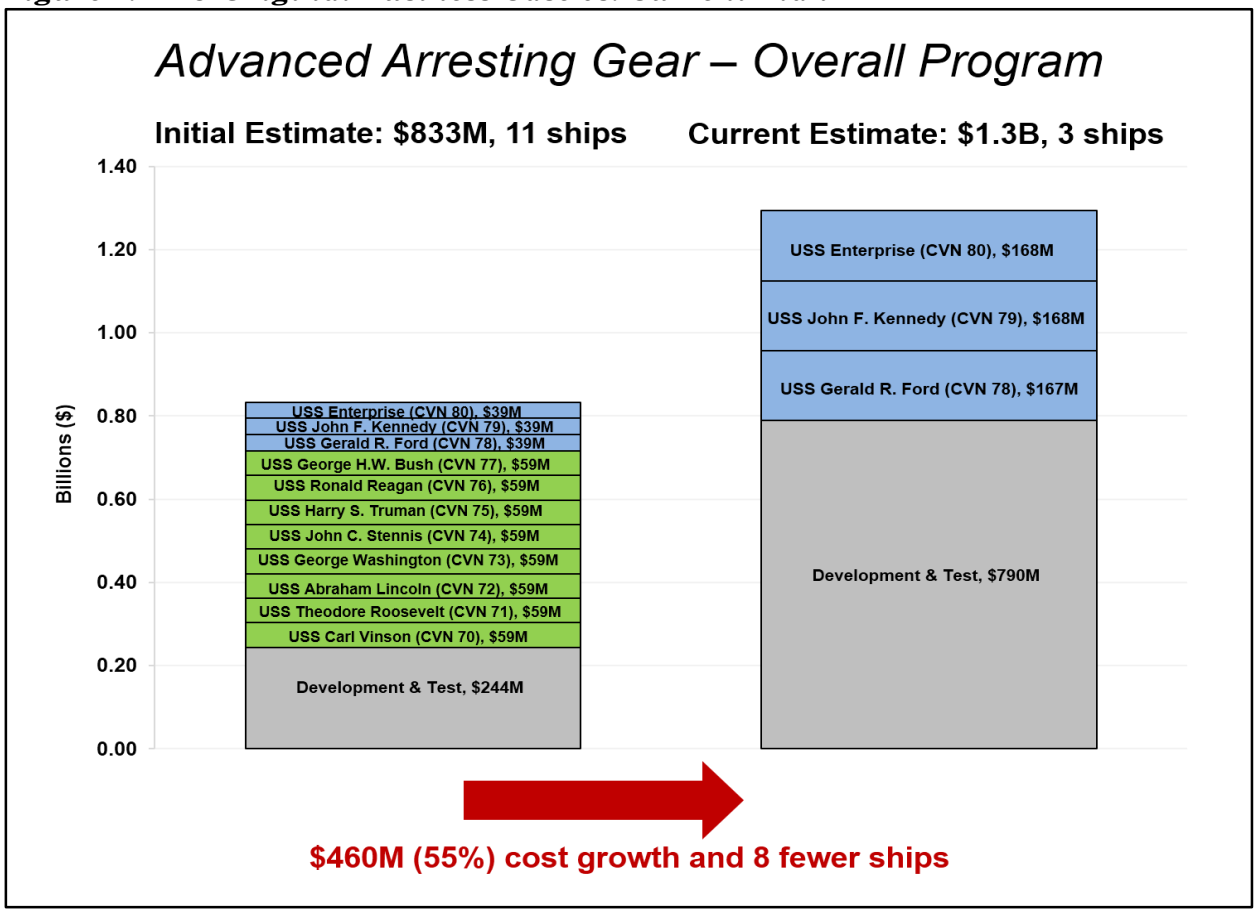
[17] Compare NAVAIR AAG design which shows a vertical configuration, with operational ESCO water twister in Brochure, P. 4 which shows horizontal configuration.

Software Control System. The software control system has not yet been completed for all variety of aircraft, or fully tested. The Navy's decision to move from a 4-wire to 3-wire configuration for AAG requires some software redesign, however NAVAIR has not yet asked the contractor to scope or complete the associated redesign work.[18]

Concurrency of Development, Test, Production, and Installation
NAVAIR is almost 5 years behind in completing land-based testing for AAG; currently the most critical risk to the CVN 78 schedule. The start of land-based testing was delayed, now it overlaps shipboard testing, and won't be complete until 2017, a year after ship delivery. Inability to complete testing prior to installing AAG on the ship has resulted in inefficient construction in the yard at increased cost. The latest schedule plans for runway tests to finish the very same day as ship delivery, which seems ambitious given the delays the program has suffered to date.

Carrier Fleet Arresting Capability
Development delays have critically restricted the Navy's original plan to demonstrate that AAG could reliably land all variants of aircraft ahead of deploying CVN 78. AAG has already been installed on the CVN 78; NAVAIR has already and will again have to modify after AAG development is complete. eanwhile the operational requirement to address aging arresting capability on *Nimitz*-class has not been addressed and will incur additional cost beyond what is budgeted today.

Figure 2: AAG Original Business Case vs. Current Plan



[18] Discussion with NAVAIR and contractor officials, July 2015.

Glossary

Acquisition Category (ACAT): DOD classifies acquisition programs into categories based on the value and type of acquisition. ACAT I programs have an estimated total acquisition cost of more than $480 million for research, development, test, and evaluation (RDT&E) or more than $2.79 billion for procurement in fiscal year 2014 constant dollars. The level of oversight for acquisition programs varies based on the assigned ACAT level. DOD and component acquisition policies specify the organizational level of the milestone decision authority—the designated individual with overall responsibility for a program—for each ACAT level. DOD can also designate programs to higher ACAT levels based on special interest. All acquisition programs are required by statute or DOD guidance to provide program information at milestones and other decision points, although these requirements differ by ACAT level.

Advanced Arresting Gear (AAG): A new system for the recovery of the aircraft that uses water turbines and an electric motor to reel out a wire under tension that slows landing aircraft to a halt when they catch the wire on landing. The primary contractor for this system is General Atomics.

Aircraft Recovery Bulletin (ARB): The instructions and procedure for a recovery system to recover different kinds of aircraft.

CVN: A nuclear-powered aircraft carrier. The primary contractor for the *Ford*-class CVN is Huntington Ingalls Industries.

Dead Load Test: Large, wheeled, steel vessels weighing up to 80,000 pounds ("dead loads") to simulate the weight of actual aircraft are launched from each catapult using a specific test sequence to verify that the catapult and its components are operating satisfactorily.

Dual Band Radar (DBR): A new radar system that can operate two different frequency ranges at the same time (S-band and X-band). The S-band allows the accurate resolving and tracking of targets, while the X-band allows for discrimination between low-altitude targets. The primary contractor for this system is Raytheon.

Director of Operational Test & Evaluation (DOT&E): The principal adviser to the Secretary of Defense on operational and live fire test and evaluation involving weapons systems.

Electromagnetic Aircraft Launch System (EMALS): A new electromagnetically powered system designed for the *Ford*-class which launches aircraft. The primary contractor for this system is General Atomics.

Full Ship Shock Trial (FSST): A culminating test of a ship in which explosive charges are set off near an operational ship, and system and component failures are documented.

Government Furnished Equipment: Equipment that is owned by the government and delivered to, or made available to a contractor. This is compared with contractor furnished equipment or CFE. A determination of whether equipment is GFE or CFE is usually made by the government Program Manager and Contracting Officer and normally specified in a Request for Proposal or contract.

Initial Operational Test & Evaluation (IOT&E): The final dedicated phase of operational test and evaluation prior to a full-rate production decision on a system. Essentially, this test is the final chance to assess a system.

Mean Cycles Between Critical Failures (MCBCFs): The average time measured in aircraft recovery cycles before a critical failure, in which a piece of equipment can no longer perform a required function.

Mean Cycles Between Operational Mission Failures (MCBOMF): The average time measured in aircraft recovery cycles before an operational mission failure, in which any incident or malfunction of the system that causes or could cause the inability to perform one or more mission-essential functions.

Post-Shakedown Availability (PSA): An availability assigned to newly built, activated or converted ships upon completion of a shakedown cruise. The PSA will normally be of 1 1/2 - 4 months duration and will be completed no later than the end of the eleventh month after completion of fitting out at which time Ship Construction, Navy (SCN) funding and work authority terminates. Work performed shall be limited to correcting defects noted during the shakedown cruise and those remaining from Acceptance Trials.

Technology Readiness Level: Technology maturity is indicated by the Technology Readiness Level. The National Aeronautics and Space Administration originally developed TRLs to determine when technologies are ready to be handed off from science and technology managers to product developers. TRLs are measured on a scale from 1 to 9, beginning with paper studies of a technology's feasibility and culminating with a technology fully integrated into a completed product. GAO's best-practices work has shown that a TRL 7—demonstration of a technology in an operational environment—is the level of technology maturity that constitutes a low risk for starting a product development program.

Water Twister: Energy-absorbing water brakes that convert kinetic energy to heat through fluid turbulence. They operate automatically during aircraft arrestment and adjust automatically to accommodate aircraft of varying weights, engaging speeds, and off-center arrestments within the specified performance limits of the system.

A Decade of Oversight Reports on the *Ford*-Class Aircraft Carrier

U.S. Government Accountability Office

GAO-15-22 *Ford*-Class Aircraft Carrier – Congress Should Consider Revising Cost Cap Legislation to Include All Construction Costs

GAO-14-122 Navy Shipbuilding – Opportunities Exist to Improve Practices Affecting Quality

GAO-13-396 *Ford*-Class Carriers – Lead Ship Testing and Reliability Shortfalls Will Limit Initial Fleet Capabilities

GAO-09-322 High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding

GAO-08-1061T *Zumwalt*-Class Destroyer Program Emblematic of Challenges Facing Navy Shipbuilding (House Subcommittee on Seapower and Expeditionary Forces)

GAO-07-866 Defense Acquisitions – Navy Faces Challenges Constructing the Aircraft Carrier *Gerald R. Ford* Within Budget

GAO-07-943T Realistic Business Cases Needed to Execute Navy Shipbuilding Programs (House Subcommittee on Seapower and Expeditionary Forces)

GAO-06-587T Challenges Associated with the Navy's Long-Range Shipbuilding Plan (House Subcommittee on Projection Forces)

GAO-05-183 Improved Management Practices Could Help Minimize Cost Growth in Navy Shipbuilding Programs

GAO Annual Assessments of *Gerald R. Ford* Class Nuclear Aircraft Carrier 2005-2015 (GAO-15-342SP, GAO-14-340SP, GAO-13-294SP, GAO-12-400SP, GAO-11-233SP, GAO-10-388SP, GAO-09-326SP, GAO-08-467SP, GAO-07-406SP, GAO-06-391 and GAO-05-301)

DOD Offices of the Director, Developmental Test & Evaluation and Director, Operational Test & Evaluation

DOT&E Annual Reports for Fiscal Years 2005-2014

DT&E Annual Report for Fiscal Years 2005-2014

Sources and Methodology

For each of the three aspects of our inquiry, we compared documentation of initial plans and estimates with documentation of current plans and estimates (listed below) to identify changes in cost, schedule, and expected performance/capability. We then reviewed our observations with officials from the relevant offices (listed below) to confirm our understanding. An *asterisk indicates sources that are marked For Official Use Only and/or Procurement Sensitive

<u>Program Cost Overruns: Key Factors</u>

- President's budget requests for fiscal years 2004-2016, Shipbuilding and Construction
- **Ford*-class program and acquisition decision memoranda
- *Ford*-class Selected Acquisition Reports (SAR) and Acquisition Program Baselines (APB)
- **Ford*-class program briefings
- **Ford*-class cost estimates
- *Ford*-class Reports to Congress
- Meetings with officials and responses to requests for information from:
    - Office of the Secretary of Defense for Acquisition, Technology, and Logistics
    - Office of the Director, Operational Test and Evaluation
    - Navy Sea Systems Command
    - Huntington Ingalls Industries
- Congressional Research Service reports on *Ford*-class (Ronald J. O'Rourke)
- GAO reports on Navy shipbuilding—20 issued over the past decade from 2005-2015
- DDT&E and DOT&E annual reports 2005-2015

<u>Testing and Evaluation</u>

- Test and Evaluation Master Plans
- DOT&E annual reports 2005-2014
- Memorandum from Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) Frank Kendall to Navy Secretary Ray Mabus, 07 August 2015
- Meetings with officials and responses to requests for information from:
    - Navy Sea Systems Command, Navy Air Systems Command
    - Office of the Director, Operational Test and Evaluation
- Prepared testimony of J. Michael Gilmore, Director of Operational & Test Evaluation, before the Senate Armed Services Committee on 01 October 2015.

<u>Case Study: The Advanced Arresting Gear</u>

- President's Budget J-books for Fiscal Year 2004 – Fiscal Year 2016 Research, Development, Test and Evaluation year-by-year comparison of R-3 and R-4 Schedule profiles
- Meetings with officials and responses to requests for information from:
    - Navy Sea Systems Command, Navy Air Systems Command
    - Navy Supervisor of Shipbuilding

    - Defense Contract Management Agency (DCMA)
    - Defense Contract Audit Agency (DCAA)
    - General Atomics
- *Acquisition strategies and plans 2004, 2009, 2014
- *Program and Acquisition Decision Memoranda
- *Technology Readiness Assessment (2004) and Updates (2009, 2011)
- Acquisition program baselines
- *Fiscal Year 2016 Program briefings
- *Development and procurement contract documentation to include – source selection memoranda, contract, statements of work, obligations, and modifications
- *Monthly development Contract Performance Reports (CPR) 2004-2015
- *Contractor Performance Assessment Reports (CPAR) of General Atomics
- *Monthly DCMA Program Assessment Reports (PAR) 2011-2015
- *DCAA audit reports on General Atomics (2008, 2010, 2012, 2013, 2014, and 2015)
- *Naval Audit Service reports (2009, 2012)