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Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress

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Summary

The Navy has been procuring Arleigh Burke (DDG-51) class Aegis destroyers since FY1985. The two DDG-51 class ships requested for procurement in FY2016 are to be the 73rd and 74th ships in the class. The 10 DDG-51s programmed for procurement in FY2013-FY2017 (in annual quantities of 3-1-2-2-2) are being procured under a multiyear-procurement (MYP) contract. The second of the two ships requested for FY2016 is to be the first of a new DDG-51 design variation called the Flight III design, which is to incorporate a new and more capable radar called the Air and Missile Defense Radar (AMDR).

The Navy estimates the combined procurement cost of the two DDG-51s requested for procurement in FY2016 at $3,522.7 million. A comparison with the cost of the two DDG-51s procured in FY2015 suggests that, within the estimated combined cost of $3,522.7 million for the two FY2016 DDG-51s, the Flight III DDG-51 might account for, very roughly, $2 billion, while the other DDG-51 might account for, very roughly, $1.5 billion. The potential difference of, very roughly, $500 million in cost between the two ships includes one-time design and change-order costs for modifying the DDG-51 design to the Flight III configuration, additional costs for the AMDR radar and associated electrical power and cooling equipment, and some loss of shipyard production learning curve benefits due to the change in the ship's design.

The two DDG-51s requested for procurement in FY2016 have received a total of $373.0 million in prior-year advance procurement (AP) funding. The Navy's proposed FY2016 budget requests the remaining $3,149.7 million needed to complete the ships' estimated combined procurement cost. The Navy's proposed FY2016 budget also requests $75.0 million in so-called cost-to-complete procurement funding to replace funding for DDG-51s procured in FY2010-FY2012 that was canceled by the March 1, 2013, sequester. The Navy's proposed FY2016 budget also requests $433.4 million in procurement funding to complete construction of Zumwalt (DDG-1000) class destroyers procured in prior years, and $241.8 million in research and development funding for development work on the AMDR.

Potential FY2016 issues for Congress concerning destroyer procurement include the following:

- the potential impact on the DDG-51 program of an extended or full-year continuing resolution (CR) for FY2016;
- September 2015 press statement indicating that the Department of Defense (DOD) is considering whether to propose canceling the construction of third DDG-1000 class ship (i.e., DDG-1002);
- the readiness of the Flight III design for procurement in FY2016;
- cost, schedule, and technical risk in the Flight III DDG-51 program;
- whether the Flight III DDG-51 design would have sufficient growth margin for a projected 35- or 40-year service life;
- issues raised in a January 2015 report from DOD's Director of Operational Testing and Evaluation (DOT&E);
- whether the Flight III DDG-51 would have sufficient air and missile capability to adequately perform future air and missile defense missions; and
- the lack of an announced Navy roadmap for accomplishing three things in the cruiser-destroyer force: restoring ship growth margins; introducing large numbers of ships with integrated electric drive systems or other technologies that could provide ample electrical power for supporting future electrically powered weapons (such as high-power solid state lasers); and introducing technologies

(such as those for substantially reducing ship crew size) for substantially reducing ship operating and support (O&S) costs.

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Introduction

This report presents background information and potential oversight issues for Congress on the Navy's Arleigh Burke (DDG-51) and Zumwalt (DDG-1000) class destroyer programs. The Navy's proposed FY2016 budget requests funding for the procurement of two DDG-51s, including the first of a new DDG-51 design variant called the Flight III design, which is to carry a new and more capable radar called the Air and Missile Defense Radar (AMDR). Decisions that Congress makes concerning destroyer procurement could substantially affect Navy capabilities and funding requirements, and the U.S. shipbuilding industrial base.

Background

Strategic and Budgetary Context

For an overview of the strategic and budgetary context in which this and other Navy shipbuilding programs may be considered, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

DDG-51 Program

General

The DDG-51 program was initiated in the late 1970s.[1] The DDG-51 (**Figure 1**) is a multi-mission destroyer with an emphasis on air defense (which the Navy refers to as anti-air warfare, or AAW) and blue-water (mid-ocean) operations. DDG-51s, like the Navy's 22 Ticonderoga (CG-47) class cruisers,[2] are equipped with the Aegis combat system, an integrated ship combat system named for the mythological shield that defended Zeus. CG-47s and DDG-51s consequently are often referred to as Aegis cruisers and Aegis destroyers, respectively, or collectively as Aegis ships. The Aegis system has been updated several times over the years. Existing DDG-51s (and also some CG-47s) are being modified to receive an additional capability for ballistic missile defense (BMD) operations.[3]

The first DDG-51 was procured in FY1985. A total of 72 have been procured through FY2015, including 62 in FY1985-FY2005 and 10 in FY2010-2016.[4] During the period FY2006-FY2009, the Navy procured three Zumwalt (DDG-1000) class destroyers (see discussion below) rather

[1] The program was initiated with the aim of developing a surface combatant to replace older destroyers and cruisers that were projected to retire in the 1990s. The DDG-51 was conceived as an affordable complement to the Navy's Ticonderoga (CG-47) class Aegis cruisers.

[2] A total of 27 CG-47s were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five, which were built to an earlier technical standard, were judged by the Navy to be too expensive to modernize and were removed from service in 2004-2005.

[3] The modification for BMD operations includes, among other things, the addition of a new software program for the Aegis combat system and the arming of the ship with the SM-3, a version of the Navy's Standard Missile that is designed for BMD operations. For more on Navy BMD programs, CRS Report RL33745, *Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress*, by Ronald O'Rourke.

[4] The ten DDG-51s procured in FY2010-FY2015 include one in FY2010, two in FY2011, one in FY2012, three in FY2013, one in FY2014, and two in FY2015.

than DDG-51s.[5] The first DDG-51 entered service in 1991, and a total of 62 were in service as of the end of FY2014. DDG-51s are built by General Dynamics Bath Iron Works (GD/BIW) of Bath, ME, and Ingalls Shipbuilding of Pascagoula, MS, a division of Huntington Ingalls Industries (HII).

Figure 1. DDG-51 Class Destroyer

Source: Navy file photograph accessed October 18, 2012, at http://www.navy.mil/view_image.asp?id=134605.

[5] The Navy had planned to end DDG-51 procurement permanently in FY2005 and procure Zumwalt (DDG-1000) class destroyers thereafter. In July 2008, however, the Navy announced that it had changed its mind—that it wanted to halt procurement of DDG-1000s and resume procuring DDG-51s. The Navy announced this change in its plans at a July 31, 2008, hearing before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee. In explaining their proposed change in plans, Navy officials cited a reassessment of threats that Navy forces are likely to face in coming years. As a result of this reassessment, Navy officials stated, the service decided that destroyer procurement over the next several years should emphasize three mission capabilities—area-defense AAW, BMD, and open-ocean ASW. Navy officials also stated that they want to maximize the number of destroyers that can be procured over the next several years within budget constraints. Navy officials stated that DDG-51s can provide the area-defense AAW, BMD, and open-ocean ASW capabilities that the Navy wants to emphasize, and that while the DDG-1000 design could also be configured to provide these capabilities, the Navy could procure more DDG-51s than reconfigured DDG-1000s over the next several years for the same total amount of funding. In addition, the Navy by 2008-2009 no longer appeared committed to the idea of reusing the DDG-1000 hull as the basis for the Navy's planned CG(X) cruiser. If the Navy had remained committed to that idea, it might have served as a reason for continuing DDG-1000 procurement.

The Navy's FY2010 budget, submitted in May 2009, reflected the Navy's July 2008 change in plans: the budget proposed truncating DDG-1000 procurement to the three ships that had been procured in FY2007 and FY2009, and resuming procurement of Flight IIA DDG-51s. Congress, as part of its action on the FY2010 defense budget, supported the proposal: The FY2010 budget funded the procurement of one DDG-51, provided advance procurement funding for two DDG-51s the Navy wants to procure in FY2011, completed the procurement funding for the third DDG-1000 (which was authorized but only partially funded in FY2009), and provided no funding for procuring additional DDG-1000s.

The DDG-51 design has been modified over time. The first 28 DDG-51s (i.e., DDGs 51 through 78) are called Flight I/II DDG-51s. Subsequent ships in the class (i.e., DDGs 79 and higher) are referred to as Flight IIA DDG-51s. The Flight IIA design, first procured in FY1994, implemented a significant design change that included, among other things, the addition of a helicopter hangar. The Flight IIA design has a full load displacement of about 9,500 tons, which is similar to that of the CG-47.

The Navy is implementing a program for modernizing all DDG-51s (and CG-47s) so as to maintain their mission and cost effectiveness out to the end of their projected service lives.[6] Older CRS reports provide additional historical and background information on the DDG-51 program.[7]

Procurement of First Flight III DDG-51 Planned for FY2016

The Navy wants to begin procuring a new version of the DDG-51 design, called the Flight III design, starting with the second of the two ships scheduled for procurement in FY2016. The Flight III design is to feature a new and more capable radar called the Air and Missile Defense Radar (AMDR). The version of the AMDR to be carried by the Flight III DDG-51 is smaller and less powerful than the version that was envisaged for a cruiser called the CG(X) that the Navy at one point was planning to procure, but subsequently canceled.[8] The Flight III DDG-51's AMDR is to have a diameter of 14 feet, while the AMDR envisaged for the CG(X) would have had a substantially larger diameter.[9]

[6] For more on this program, see CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

[7] See CRS Report 94-343, *Navy DDG-51 Destroyer Procurement Rate: Issues and Options for Congress*, by Ronald O'Rourke (April 25, 1994; out of print and available directly from the author), and CRS Report 80-205, *The Navy's Proposed Arleigh Burke (DDG-51) Class Guided Missile Destroyer Program: A Comparison With An Equal-Cost Force Of Ticonderoga (CG-47) Class Guided Missile Destroyers*, by Ronald O'Rourke (November 21, 1984; out of print and available directly from the author).

[8] The Navy's FY2011 budget, submitted in February 2010, proposed terminating a planned cruiser called the CG(X) in favor of procuring the Flight III version of the DDG-51. The Navy stated that its desire to terminate the CG(X) program was "driven by affordability considerations." (Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2011 Budget*, February 2010, pp. 5-7.) For more on the CG(X) program and its termination in favor of procuring Flight III DDG-51s, see **Appendix B**.

[9] Government Accountability Office, *Arleigh Burke Destroyers[:] Additional Analysis and Oversight Required to Support the Navy's Future Surface Combatant Plans*, GAO-12-113, January 2012, pp. 31 and 42. See also Zachary M. Peterson, "DDG-51 With Enhanced Radar in FY-16, Design Work To Begin Soon," *Inside the Navy*, February 8, 2010; Amy Butler, "STSS Prompts Shift in CG(X) Plans," *Aerospace Daily & Defense Report*, December 11, 2010: 1-2; "[Interview With] Vice Adm. Barry McCullough," *Defense News*, November 9, 2009: 38.

The written testimony of the Chief of Naval Operations (CNO) before the House Armed Services Committee on February 16, 2012, and before the Defense subcommittee of the House Appropriations Committee on March 1, 2012, stated that the Flight III design would use an all-electric propulsion system, in contrast to the mechanical propulsion system used on the Flight IIA design and other Navy surface combatants. (See, for example, Statement of Admiral Jonathan Greenert, Chief of Naval Operations, Before the House Armed Services Committee [hearing] on FY2013 Department of the Navy Posture, February 16, 2012, which stated on page 10: "Our Lewis and Clark class supply ships now employ an all-electric propulsion system, as will our new Zumwalt and Flight III Arleigh Burke class destroyers (DDG).") The written testimony of the CNO before the Defense subcommittee of the Senate Appropriations Committee on March 7, 2012, and before the Senate Armed Services Committee on March 15, 2012, omitted the reference to the Flight III DDG-51 being equipped with an all-electric propulsion system. In response to a question from CRS about the change in the testimony, the Navy informed CRS on March 15, 2012, that the statement in the earlier testimony was an error, and that the Flight III DDG-51 will likely not be equipped with an all-electric propulsion system.

Multiyear Procurement (MYP) in FY2013-FY2017

As part of its action on the Navy's FY2013 budget, Congress granted the Navy authority to use a multiyear procurement (MYP) contract for DDG-51s to be procured FY2013-FY2017.[10] The Navy awarded the contract on June 3, 2013.[11] The Navy plans to use an engineering change proposal (ECP) to shift from the Flight IIA design to the Flight III design during this MYP contract. If the Flight III design is not ready to support the procurement of the first Flight III ship in FY2016, the Navy can delay issuing the ECP and shift the start of Flight III procurement to FY2017.

DDG-1000 Program

The DDG-1000 program was initiated in the early 1990s.[12] The DDG-1000 is a multi-mission destroyer with an emphasis on naval surface fire support (NSFS) and operations in littoral (i.e., near-shore) waters. The DDG-1000 is intended to replace, in a technologically more modern form, the large-caliber naval gun fire capability that the Navy lost when it retired its Iowa-class battleships in the early 1990s,[13] to improve the Navy's general capabilities for operating in defended littoral waters, and to introduce several new technologies that would be available for use on future Navy ships. The DDG-1000 was also intended to serve as the basis for the Navy's now-canceled CG(X) cruiser.

The DDG-1000 is to have a reduced-size crew of 142 sailors (compared to roughly 300 on the Navy's Aegis destroyers and cruisers) so as to reduce its operating and support (O&S) costs. The ship incorporates a significant number of new technologies, including an integrated electric-drive propulsion system[14] and automation technologies enabling its reduced-sized crew.

With an estimated full load displacement of 15,482 tons, the DDG-1000 design is roughly 63% larger than the Navy's current 9,500-ton Aegis cruisers and destroyers, and larger than any Navy destroyer or cruiser since the nuclear-powered cruiser *Long Beach* (CGN-9), which was procured in FY1957.

The first two DDG-1000s were procured in FY2007 and split-funded (i.e., funded with two-year incremental funding) in FY2007-FY2008; the Navy's FY2016 budget submission estimates their combined procurement cost at $8,797.9 million. The third DDG-1000 was procured in FY2009 and split-funded in FY2009-FY2010; the Navy's FY2016 budget submission estimates its procurement cost at $3,490.8 million.

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[10] For more on MYP contracts, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke and Moshe Schwartz.

[11] "DDG 51 Multiyear Procurement Contract Awarded," *Navy News Service*, June 3, 2013, accessed July 1, 2013, at http://www.navy.mil/submit/display.asp?story_id=74583. See also Mike McCarthy, "Navy Awards Multi-Year Contracts For Destroyers," *Defense Daily*, June 4, 2013: 1.

[12] The program was originally designated DD-21, which meant destroyer for the 21st Century. In November 2001, the program was restructured and renamed DD(X), meaning a destroyer whose design was in development. In April 2006, the program's name was changed again, to DDG-1000, meaning a guided missile destroyer with the hull number 1000.

[13] The Navy in the 1980s reactivated and modernized four Iowa (BB-61) class battleships that were originally built during World War II. The ships reentered service between 1982 and 1988 and were removed from service between 1990 and 1992.

[14] For more on integrated electric-drive technology, see CRS Report RL30622, *Electric-Drive Propulsion for U.S. Navy Ships: Background and Issues for Congress*, by Ronald O'Rourke.

As shown in **Table 1** below, the estimated combined procurement cost for all three DDG-1000s, as reflected in the Navy's annual budget submission, has grown by $3,311.6 million, or 36.9%, since the FY2009 budget (i.e., the budget for the fiscal year in which the third DDG-1000 was procured).

Table 1. Change in Estimated Combined Procurement Cost of DDG-1000, DDG-1001, and DDG-2002

In millions, rounded to nearest tenth, as shown in annual Navy budget submissions

	Estimated combined procurement cost (millions of dollars)	Change from prior year's budget submission	Cumulative change from FY2009 budget submission
FY2009 budget	8,977.1	—	—
FY2010 budget	9,372.5	+395.4 (+4.4%)	+395.4 (+4.4%)
FY2011 budget	9,993.3	+620.8 (+6.6%)	+1,016.2 (+11.3%)
FY2012 budget	11,308.8	+1,315.5 (+13.2%)	+2,331.7 (+26.0%)
FY2013 budget	11,470.1	+161.3 (+1.4%)	+2,493.0 (+27.8%)
FY2014 budget	11,618.4	+148.3 (+1.3%)	+2,641.3 (+29.4%)
FY2015 budget	12,069.4	+451.0 (+3.9%)	+3,092.3 (+34.4%)
FY2016 budget	12,288.7	+219.3 (+1.8%)	+3,311.6 (+36.9%)

Source: Table prepared by CRS based on data in annual Navy budget submissions.

Some of the cost growth in the earlier years in the table was caused by the truncation of the DDG-1000 program from seven ships to three, which caused some class-wide procurement-rated costs that had been allocated to the fourth through seventh ships to be reallocated to the three remaining ships.

The Navy states that the cost growth shown in the later years of the table reflects, among other things, a series of incremental, year-by-year movements away from an earlier Navy cost estimate for the program, and toward a higher estimate developed by Cost Assessment and Program Evaluation (CAPE) office within the Office of the Secretary of Defense (OSD). As one consequence of a Nunn-McCurdy cost breach experienced by the DDG-1000 program in 2010 (see "2010 Nunn-McCurdy Breach, Program Restructuring, and Milestone Recertification" in **Appendix A**), the Navy was directed to fund the DDG-1000 program to CAPE's higher cost estimate for the period FY2011-FY2015, and to the Navy's cost estimate for FY2016 and beyond. The Navy states that it has been implementing this directive in a year-by-year fashion with each budget submission since 2010, moving incrementally closer each year to CAPE's higher estimate. The Navy stated in 2014 that even with the cost growth shown in the table, the DDG-1000 program as of the FY2015 budget submission was still about 3% *below* the program's rebaselined starting point for calculating any new Nunn-McCurdy cost breach on the program.[15]

All three ships in the DDG-1000 program are to be built at GD/BIW, with some portions of each ship being built by Ingalls Shipbuilding for delivery to GD/BIW. Raytheon is the prime contractor for the DDG-1000's combat system (its collection of sensors, computers, related software,

[15] Source: Navy briefing for CRS and the Congressional Budget Office (CBO) on the DDG-1000 program, April 30, 2014.

displays, and weapon launchers). The Navy awarded GD/BIW the contract for the construction of the second and third DDG-1000s on September 15, 2011.[16]

For additional background information on the DDG-1000 program, see **Appendix A**.

Surface Combatant Construction Industrial Base

All cruisers, destroyers, and frigates procured since FY1985 have been built at General Dynamics' Bath Iron Works (GD/BIW) shipyard of Bath, ME, and Ingalls Shipbuilding of Pascagoula, MS, a division of Huntington Ingalls Industries (HII).[17] Both yards have long histories of building larger surface combatants. Construction of Navy surface combatants in recent years has accounted for virtually all of GD/BIW's ship-construction work and for a significant share of Ingalls' ship-construction work. (Ingalls also builds amphibious ships for the Navy.) Navy surface combatants are overhauled, repaired, and modernized at GD/BIW, Ingalls, other private-sector U.S. shipyards, and government-operated naval shipyards (NSYs).

Lockheed Martin and Raytheon are generally considered the two leading Navy surface combatant radar makers and combat system integrators. Northrop Grumman is a third potential maker of Navy surface combatant radars. Lockheed is the lead contractor for the DDG-51 combat system (the Aegis system), while Raytheon is the lead contractor for the DDG-1000 combat system, the core of which is called the Total Ship Computing Environment Infrastructure (TSCE-I). Lockheed has a share of the DDG-1000 combat system, and Raytheon has a share of the DDG-51 combat system. Lockheed, Raytheon, and Northrop competed to be the maker of the AMDR to be carried by the Flight III DDG-51. On October 10, 2013, the Navy announced that it had selected Raytheon to be the maker of the AMDR.

The surface combatant construction industrial base also includes hundreds of additional firms that supply materials and components. The financial health of Navy shipbuilding supplier firms has been a matter of concern in recent years, particularly since some of them are the sole sources for what they make for Navy surface combatants.

FY2016 Funding Request

The Navy estimates the combined procurement cost of the two DDG-51s requested for procurement in FY2016 at $3,522.7 million. A comparison with the cost of the two DDG-51s procured in FY2015 suggests that, within the estimated combined cost of $3,522.7 million for the two FY2016 DDG-51s, the Flight III DDG-51 might account for, very roughly, $2 billion, while the other DDG-51 might account for, very roughly, $1.5 billion. The potential difference of, very roughly, $500 million in cost between the two ships includes one-time design and change-order costs for modifying the DDG-51 design to the Flight III configuration, additional costs for the AMDR radar and associated electrical power and cooling equipment, and some loss of shipyard production learning curve benefits due to the change in the ship's design.

The two DDG-51s requested for procurement in FY2016 have received a total of $373.0 million in prior-year advance procurement (AP) funding. The Navy's proposed FY2016 budget requests the remaining $3,149.7 million needed to complete the ships' estimated combined procurement

[16] See, for example, Mike McCarthy, "Navy Awards Contract for DDG-1000s," *Defense Daily*, September 16, 2011: 3-4.

[17] HII was previously owned by Northrop Grumman, during which time it was known as Northrop Grumman Shipbuilding.

cost. The Navy's proposed FY2016 budget also requests $75.0 million in so-called cost-to-complete procurement funding to replace funding for DDG-51s procured in FY2010-FY2012 that was canceled by March 1, 2013, sequester. The Navy's proposed FY2016 budget also requests $433.4 million in procurement funding to complete construction of Zumwalt (DDG-1000) class destroyers procured in prior years, and $241.8 million in research and development funding for development work on the AMDR. The funding request for the AMDR is contained in Program Element (PE) 0604522N ("Advanced Missile Defense Radar [AMDR] System"), which is line 118 in the Navy's FY2016 research and development account.

Issues for Congress

Potential Impact of Continuing Resolution (CR) for FY2016

Overview

One issue for Congress concerns the potential impact on the DDG-51 program of an extended continuing resolution (CR) or a full-year CR for FY2016. Extended or full-year CRs can lead to challenges in program execution because they typically prohibit the following:

- new program starts ("new starts"), meaning the initiation of new program efforts that did not exist in the prior year;
- an increase in procurement quantity for a program compared to that program's procurement quantity in the prior year; and
- the signing of new multiyear procurement (MYP) contracts.[18]

In addition, the Navy's shipbuilding account, known formally as the Shipbuilding and Conversion, Navy (SCN) appropriation account, is written in the annual Department of Defense (DOD) appropriations act not just with a total appropriated amount for the entire account (like other DOD acquisition accounts), but also with specific appropriated amounts at the line-item level. As a consequence, under a CR (which is typically based on the prior year's appropriations act), SCN funding is managed not at the account level (like it is under a CR for other DOD acquisition accounts), but at the line-item level. For the SCN account—uniquely among DOD acquisition accounts—this can lead to line-by-line misalignments (excesses and shortfalls) in funding for SCN-funded programs, compared to the amounts those programs received in the prior year. The shortfalls in particular can lead to program-execution challenges under an extended or full-year CR.

In addition to the above impacts, a CR might also require the agency (in this case, the Navy) to divide a contract action into multiple actions, which can increase the total cost of the effort by reducing economies of scale and increasing administrative costs.

The potential impacts described above can be avoided or mitigated if the CR includes special provisions (called anomalies) for exempting individual programs or groups of programs from the general provisions of the CR, or if the CR includes expanded authorities for DOD for reprogramming and transferring funds.

[18] For more on MYP contracts, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke and Moshe Schwartz.

Impact on DDG-51 Program

The Navy states that an extended or full-year CR for FY2016 would impact the DDG-51 program because of its effect on a line item in the SCN account, called the completion of prior-year programs line item, that provides funding to cover cost growth on ships that were procured and fully funded in prior years, thereby permitting the construction of the ships in question to be completed. The impact of an extended or full-year CR for FY2016 on this line item, the Navy states, will affect several ongoing Navy shipbuilding programs, including the DDG-51 program. In addition, the Navy states, a CR's typical prohibition on year-to-year quantity increases in a procurement program will impact the Navy's ability to procure the first Flight III DDG-51 in FY2016, because the funding for the new Air and Missile Defense Radar (AMDR) that is to be carried by the Flight III version would not occur.[19]

Potential DOD Proposal to Cancel Third DDG-1000 Class Ship

Another potential issue for Congress concerns the third DDG-1000 class ship (i.e., DDG-1002): In September 2015, it was reported that DOD is considering whether to propose canceling the construction of DDG-1002.[20] The Navy reportedly favors continuing with the construction of the ship.[21]

If DOD were to propose cancelling DDG-1002, perhaps as part of its FY2017 budget submission, Congress would have the opportunity to approve, reject, or modify the proposal, perhaps as part of its action on DOD's FY2017 budget. Factors to consider in weighing such a proposal would include, among other things, sunk costs and remaining costs on DDG-1002; the potential, if any, for using parts and materials intended for DDG-1002 on other Navy ships; the industrial-base impact of continuing with or canceling DDG-1002 (including the impact on DDG-51s being built at GD/BIW); the expected operational value of DDG-1002 over its 35-year life cycle; and the expected operation and support (O&S) costs of the ship over its 35-year life cycle.[22]

Flight III DDG-51: Readiness of Design for Procurement in FY2016

Another issue for Congress concerns the readiness of the Flight III design for procurement in FY2016. As noted earlier, the Navy plans to shift to procurement of the Flight III design with the second of the two DDG-51s requested for procurement in FY2016.

The Navy argues that the Flight III design will be ready for procurement in FY2016. If it is judged that the design is not ready, the Navy's plan allows for procurement of the first Flight III DDG-51 to be shifted to FY2017 or a later year.

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[19] Source: Navy point paper, entitled "FY 2016 DON Continuing Resolution (CR) Impact," undated, provided by Navy Office of Legislative Affairs to CRS on September 14, 2015. See also Christopher P. Cavas, "US Navy Considers Impact of a Yearling CR," *Defense News*, September 5, 2015.

[20] See, for example, Anthony Capaccio, "General Dynamics Destroyer Reviewed by U.S. for Cancellation," *Bloomberg News*, September 14, 2015; Michael Fabey, "Despite Cancellation Reports, Work Continues On [Third] Zumwalt," *Aerospace Daily & Defense Report*, September 18, 2015: 6.

[21] See, for example, Sam LaGrone, "SECNAV Mabus, Maine Delegation Back Third Zumwalt Construction, *USNI News*, September 16, 2015. See also Philip Ewing, "Navy Sticks By New Ships Amid Delays," *Politico*, September 7, 2015.

[22] See., for example, Sam LaGrone, "Delays in Zumwalt Destroyer Program Hamper Production of DDG-51s at Bath Iron Works," *USNI News*, July 15, 2015; Sydney J. Freedberg, Jr., "Cuts To Zumwalt Destroyer Won't Save Much," *Breaking Defense*, September 21, 2015.

At a February 25, 2015, hearing on Department of the Navy acquisition programs before the Seapower and Projection Forces subcommittee of House Armed Services Committee, Department of the Navy officials testified that

> In October 2013, the Navy awarded the contract for development of the AMDR, with options for up to nine low rate initial production (LRIP) units. The AMDR radar suite will be capable of providing simultaneous surveillance and engagement support for long range BMD and area defense. The program continues to demonstrate maturity in the design development as shown in successful completion of the AMDR hardware critical design review (CDR) in December 2014 and is on track for the system CDR in April 2015. Engineering Change Proposal (ECP) detail design efforts for the DDG Flight III design will continue in FY 2016, ultimately leading to over 90 percent detail design completion prior to construction on the first Flight III ship.[23]

In a February 2015 report to Congress on the status of the Flight III design, the Navy stated that

> with respect to systems and equipment levels of maturity for Flight III, the AMDR is the only new development technology. The AMDR has successfully completed Milestone B, a full system Preliminary Design Review, a hardware Critical Design Review, and will deliver its first full ship set of production equipment by early FY 2020. The remaining equipment required to provide power and cooling to the AMDR are all based on currently existing equipment and therefore induce low technical risk to the program. Given the tremendous capability improvement AMDR provides to defeat emerging air and ballistic missile threats over current radars, the low to moderate technical risk associated with implementing this radar on an FY 2016 DDG 51 justifies execution of the ECP during the FY 2013-2017 multiyear procurement contract....
>
> All major equipment development is on track to support DDG 51 Class implementation of the AMDR in FY16....
>
> The Flight III program is supported by appropriate design execution, Systems Engineering Technical Reviews, and stakeholder relationships consistent with meeting requirements and overall pro-gram schedule. Major supporting component developments for AMDR-S [AMDR S band], PCMs [power conversion modules], and SSGTGs [ship service gas turbine generators] are well underway by the associated Participating Resource Managers (PARMs) with schedules and milestones that support the overall Flight III delivery targets. Detail design was started in FY14 with the Program Office delivering Government Furnished Information (GFI) to the shipyard services to support continued Flight III development. Continued development of GFI will support detail design fidelity leading to successful Preliminary Design Review (PDR), Critical Design Review (CDR), and Production Readiness Review (PRR) targeting 90% design completion supporting start of construction.... PARM schedules are integrated with anticipated in-yard need dates for construction and testing resulting in successful light-off and delivery targeted for FY22. Management approach to supporting construction, test, and delivery will be consistent with multi-year procedures already in place.
>
> The DDG 51 AEGIS program office employs a risk management plan based on the guidance pro-vided in applicable Defense Acquisition documents, which were then tailored specifically to the DDG 51 Flight III program. Risk management occurs in main areas for Flight III: AMDR/RSC [Radar Suite Control] development, combat system

[23] Statement of the Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition) and Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations for Integration of Capabilities and Resources and Lieutenant General Kenneth J. Glueck, Jr., Deputy Commandant, Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, Before the Subcommittee on Seapower and Projection Forces of the House Armed Services Committee on Department of the Navy Seapower and Projection Forces Capabilities, February 25, 2015, pp. 9-10.

> development and total ship design, including HM&E [hull, mechanical, and electrical] modifications necessary to support AMDR and the combat system.
>
> DDG 51 Flight III risk management is tracked internally by a Risk Management Board (RMB) which meets quarterly. Participants of the RMB include the AEGIS program office, shipyard representatives, and PARM (AMDR, SSGTG, and PCM) representatives, along with combat system and ship design team members. The purpose of these meetings is to discuss and track the status on current risks, along with introducing any additional risks that may need to be added to the risk register. Once a risk is entered into the risk register, it is tracked through the life of the program. Quarterly RMB reviews and numerical rescoring of the risk show trends and effectiveness of mitigation efforts....
>
> With respect to Flight III systems level of maturity, the AMDR is the only new development technology. The AMDR has successfully completed Milestone B, a full system Preliminary Design Review, a hardware Critical Design Review, and will deliver its first full ship set of production equipment by early FY 2020. The remaining equipment required to provide power and cooling to the AMDR are all based on currently existing equipment and therefore induce low technical risk to the program. Given the tremendous capability improvement AMDR provides to defeat emerging air and ballistic missile threats over current radars, the low to moderate technical risk associated with implementing this radar on an FY 2016 DDG 51 justifies execution of the ECP [Engineering Change Proposal] during the FY 2013-2017 multiyear procurement contract.
>
> This report has assembled the latest available design and integration information based on the recent design reviews, assumptions, decisions, and sources provided to address the questions posed. In summary, the AMDR technology has matured, ship impacts are clearly understood, and design efforts are underway for ECP development. The Navy's intention, as stated and supported by the contents of this report, is to integrate AMDR-S into the DDG 51 ARLEIGH BURKE Class ships beginning with the last ship of FY16.[24]

Flight III DDG-51: Cost, Technical, and Schedule Risk

Another issue for Congress concerns cost, technical, and schedule risk for the Flight III DDG-51. Some observers have expressed concern about the Navy's ability to complete development of the AMDR and deliver the first AMDR to the shipyard in time to support the construction schedule for a first Flight III DDG-51 procured in FY2016. The Navy could respond to a delay in the development of the AMDR by shifting the procurement of the first Flight III DDG-51 to FY2017 or a later year, while continuing to procure Flight IIA DDG-51s. (The MYP that the Navy has awarded for FY2013-FY2017 is structured to accommodate such a shift, should it become necessary.) Some observers have also expressed concern about the potential procurement cost of the Flight III DDG-51 design.

A February 2, 2015, press report stated:

> The Navy began detailed design work on the Flight III variant... in December and will conduct a preliminary design review [PDR] of the program in July....
>
> The program completed several significant milestones on schedule in 2014 and is on track to do the same in 2015, Capt. Mark Vandroff, DDG-51 program manager, said Jan. 14...

[24] U.S. Navy, *Report to Congress [on] DDG 51 Flight III Ships and Air and Missile Defense Radar Engineering Change Proposal*, February 2015, pp. 2, 7, 29-30. The report was directed by language on page 14 of S.Rept. 112-173 of June 4, 2012, the Senate Armed Services Committee's report on S. 3254, the FY2013 National Defense Authorization Act.

> The capabilities development document for Flight III was validated by the Joint Requirements Oversight Council on Oct. 28, 2014, Vandroff said, and preliminary design was completed that same month. Detailed design work was initiated in December and the program office plans to conduct PDR in July, he added.
>
> The detailed design phase will last about two and a half years, Vandroff estimated.[25]

October 2015 CBO Report

An October 2015 Congressional Budget Office (CBO) report on the cost of the Navy's shipbuilding programs stated:

> The Navy's strategy for meeting the combatant commanders' goal that future ballistic missile defense capabilities exceed those provided by existing DDG-51s—and for replacing 11 Ticonderoga class cruisers when they are retired in the 2020s—is to substantially modify the design of the DDG-51 Flight IIA destroyer, creating a Flight III configuration. That change would incorporate the new Air and Missile Defense Radar (AMDR), now under development, which will be larger and more capable than the radar on current DDG-51s. The effective operation of the AMDR in the new Flight III configuration, however, will require an increase in the ships' capacity to generate electrical power and their ability to cool major systems.
>
> With those changes and associated increases in the ships' displacement, CBO expects that the average cost per ship over the entire production run would be $1.9 billion in 2015 dollars, or about 15 percent more than the Navy's estimate of $1.7 billion. Costs could be higher or lower than CBO's estimate, however, depending on the eventual cost and complexity of the AMDR and the associated changes in the ship's design to integrate the new radar.[26]

March 2015 GAO Report

A March 2015 Government Accountability Office (GAO) report assessing selected DOD acquisition programs stated the following in its assessment of the DDG-51 program:

> The Navy is undertaking Flight III detail design activities in fiscal 2015 concurrent with AMDR development—a strategy that could disrupt detail design activities as AMDR attributes become more defined. The Navy identifies AMDR integration as posing technical, cost, and schedule risks to the Flight III program. In addition to AMDR, Flight III changes include upgrades to the ships' cooling and electrical systems and other configuration changes intended to increase weight and stability margins. The Navy reports that a prototype of the cooling system is in operation at the vendor's factory and is undergoing environmental qualification testing. However, the Navy identifies cost and schedule risks to the Flight III program associated with these cooling upgrades. The electrical system upgrades include changes to the distribution system to add and modify switchgear and transformers based on the system installed on LHA 6.
>
> The Navy plans to use engineering change proposals to the existing Flight IIA multiyear procurement contracts to construct the first three Flight III ships rather than establish new contracts for detail design and construction. The Navy has allotted 17 months to mature the Flight III detail design ahead of the planned solicitation for these proposals and plans to award construction of the first Flight III ship in fiscal 2016, with two follow-on ships in fiscal 2017. To support this, per DOD policy the Navy sought congressional approval

[25] Lara Seligman, "Detailed Design Initiated For Flight III Destroyer, Review Scheduled For July," *Inside the Navy*, February 2, 2015.

[26] Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2016 Shipbuilding Plan*, October 2015, p. 27.

in 2014 to transfer funds and begin detail design in the fourth quarter of fiscal 2014. However, this request was denied, postponing detail design start by several months. In September 2014, the Navy notified Congress that a delayed detail design start may prompt it to delay the introduction of AMDR until fiscal 2017.[27]

Regarding the AMDR specifically, the report stated:

Technology and Design Maturity

All four of AMDR's critical technologies—digital-beam-forming; transmit-receive modules; software; and digital receivers/exciters—are approaching full maturity, and program officials state that AMDR is on pace to meet DDG 51 Flight III's schedule requirements. In 2015, the contractor is expected to complete an engineering development model consisting of a single full-sized 14 foot radar array—as opposed to the final four array configuration planned for installation on DDG 51 Flight III—and begin testing in the contractor's indoor facilities. Following the critical design review, scheduled for April 2015, the program plans to install the array in the Navy's land-based radar test facility in Hawaii for further testing in a more representative environment. However, the Navy has no plans to test AMDR in a realistic (at-sea) environment prior to installation on the lead DDG 51 Flight III ship. Though the Navy is taking some risk reduction measures, there are only 15 months planned to install and test the AMDR prototype prior to making a production decision. Delays may cause compounding effects on testing of upgrades to the Aegis combat system since the Navy plans to use the AMDR engineering development model in combat system integration and testing.

In August 2014, AMDR completed its final preliminary design review, which assessed both hardware and software. The total number of design drawings required for AMDR has not yet been determined and will be finalized at the program's critical design review. However, AMDR officials are confident that the robust technology in the prototype represents the physical dimensions, weight, and power requirements to support DDG 51 Flight III integration. The AMDR program office provided an initial interface control document listing AMDR specifications to the DDG 51 Flight III program office. Ensuring correct AMDR design parameters is important since the available space, weight, power, and cooling for DDG 51 Flight III is constrained, and design efforts for the ship will begin before AMDR is fully matured.

The AMDR radar suite controller requires significant software development, with 1.2 million lines of code and four planned builds. The program also plans to apply an open systems approach to available commercial hardware to decrease development risk and cost. The program office identified that the first of four planned builds is complete, has passed the Navy's formal qualification testing and will enter developmental testing next summer. Each subsequent build will add more functionality and complexity. AMDR will eventually need to interface with the Aegis combat management system found on DDG 51 destroyers. This interface will be developed in later software builds for fielding in 2020, and the Navy plans on conducting early combat system integration and risk reduction testing prior to making a production decision.

Other Program Issues

AMDR still lacks a Test and Evaluation Master Plan approved by DOD's Director, Operational Test and Evaluation (DOT&E), as required by DOD policy. DOT&E expressed concerns with the lack of a robust live-fire test plan involving AMDR and the Navy's self-defense test ship. According to program officials, their current test plan's

[27] Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-15-342SP, March 2015, p. 138.

models will provide sufficient data to support validation and accreditation and thus verify system performance.

Program Office Comments

According to the Navy, AMDR is on track to deliver a capability 30 times greater than the radar it will replace. To mitigate development risk and deliver AMDR's software at the earliest possible delivery date, the contractor is implementing software development approaches to improve productivity, in coordination with robust testing, modeling, and live flight test simulations. Further, an AMDR hardware facility—including a fully functioning portion of AMDR's processing equipment and a software integration lab—is operating at the contractor's facility to support iterative testing ahead of, and then in support of, production of the engineering development model. In December 2014, a hardware specific critical design review was successfully completed demonstrating that technical performance measures are in compliance with requirements and the hardware design is sufficiently mature to complete detailed design, and will proceed to engineering development model array production.[28]

Flight III DDG-51: Growth Margin

Another issue for Congress is whether the Flight III DDG-51 design would have sufficient growth margin for a projected 35- or 40-year service life. A ship's growth margin refers to its capacity for being fitted over time with either additional equipment or newer equipment that is larger, heavier, or more power-intensive than the older equipment it is replacing, so as to preserve the ship's mission effectiveness. Elements of a ship's growth margin include interior space, weight-carrying capacity, electrical power, cooling capacity (to cool equipment), and ability to accept increases in the ship's vertical center of gravity. Navy ship classes are typically designed so that the first ships in the class will be built with a certain amount of growth margin. Over time, some or all of the growth margin in a ship class may be used up by backfitting additional or newer systems onto existing ships in the class, or by building later ships in the class to a modified design that includes additional or newer systems.

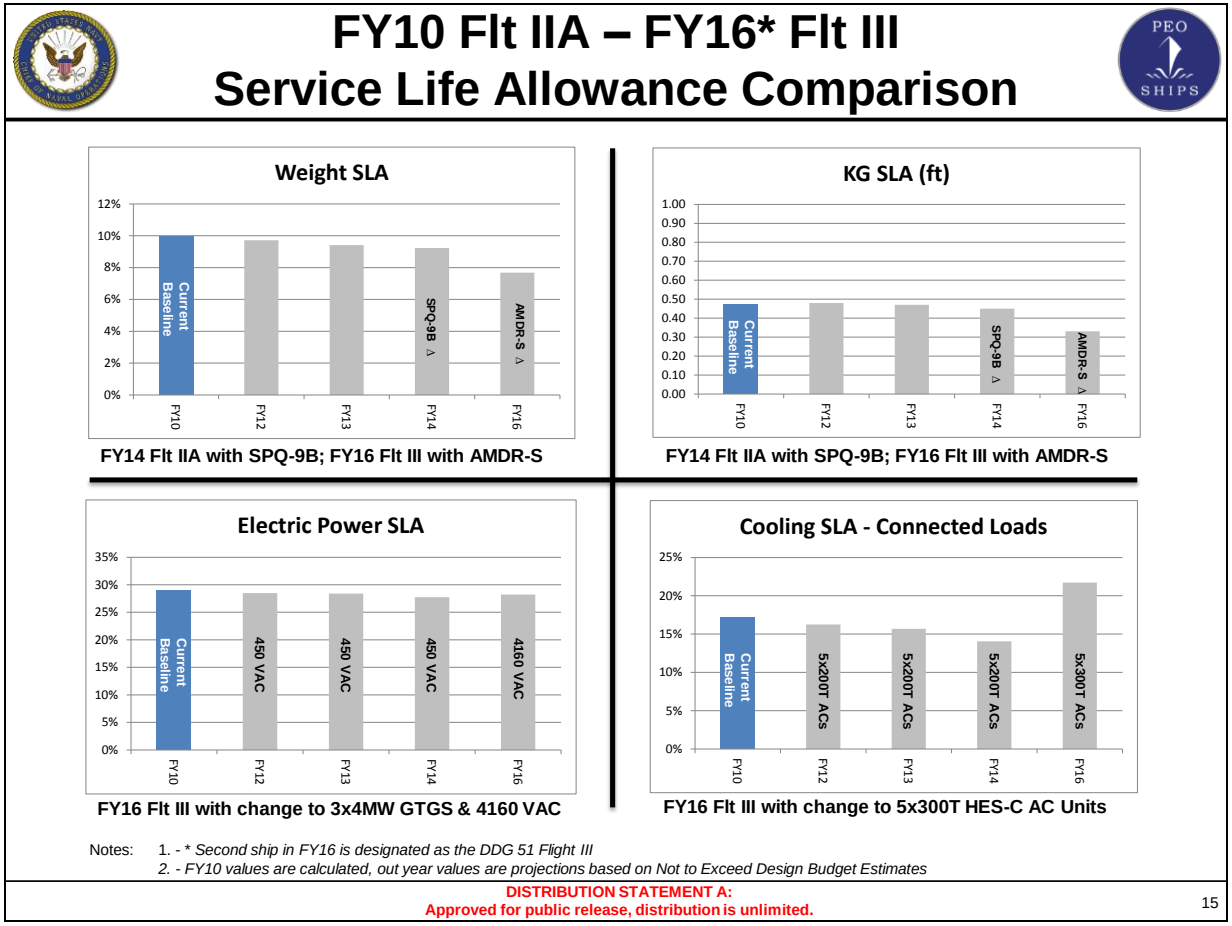
Modifying the DDG-51 design over time has used up some of the design's growth margin. The Flight III DDG-51 would in some respects have less of a growth margin than what the Navy would aim to include in a new destroyer design of about the same size. A January 18, 2013, press report stated, "In making decisions about the [Flight III] ship's power, cooling, weight and other margins, [DDG-51 program manager Captain Mark] Vandroff said [in a presentation at a conference on January 15, 2013, that] the Navy wanted to ensure that there was room to grow in the future, to allow for modernization as well as capability upgrades when new weapons such as the electromagnetic railgun enter the fleet. Allowing for growth was balanced with cost, and Vandroff said he thought the program did a great job of coming up with an affordable solution to a leap-ahead capability for the fleet."[29] In his presentation, Vandroff showed a slide comparing the growth margins of the Flight III design to those of Flight IIA DDG-51s procured or scheduled to be procured in FY2010-FY2014; the slide is reproduced below as **Figure 2**.

[28] Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-15-342SP, March 2015, p. 64.

[29] Megan Eckstein, "Flight III DDGs To Cost About $2 Billion, Have Margins For Future Growth," *Inside the Navy*, January 18, 2013.

Figure 2. Navy Briefing Slide on DDG-51 Growth Margins

Flight III DDG-51 Design Compared to Flight IIA DDG-51s



Source: Presentation of Captain Mark Vandroff to Surface Navy Association, January 15-17, 2013; a copy of the slides was provided to CRS by the Navy Office of Legislative Affairs on January 28, 2013.

Note: SLA means service life allowance (i.e., growth margin).

A June 7, 2013, blog post stated:

> The Navy is confident it has enough space, power and cooling onboard the hull of its planned new line of destroyers to accommodate the planned high-powered Air and Missile Defense Radar (AMDR), Capt. Mark Vandroff, Naval Sea Systems Command program manager for the DDG-51 shipbuilding program, told USNI News in an interview on Thursday.
>
> However, the Arleigh Burke-class destroyer (DDG-51) Flight III would be limited in the amount of additional weapons the ship could accommodate—including electromagnetic railguns and high-energy lasers—without removing other capabilities.
>
> "Depending on how heavy that railgun is, could you fit it on a DDG? My answer is what on that DDG are you willing to live without right now?" Vandroff said.
>
> "You wouldn't have the space and weight to put on something very large without something relatively sizable coming off."[30]

Supporters of the Navy's proposal to procure Flight III DDG-51s could argue that the ship's growth margin would be comparable to that of recently procured Flight IIA DDG-51s, and would be adequate because the increase in capability achieved with the Flight III configuration reduces the likelihood that the ship will need much subsequent modification to retain its mission effectiveness over its projected service life. They could also argue that, given technology advances, new systems added to the ship years from now might require no more (and possibly less) space, weight, electrical power, or cooling capacity than the older systems they replace.

Skeptics could argue that there are uncertainties involved in projecting what types of capabilities ships might need to have to remain mission effective over a 35- or 40-year life, and that building expensive new warships with relatively modest growth margins consequently would be imprudent. The Flight III DDG-51's growth margin, they could argue, could make it more likely that the ships would need to be removed from service well before the end of their projected service lives due to an inability to accept modifications needed to preserve their mission effectiveness. Skeptics could argue that it might not be possible to fit the Flight III DDG-51 in the future with a high-power (200 kW to 300 kW) solid state laser (SSL), because the ship would not have enough available electrical power or cooling capacity to support such a weapon. Skeptics could argue that high-power SSLs could be critical to the Navy's ability years from now to affordably counter large numbers of enemy anti-ship cruise missiles (ASCMs) and anti-ship ballistic missiles (ASBMs) that might be fielded by a wealthy and determined adversary. Skeptics could argue that procuring Flight III DDG-51s could delay the point at which high-power SSLs could be introduced into the cruiser-destroyer force, and reduce for many years the portion of the cruiser-destroyer force that could ultimately be backfitted with high-power SSLs. This, skeptics could argue, might result in an approach to AAW and BMD on cruisers and destroyers that might ultimately be unaffordable for the Navy to sustain in a competition against a wealthy and determined adversary.[31]

[30] "NAVSEA on Flight III Arleigh Burkes," *USNI News*, June 7, 2013, accessed July 1, 2013, at http://news.usni.org/2013/06/07/navsea-on-flight-iii-arleigh-burkes.

[31] For more on potential shipboard lasers, see CRS Report R44175, *Navy Lasers, Railgun, and Hypervelocity Projectile: Background and Issues for Congress*, by Ronald O'Rourke.

Flight III DDG-51: Issues Raised in January 2015 DOT&E Report

Another issue for Congress concerns issues raised in a January 2015 report from DOD's Director of Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2014. Regarding the Flight III DDG-51 program, the report stated:

> **Executive Summary**
>
> • On March 6, 2014, the Deputy Secretary of Defense (DEPSECDEF) issued a Resource Management Decision memorandum directing the Navy to develop a plan to conduct at-sea testing of the self-defense capability of the DDG 51 Flight III Destroyer with the Air and Missile Defense Radar (AMDR) and Aegis Combat System. The plan was to be approved by DOT&E and then adequately funded by the Navy. However, the Navy has not provided any plan to DOT&E or planned funding to facilitate the testing.
>
> • On April 23, 2014, DOT&E issued a memorandum to USD(AT&L) [Under Secretary of Defense for Acquisition, Technoogy, and Logistics—DOD's acquisition executive] stating the intention to not approve any operational test plan for an Early Operational Assessment (EOA) of the AMDR due to non-availability of the required AMDR hardware and software.
>
> • On September 10, 2014, DOT&E issued a classified memorandum to USD(AT&L) with a review of the Navy Program Executive Office for Integrated Warfare Systems Design of Experiments study. The study attempted to provide a technical justification to show the test program did not require using a Self-Defense Test Ship (SDTS) to adequately assess the self-defense capability of the DDG 51 Flight III Class Destroyers. DOT&E found the study presented a number of flawed rationales, contradicted itself, and failed to make a cogent argument for why an SDTS is not needed for operational testing....
>
> **Activity**
>
> • On March 6, 2014, DEPSECDEF issued a Resource Management Decision memorandum directing the Navy to develop a plan to conduct at-sea testing of the self-defense capability of the DDG 51 Flight III Destroyer with the AMDR and Aegis Combat System. The plan was to be approved by DOT&E and then adequately funded by the Navy. To date, the Navy has not provided any plan to DOT&E or funding in response to this direction.
>
> • On April 23, 2014, DOT&E issued a memorandum to USD(AT&L) stating the operational test plan for an EOA of the AMDR could not be approved because the required AMDR hardware and software were not available as planned, per the 2010 DOT&E- and Navy-approved Test and Evaluation Strategy, and as briefed to the Deputy Assistant Secretary of Defense (Strategic and Tactical Systems) in 2012. A prototype AMDR array, coupled to an upgraded radar controller using basic software for radar control and simple search and track functionality, was expected to be available. The lack of this hardware and software would have limited the EOA to a "table-top" review of program documentation, program plans, and available design data, which would, in DOT&E's view, not have been a worthwhile use of resources.
>
> • On September 10, 2014, DOT&E issued a classified memorandum to USD(AT&L) that provided a review of the Navy Program Executive Office for Integrated Warfare Systems Design of Experiments study. The study attempted to provide a technical justification to show the test program did not require using an SDTS to adequately assess the self-defense capability of the DDG 51 Flight III Class Destroyers. DOT&E found the study presented a number of flawed rationales, contradicted itself, and failed to make a cogent argument for why an SDTS is not needed for operational testing.

Assessment

• DOT&E's assessment continues to be that the operational test programs for the AMDR, Aegis Modernization, and DDG 51 Flight III Destroyer programs are not adequate to fully assess their self-defense capabilities in addition to being inadequate to test the following Navy-approved AMDR and DDG 51 Flight III requirements.

- The AMDR Capability Development Document describes AMDR's IAMD mission, which requires AMDR to support simultaneous defense against multiple ballistic missile threats and multiple advanced anti-ship cruise missile (ASCM) threats. The Capability Development Document also includes an AMDR minimum track range Key Performance Parameter.

- The DDG 51 Flight III Destroyer has a survivability requirement directly tied to meeting a self-defense requirement threshold against ASCMs described in the Navy's Surface Ship Theater Air and Missile Defense Assessment document of July 2008. It clearly states that area defense will not defeat all the threats, thereby demonstrating that area air defense will not completely attrite all ASCM raids and that individual ships must be capable of defeating ASCM leakers in the self-defense zone.

• Use of manned ships for operational testing with threat representative ASCM surrogates in the close-in, self- defense battlespace is not possible due to Navy safety restrictions because targets and debris from intercepts pose an unacceptable risk to personnel at ranges where some of the engagements will take place. The November 2013 mishap on the USS Chancellorsville (CG 62) involving an ASCM surrogate target resulted in even more stringent safety constraints.

- In addition to stand-off ranges (on the order of 1.5 to 5 nautical miles for subsonic and supersonic surrogates, respectively), safety restrictions require that ASCM targets not be flown directly at a manned ship, but at some cross- range offset, which unacceptably degrades the operational realism of the test.

- Similar range safety restrictions will preclude manned ship testing of eight of the nine ASCM scenarios contained in the Navy-approved requirements document for the Aegis Modernization Advanced Capability Build 16 Combat System upgrade as well as testing of the AMDR minimum track range requirement against supersonic, sea-skimming ASCM threat-representative surrogates at the land-based AMDR Pacific Missile Range Facility test site.

- To overcome these safety restrictions for the LHA-6, Littoral Combat Ship (LCS), DDG 1000, LPD-17, LSD- 41/49, and CVN-78 ship classes, the Navy developed an Air Warfare/Ship Self Defense Enterprise modeling and simulation (M&S) test bed that uses live testing in the close-in battlespace with targets flying realistic threat profiles and manned ship testing for other battlespace regions and softkill capabilities to validate and accredit the M&S test bed. The same needs to be done for the DDG 51 Flight III Destroyer with its AMDR. Side-by-side comparison between credible live fire test results and M&S test results form the basis for the M&S accreditation. Without an SDTS with AMDR and an Aegis Combat System, there will not be a way to gather all of the operationally realistic live fire test data needed for comparison to accredit the M&S.

• The Navy needs to improve its Aegis Weapon System (AWS) models that are currently provided by Lockheed Martin's Multi-Target Effectiveness Determined under Simulation by Aegis (MEDUSA) M&S tool.

- MEDUSA encompasses several components of the AWS including the SPY-1 radar, Command and Decision, and Weapon Control System. MEDUSA models AWS performance down to the system specification and the Navy considers it a high-fidelity simulation of AWS.

- However, it is not a tactical code model, so its fidelity is ultimately limited to how closely the specification corresponds to the Aegis tactical code (i.e., the specification is how the system is supposed to work while the tactical code is how the system actually works). This adds to the need for realistic live fire shots to support validation efforts.

- Earlier test events highlight the limitations of specification models like MEDUSA. During Aegis Advanced Capability Build 08 testing in 2011, five AWS software errors were found during live fire events and tracking exercises. Three software errors contributed to a failed SM-2 engagement, one to a failed ESSM engagement, and one to several failed simulated engagements during tracking exercises. Since these problems involved software coding errors, it is unlikely that a specification model like MEDUSA (which assumes no software errors in tactical code) would account for such problems and hence it would overestimate the combat system's capability.

- By comparison, the Air Warfare/Ship Self Defense Enterprise M&S test bed used for assessing USS San Antonio's (LPD-17) self-defense capabilities used re-hosted Ship Self-Defense System Mk 2 tactical code.

• Since Aegis employs ESSM in the close-in, self-defense battlespace, understanding ESSM's performance is critical to understanding the self-defense capabilities of the DDG 51 Flight III Destroyer.

- Past DOT&E annual reports have stated that the ESSM's operational effectiveness has not been determined. The Navy has not taken action to adequately test the ESSM's operational effectiveness.

- Specifically, because safety limitations preclude ESSM firing in the close-in self-defense battlespace, there are very little test data available concerning ESSM's performance, as installed on Aegis ships, against supersonic ASCM surrogates.

- Any data available regarding ESSM's performance against supersonic ASCM surrogates are from a Ship Self-Defense System-based combat system configuration, using a completely different guidance mode or one that is supported by a different radar suite.

• The cost of building and operating an Aegis SDTS is small when compared to the total cost of the AMDR development/ procurement and the eventual cost of the 22 (plus) DDG 51 Flight III ships that are planned for acquisition ($55+ Billion). Even smaller is the cost of the SDTS compared to the cost of the ships that the DDG 51 Flight III Destroyer is expected to protect (approximately $450 Billion in new ship construction over the next 30 years).

- If DDG 51 Flight III Destroyers are unable to defend themselves, these other ships are placed at substantial risk.

- Moreover, the SDTS is not a one-time investment for only the AMDR/DDG 51 Flight III IOT&E [Initial Operational Test & Evaluation], as it would be available for other testing that cannot be conducted with manned ships (e.g., the ESSM Block 2) and as the combat system capabilities are improved.

Recommendations

• Status of Previous Recommendations. There are three previous recommendations that remain valid. The Navy should:

1. Program and fund an SDTS equipped with the AMDR and DDG 51 Flight III Aegis Combat System in time for the DDG 51 Flight III Destroyer IOT&E.

2. Modify the AMDR, Aegis Modernization, and DDG 51 Flight III Test and Evaluation Master Plans to include a phase of IOT&E using an SDTS equipped with the AMDR and DDG 51 Flight III Combat System.

> 3. Modify the AMDR, Aegis Modernization, and DDG 51 Flight III Test and Evaluation Master Plans to include a credible M&S effort that will enable a full assessment of the AMDR and DDG 51 Flight III Combat System's self-defense capabilities.
>
> • FY14 Recommendation.
>
> 1. The Navy should comply with the DEPSECDEF direction to develop and fund a plan, to be approved by DOT&E, to conduct at-sea testing of the self-defense of the DDG 51 Flight III Destroyer with the AMDR and Aegis Combat System.[32]

Flight III DDG-51: Adequacy of AAW and BMD Capability

Another issue for Congress is whether the Flight III DDG-51 will have sufficient AAW and BMD capability to adequately perform future AAW and BMD missions. The Flight III DDG-51 would have more AAW and BMD capability than the current DDG-51 design, but less AAW and BMD capability than was envisioned for the CG(X) cruiser, in large part because the Flight III DDG-51 would be equipped with a 14-foot-diameter version of the AMDR that would have more sensitivity than the SPY-1 radar on Flight IIA DDG-51s, but less sensitivity than the substantially larger version of the AMDR that was envisioned for the CG(X). The CG(X) also may have had more missile-launch tubes than the Flight III DDG-51.

The Navy argues that while the version of the AMDR on the Flight III DDG-51 will have less sensitivity than the larger version of the AMDR envisioned for the CG(X), the version of the AMDR on the Flight III DDG-51 will provide sufficient AAW and BMD capability to address future air and missile threats. A March 2014 GAO report assessing selected DOD acquisition programs stated:

> The X-band portion of AMDR will be comprised of an upgraded version of an existing rotating radar (SPQ-9B), instead of the new design initially planned. The new radar will instead be developed as a separate program at a later date and integrated with the thirteenth AMDR unit. According to the Navy, the upgraded SPQ-9B radar fits better within the Flight III's sea frame and expected power and cooling availability. Program officials state that the SPQ-9B radar will have capabilities equal to the new design for current anti-air warfare threats, it will not perform as well against future threats.
>
> The Navy plans to install a 14-foot variant of AMDR on Flight III DDG 51s starting in 2019. According to draft AMDR documents, a 14-foot radar is needed to meet threshold requirements, but an over 20-foot radar is required to fully meet the Navy's desired integrated air and missile defense needs. However, the shipyards and the Navy have determined that a 14-foot active radar is the largest that can be accommodated within the existing DDG 51deckhouse. Navy officials stated that AMDR is being developed as a scalable design but a new ship would be required to host a larger version of AMDR.[33]

Lack of Roadmap for Accomplishing Three Things in Cruiser-Destroyer Force

Another issue for Congress concerns the lack of an announced Navy roadmap for accomplishing three things in the cruiser-destroyer force:

[32] Department of Defense, *Director, Operational Test and Evaluation, FY 2014 Annual Report*, January 2015, pp. 171-174.

[33] Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-14-340SP, March 2014, p. 55.

- restoring ship growth margins;
- introducing large numbers of ships with integrated electric drive systems or other technologies that could provide ample electrical power for supporting future electrically powered weapons (such as high-power solid state lasers); and
- introducing technologies (such as those for substantially reducing ship crew size) for substantially reducing ship operating and support (O&S) costs. (The potential importance of high-power solid state lasers is discussed in the previous section on the Flight III DDG-51's growth margin.)

The Navy's pre-2008 plan to procure DDG-1000 destroyers and then CG(X) cruisers based on the DDG-1000 hull design represented the Navy's roadmap at the time for restoring growth margins, and for introducing into the cruiser-destroyer force significant numbers of ships with integrated electric drive systems and technologies for substantially reducing ship crew sizes. The ending of the DDG-1000 and CG(X) programs in favor of continued procurement of DDG-51s leaves the Navy without an announced roadmap to do these things, because the Flight III DDG-51 will not feature a fully restored growth margin, will not be equipped with an integrated electric drive system or other technologies that could provide ample electrical power for supporting future electrically powered weapons, and will not incorporate features for substantially reducing ship crew size or for otherwise reducing ship O&S costs substantially below that of Flight IIA DDG-51s.

Options for Congress

In general, options for Congress concerning destroyer acquisition include the following:

- approving, rejecting, or modifying the Navy's procurement, advance procurement, and research and development funding requests for destroyers and their associated systems (such as the AMDR);
- establishing conditions for the obligation and expenditure of funding for destroyers and their associated systems; and
- holding hearings, directing reports, and otherwise requesting information from DOD on destroyers and their associated systems.

In addition to these general options, below are some additional acquisition options relating to destroyers that Congress may wish to consider.

Adjunct Radar Ship

The Navy canceled the CG(X) cruiser program in favor of developing and procuring Flight III DDG-51s reportedly in part on the grounds that the Flight III destroyer would use data from off-board sensors to augment data collected by its AMDR.[34] If those off-board sensors turn out to be less capable than the Navy assumed when it decided to cancel the CG(X) in favor of the Flight III DDG-51, the Navy may need to seek other means for augmenting the data collected by the Flight III DDG-51's AMDR.

One option for doing this would be to procure an adjunct radar ship—a non-combat ship equipped with a large radar that would be considerably more powerful than the Flight III DDG-

[34] Amy Butler, "STSS Prompts Shift in CG(X) Plans," *Aerospace Daily & Defense Report*, December 11, 2009: 1-2.

51's AMDR. The presence in the fleet of a ship equipped with such a radar could significantly improve the fleet's AAW and BMD capabilities. The ship might be broadly similar to (but perhaps less complex and less expensive than) the new Cobra Judy Replacement missile range instrumentation ship (**Figure 3**),[35] which is equipped with two large and powerful radars, and which has an estimated total acquisition cost of about $1.7 billion.[36] One to a few such adjunct radar ships might be procured, depending on the number of theaters to be covered, requirements for maintaining forward deployments of such ships, and their homeporting arrangements. The ships would have little or no self-defense capability and would need to be protected in threat situations by other Navy ships.

Flight III DDG-51 With Increased Capabilities

Another option would be to design the Flight III DDG-51 to have greater capabilities than what the Navy is currently envisioning. Doing this might well require the DDG-51 hull to be lengthened—something that the Navy is not envisioning for the Flight III design. Navy and industry studies on the DDG-51 hull design that were performed years ago suggested that the hull has the potential for being lengthened by as much as 55 feet to accommodate additional systems. Building the Flight III DDG-51 to a lengthened configuration could make room for additional power-generation and cooling equipment, additional vertical launch system (VLS) missile tubes,

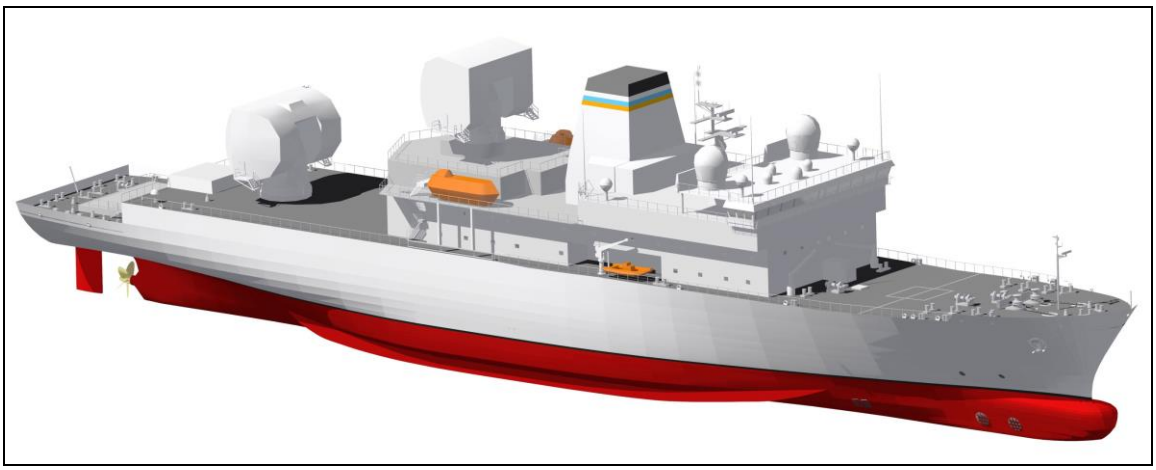
[35] As described by DOD,

> The COBRA JUDY REPLACEMENT (CJR) program replaces the capability of the current United States Naval Ship (USNS) Observation Island (OBIS), its COBRA JUDY radar suite, and other mission essential systems. CJR will fulfill the same mission as the current COBRA JUDY/OBIS. CJR will collect foreign ballistic missile data in support of international treaty verification.
>
> CJR represents an integrated mission solution: ship, radar suite, and other Mission Equipment (ME). CJR will consist of a radar suite including active S-Band and X-Band Phased Array Radars (PARs), weather equipment, and a Mission Communications Suite (MCS). The radar suite will be capable of autonomous volume search and acquisition. The S-Band PAR will serve as the primary search and acquisition sensor and will be capable of tracking and collecting data on a large number of objects in a multi-target complex. The X-Band PAR will provide very high-resolution data on particular objects of interest.…
>
> The OBIS replacement platform, USNS Howard O. Lorenzen (Missile Range Instrumentation Ship (T-AGM) 25), is a commercially designed and constructed ship, classed to American Bureau of Shipping standards, certified by the U.S. Coast Guard in accordance with Safety of Life at Sea, and in compliance with other commercial regulatory body rules and regulations, and other Military Sealift Command (MSC) standards. The ship will be U.S. flagged, operated by a Merchant Marine or MSC Civilian Mariner crew, with a minimum of military specifications. The ship is projected to have a 30-year operating system life-cycle.
>
> The U.S. Navy will procure one CJR for the U.S. Air Force using only Research, Development, Test and Evaluation funding. CJR will be turned over to the U.S. Air Force at Initial Operational Capability for all operations and maintenance support.…
>
> Program activities are currently focused on installation and final integration of the X and S-band radars onto the ship at Kiewit Offshore Services (KOS) following completion of radar production and initial Integration and Test (I&T) at Raytheon and Northrop Grumman (NG). Raytheon and its subcontractors have completed I&T of the X-band radar and X/S ancillary equipment at KOS. The S-band radar arrived at KOS on February 19, 2011. The United States Naval Ship (USNS) Howard O. Lorenzen (Missile Range Instrumentation Ship (T-AGM) 25) completed at-sea Builder's Trials (BT) in March 2011. The ship is expected to depart VT Halter Marine (VTHM) and arrive at KOS in the third quarter of Fiscal Year 2011 (3QFY11).
>
> (Department of Defense, *Selected Acquisition Report (SAR), Cobra Judy Replacement*, December 31, 2010, pp. 3-5.)

[36] Department of Defense, *Selected Acquisition Report (SAR), Cobra Judy Replacement*, December 31, 2010, p. 13.

and larger growth margins. It might also permit a redesign of the deckhouse to support a larger and more capable version of the AMDR than the 14-foot diameter version currently planned for the Flight III DDG-51. Building the Flight III DDG-51 to a lengthened configuration would increase its development cost and its unit procurement cost. The increase in unit procurement cost could reduce the number of Flight III DDG-51s that the Navy could afford to procure without reducing funding for other programs.

Figure 3. Cobra Judy Replacement Ship



Source: Naval Research Laboratory (http://www.nrl.navy.mil/PressReleases/2010/image1_74-10r_hires.jpg, accessed on April 19, 2011).

DDG-1000 Variant with AMDR

Another option would be to design and procure a version of the DDG-1000 destroyer that is equipped with the AMDR and capable of BMD operations. Such a ship might be more capable in some regards than the Flight III DDG-51, but it might also be more expensive to develop and procure. An AMDR-equipped, BMD-capable version of the DDG-1000 could be pursued as either a replacement for the Flight III DDG-51 or a successor to the Flight III DDG-51 (after some number of Flight III DDG-51s were procured). A new estimate of the cost to develop and procure an AMDR-equipped, BMD-capable version of the DDG-1000 might differ from the estimate in the Navy's 2009 destroyer hull/radar study (the study that led to the Navy's decision to stop DDG-1000 procurement and resume DDG-51 procurement) due to the availability of updated cost information for building the current DDG-1000 design.

New-Design Destroyer

Another option would be to design and procure a new-design destroyer that is intermediate in size between the DDG-51 and DDG-1000 designs, equipped with the AMDR, and capable of BMD operations. This option could be pursued as either a replacement for the Flight III DDG-51 or a successor to the Flight III DDG-51 (after some number of Flight III DDG-51s were procured). Such a ship might be designed with the following characteristics:

- either the same version of the AMDR that is envisioned for the Flight III DDG-51, or a version that is larger (but not as large as the one envisioned for the CG[X]);

- enough electrical power and cooling capacity to permit the ship to be backfitted in the future with a high-power SSL;
- more growth margin than on the Flight III DDG-51;
- producibility features for reducing construction cost per ton that are more extensive than those on the DDG-51 design;
- automation features permitting a crew that is smaller than what can be achieved on a Flight III DDG-51, so as to reduce ship O&S costs;
- physical open-architecture features that are more extensive than those on the Flight III DDG-51, so as to reduce modernization-related life-cycle ownership costs;
- no technologies not already on, or being developed for, other Navy ships, with the possible exception of technologies that would enable an integrated electric drive system that is more compact than the one used on the DDG-1000; and
- DDG-51-like characteristics in other areas, such as survivability, maximum speed, cruising range, and weapons payload.

Such a ship might have a full load displacement of roughly 11,000 to 12,000 tons, compared to about 10,000 tons for the Flight III DDG-51, 15,000 or more tons for an AAW/BMD version of the DDG-1000, and perhaps 15,000 to 23,000 tons for a CG(X).[37]

A March 18, 2013, press report states that

> A recommended reevaluation of the next flights of LCSs [Littoral Combat Ships][38]... is only part of a classified memo, "Vision for the 2025 Surface Fleet," submitted late last year by the head of Naval Surface Forces, Vice Adm. Tom Copeman, to Chief of Naval Operations Adm. Jon Greenert....
>
> Copeman, according to several sources familiar with the document, also recommended against building the DDG 51 Flight III destroyers, a modification of the Arleigh Burke class to be fitted with the new Air Missile Defense Radar (AMDR) under development to replace the SPY-1 radars used in Aegis warships. The AMDR, designed with higher power and fidelity to handle the complex ballistic-missile defense mission, will require significantly more electrical power than the current system. And, while the AMDR apparently will fit into the DDG 51 hull, margins for future growth are severely limited.

[37] The cost and technical risk of developing the new destroyer's hull design could be minimized by leveraging, where possible, existing surface combatant hull designs. The cost and technical risk of developing its combat system could be minimized by using a modified version of the DDG-51 or DDG-1000 combat system. Other development costs and risks for the new destroyer would be minimized by using no technologies not already on, or being developed for, other Navy ships (with the possible exception of some integrated electric drive technologies). Even with such steps, however, the cost and technical risk of developing the new destroyer would be greater than those of the Flight III DDG-51. The development cost of the new destroyer would likely be equivalent to the procurement cost of at least one destroyer, and possibly two destroyers.

The procurement cost of the new destroyer would be minimized by incorporating producibility features for reducing construction cost per ton that are more extensive than those on the Flight III DDG-51. Even with such features, the new destroyer would be more expensive to procure than the Flight III DDG-51, in part because the Flight III DDG-51 would leverage many years of prior production of DDG-51s. In addition, the new destroyer, as a new ship design, would pose more risk of procurement cost growth than would the Flight III DDG-51. The procurement cost of the new destroyer would nevertheless be much less than that of the CG(X), and might, after the production of the first few units, be fairly close to that of the Flight III DDG-51.

[38] For more on the LCS program, see CRS Report RL33741, *Navy Littoral Combat Ship (LCS)/Frigate Program: Background and Issues for Congress*, by Ronald O'Rourke.

> Instead, sources said Copeman recommends creating a new, large surface combatant fitted with AMDR and designed with the power, weight and space to field "top-end energy weapons" like the electromagnetic rail gun under development by the Navy.
>
> The new ship could also be developed into a replacement for today's Ticonderoga-class missile cruisers in the air defense mission of protecting deployed aircraft carriers—a mission Copeman says needs to be preserved. All flattops have a "shotgun" cruiser that accompanies them throughout a deployment, but the missile ships are aging and, by 2025, only four will remain in service to protect the fleet's 11 carriers.
>
> The Navy prefers cruisers over destroyers for the role because of the bigger ships' extra missile fire control channels, their more senior commanders and a better ability to tow the carrier should it be disabled.
>
> While recommending against the Flight III, Copeman would continue building the existing DDG 51 Flight IIA variant until a new design is available.[39]

An April 9, 2014, press report states:

> The U.S. Navy is in the very early stages of developing a new destroyer—called the Future Surface Combatant—which will replace the existing Arleigh Burke-class destroyers and enter service by the early 2030s, Navy leaders told Military.com.
>
> Navy officials said it is much too early to speculate on hull design or shape for the new ship but lasers, on-board power-generation systems, increased automation, next-generation weapons, sensors and electronics are all expected to figure prominently in the development of the vessel.
>
> The Future Surface Combatant will succeed and serve alongside the Navy's current Flight III DDG 51 Arleigh Burke-class destroyer program slated to being construction in 2016. Overall, the Secretary of the Navy's long-range shipbuilding plan calls for construction of 22 Flight III DDGs, Navy officials said.
>
> There are a handful of early emerging requirements regarding what admirals want for the ship, Rear Adm. Tom Rowden, director of surface warfare, told Military.com in an interview.
>
> "I could not even draw a picture for you," said Rowden, who went on to explain that greater automation and integrated electrical power are part of the calculus of early discussions.
>
> He emphasized that the new ship will leverage successful next-generation technologies already underway in other platforms such as the DDG 1000 destroyer, Littoral Combat Ship and Ford-class aircraft carriers.
>
> The Future Surface Combatant may draw from the DDG 1000's high-tech electric drive system that propels the ship while generating 58 megawatts of on-board electrical power. On-board power will be in high demand as lasers and directed energy weapons become more prominent, Rowden said.
>
> "We are moving all ahead with respect to the development of lasers as a weapon in the future. You can take the power that is generated on the ship and convert that into a fire control solution without having to shoot a missile that may cost a million to ten million," Rowden explained....
>
> The largest aspect of emphasis for the nascent Future Surface Combatant program is something Rowden called modularity, a term referring to a technological ability to rapidly and effectively make adjustments as needed.

[39] Christopher P. Cavas, "U.S. Navy Weighs Halving LCS Order," *Defense News*, March 18, 2013: 1.

> The new ship design will emphasize flexibility to ensure the platform keeps pace with fast-moving technological change and threats, he said....
>
> "The modules that we install in the ship may have no bearing or resemblance to what needs to be there when we decommission the ship. The weapons and sensors will be different. We have to think about how to move through the design, manufacture and subsequent upgrades in the most cost-effective and affordable fashion. We need to design that into the ship," he said.[40]

Legislative Activity for FY2016

FY2016 Funding Request

The Navy estimates the combined procurement cost of the two DDG-51s requested for procurement in FY2016 at $3,522.7 million. The two DDG-51s requested for procurement in FY2016 have received a total of $373.0 million in prior-year advance procurement (AP) funding. The Navy's proposed FY2016 budget requests the remaining $3,149.7 million needed to complete the ships' estimated combined procurement cost.

The Navy's proposed FY2016 budget also requests $75.0 million in so-called cost-to-complete procurement funding to replace funding for DDG-51s procured in FY2010-FY2012 that was canceled by March 1, 2013, sequester.

The Navy's proposed FY2016 budget also requests $433.4 million in procurement funding to complete construction of Zumwalt (DDG-1000) class destroyers procured in prior years, and $241.8 million in research and development funding for development work on the AMDR. The funding request for the AMDR is contained in Program Element (PE) 0604522N ("Advanced Missile Defense Radar [AMDR] System"), which is line 118 in the Navy's FY2016 research and development account.

FY2016 National Defense Authorization Act (H.R. 1735/S. 1376)

House

The House Armed Services Committee, in its report (H.Rept. 114-112 of May 5, 2015) on H.R. 1735, recommends approving the Navy's FY2016 request for procurement and cost-to-complete procurement funding for the DDG-51 program and the Navy's FY2016 request for procurement funding for the DDG-1000 program (page 422, lines 007, 008, and 025). The report recommends approving the Navy's FY2016 request for research and development funding for the AMDR (page 465, line 118).

Section 121 of H.R. 1735 as reported by the committee states:

> SEC. 121. Modification to multiyear procurement authority for Arleigh Burke class destroyers and associated systems.
>
> Section 123(a) of the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112–239; 126 Stat. 1655) is amended by inserting "or Flight III" after "Flight IIA".

Section 123(a) of P.L. 112-239—the provision that would be amended by the above legislation—currently states:

[40] Kris Osborn, "Navy Makes Plans for New Destroyer for 2030s," *Military.com*, April 9, 2014.

SEC. 123. MULTIYEAR PROCUREMENT AUTHORITY FOR ARLEIGH BURKE CLASS DESTROYERS AND ASSOCIATED SYSTEMS.

(a) Authority for Multiyear Procurement.--Subject to section 2306b of title 10, United States Code, the Secretary of the Navy may enter into one or more multiyear contracts, beginning with the fiscal year 2013 program year, for the procurement of up to 10 Arleigh Burke class Flight IIA guided missile destroyers, as well as the Aegis weapon systems, MK 41 vertical launching systems, and commercial broadband satellite systems associated with such vessels.

Regarding Section 121, H.Rept. 114-112 states:

Section 121—Modification to Multiyear Procurement Authority for Arleigh Burke Class Destroyers and Associated Systems

This section would amend section 123(a) of the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112–239) and provide authority to the Secretary of the Navy to enter into a multiyear contract for a Flight III destroyer, in addition to the existing multiyear authority for a Flight IIA destroyer.

The committee supports the changes proposed by the Secretary of the Navy to integrate the Air and Missile Defense Radar in the Arleigh Burke class destroyer and the inclusion of the Flight III guided missile destroyer into the current multiyear authority. However, the committee is concerned about the Secretary of the Navy's strategy to implement an Engineering Change Proposal to fundamentally change integral elements of the Arleigh Burke class destroyer multiyear procurement without congressional authorization. When the initial multiyear procurement was authorized by section 123 of Public Law 112–239, the authorization was limited to an ''Arleigh Burke class Flight IIA guided missile destroyer.'' The committee includes this provision because it believes that implementation of a Flight III destroyer without an explicit congressional authorization would violate section 123 of Public Law 112–239, by constituting a cardinal change in the scope of the initial authorization. (Page 47)

H.Rept. 114-112 also states:

Air and Missile Defense Radar Testing evaluation

The committee notes that the Navy plans to use the Arleigh Burke-class destroyers (DDG 51) hull form as the platform for the Air and Missile Defense Radar (AMDR), which will provide integrated air and ballistic missile defense capability for the fleet. The committee further notes that the Director of Operational Test and Evaluation has disagreed with the Navy's plans for AMDR testing and believes that in order to achieve full end-to-end test results, testing must be performed aboard the self-defense test ship. Considering the central role that AMDR and DDG 51 Flight III will play in sea-based ballistic missile defense and the magnitude of the Navy's planned investment, the committee directs the Comptroller General of the United States to submit a report to the congressional defense committees by March 1, 2016, as to the potential use of AMDR on the self-defense test ship. This report should include, but is not limited to, an analysis of the following:

(1) Maturity of AMDR and the Navy's plans for developing, testing, and integrating AMDR, to include a cost benefit of performing AMDR testing aboard the self-defense test ship versus a manned ship;

(2) Risks associated with the Navy's planned acquisition strategy for the DDG 51 class and AMDR; and

(3) Any additional items the Comptroller General deems relevant to the report. (Pages 27-28)

H.Rept. 114-112 also states:

Air and Missile Defense Radar

The committee understands that the Navy Air and Missile Defense Radar (AMDR) is designed to be fully scalable and modular to support a variety of shipboard radar applications on a variety of platforms. The committee further understands that the flexibility in the design of AMDR could also provide the foundation for land based applications.

Therefore, the committee directs the Under Secretary of Defense for Acquisition, Technology, and Logistics to provide a briefing to the House Committee on Armed Services by February 1, 2016, on the Department of the Navy's plan to utilize the AMDR investment across existing and future platforms in the fleet. The briefing shall also include options that the Secretary is considering to exploit AMDR scalability in other service radar acquisitions to realize greater affordability through economies of scale. (Pages 33-34)

Senate

The Senate Armed Services Committee, in its report (S.Rept. 114-49 of May 19, 2015) on S. 1376, recommends increasing by $400 million the Navy's FY2016 request for procurement funding for the DDG-51 program, with the increase being for "Incremental funding for one DDG–51." The report recommends approving the Navy's FY2016 request for cost-to-complete procurement funding for the DDG-51 program and procurement funding for the DDG-1000 program. (Page 363, lines 7, 8, and 25.) The report recommends approving the Navy's FY2016 request for research and development funding for the AMDR (page 408, line 118).

Section 117 of S. 1376 as reported by the committee states:

SEC. 117. Construction of additional Arleigh Burke destroyer.

(a) In general.—The Secretary of the Navy may enter into a contract beginning with the fiscal year 2016 program year for the procurement of one Arleigh Burke class destroyer in addition to the ten DDG–51s in the fiscal year 2013 through 2017 multiyear procurement contract or for one DDG–51 in fiscal year 2018. The Secretary may employ incremental funding for such procurement.

(b) Condition on Out-year Contract Payments.—A contract entered into under subsection (a) shall provide that any obligation of the United States to make a payment under such contract for any fiscal year after fiscal year 2016 is subject to the availability of appropriations for that purpose for such fiscal year.

Regarding Section 117, S.Rept. 114-49 states:

Construction of additional Arleigh Burke destroyer (sec. 117)

The committee recommends a provision that would allow the Secretary of the Navy to enter into a contract beginning with the fiscal year 2016 program year for the procurement of one Arleigh Burke-class destroyer in addition to the ten DDG–51s in the fiscal year 2013 through 2017 multiyear procurement contract or for one DDG–51 in fiscal year 2018. The Secretary may employ incremental funding for such procurement.

Additional funding and incremental funding authority would help relieve pressure on the shipbuilding budget as funding requirements grow for the Ohio-class replacement program over the next several years. As a result, the committee recommends incremental funding authority for 1 Arleigh Burke-class destroyer in addition to the 10 DDG–51s in the fiscal year 2013–2017 multiyear procurement contract or for a DDG–51 in fiscal year 2018. (Page 11)

S.Rept. 114-49 also states:

Arleigh Burke-class destroyers

The budget request included $3.1 billion in Shipbuilding and Conversion, Navy for procurement of Arleigh Burke-class destroyers (DDG–51). Additional funding and incremental funding authority would help relieve pressure on the shipbuilding budget as funding requirements grow for the Ohio-class replacement program over the next several years. As a result, the committee recommends an increase of $400.0 million and incremental funding authority for 1 Arleigh Burke-class destroyer in addition to the 10 DDG–51s in the fiscal year 2013–2017 multiyear procurement contract or for a DDG–51 in fiscal year 2018. (Page 24)

S.Rept. 114-49 also states:

Air and Missile Defense Radar backfit

The Navy designed the Air and Missile Defense Radar (AMDR) to be fully scalable and modular to support a variety of shipboard radar applications on a variety of platforms. The first AMDR will be on the second DDG–51 destroyer in the fiscal year 2016 shipbuilding program. As can be seen with the Aegis Ashore program, ship-based radars such as AMDR also provide the foundation for land-based applications.

The committee directs the Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN (RDA)) to provide a report to congressional defense committees on the Navy's plan to employ AMDR technology in existing and future platforms across the fleet. Additionally, the committee directs the Under Secretary of Defense for Acquisition, Technology, and Logistics to report to the congressional defense committees on whether and to what extent the Department of Defense could exploit the AMDR scalability across radar acquisitions by the Army, Air Force, and Missile Defense Agency to realize greater affordability through economies of scale. These reports shall be provided with the fiscal year 2017 budget submission. (Page 212)

Conference Version (Version Vetoed)

The conference report (H.Rept. 114-270 of September 29, 2015) on H.R. 1735 (which was agreed to by the House and Senate on October 1 and 7, 2015, respectively, and vetoed by the President on October 22, 2015) recommends increasing by $400 million the Navy's FY2016 request for procurement funding for the DDG-51 program, with the increase being for "Incremental funding for one DDG–51." The report recommends approving the Navy's FY2016 request for cost-to-complete procurement funding for the DDG-51 program and procurement funding for the DDG-1000 program. (Page 911, lines 007, 008, and page 912, line 025.) The report recommends approving the Navy's FY2016 request for research and development funding for the AMDR (page 955, line 118).

Section 124 of H.R. 1735 states:

SEC. 124. Modification to multiyear procurement authority for Arleigh Burke class destroyers and associated systems.

Section 123(a) of the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112–239; 126 Stat. 1655) is amended by inserting "or Flight III" after "Flight IIA".

Section 123(a) of P.L. 112-239—the provision that would be amended by the above legislation—currently states:

SEC. 123. MULTIYEAR PROCUREMENT AUTHORITY FOR ARLEIGH BURKE CLASS DESTROYERS AND ASSOCIATED SYSTEMS.

(a) Authority for Multiyear Procurement.--Subject to section 2306b of title 10, United States Code, the Secretary of the Navy may enter into one or more multiyear contracts,

beginning with the fiscal year 2013 program year, for the procurement of up to 10 Arleigh Burke class Flight IIA guided missile destroyers, as well as the Aegis weapon systems, MK 41 vertical launching systems, and commercial broadband satellite systems associated with such vessels.

Regarding Section 124, H.Rept. 114-270 states:

Modification to multiyear procurement authority for Arleigh Burke-class destroyers and associated systems (sec. 124)

The House bill contained a provision (sec. 121) that would amend section 123(a) of the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112–239) to clarify that the Secretary of the Navy has the authority to procure Flight III destroyers as part of the existing Arleigh Burke-class multiyear procurement authority.

The Senate amendment contained no similar provision.

The Senate recedes.

The Senate report accompanying S. 3254 (S. Rept. 112–173) of the National Defense Authorization Act for Fiscal Year 2013 described Senate intent regarding the current multiyear procurement authority for Arleigh Burke-class destroyers and associated systems. The Senate report supported the change to buying Flight III destroyers through an engineering change proposal and the inclusion of such ships in the multiyear procurement authority, following submission of a specified report. The House report accompanying H.R. 1960 (H. Rept. 113–102) of the National Defense Authorization Act for Fiscal Year 2014 expressed concern about the physical limitations associated with the integration of the Air and Missile Defense Radar on the Flight III version of the Arleigh Burke-class destroyer and requested a report to assess this integration process. Having received the required reports, the conferees support the changes proposed by the Secretary of the Navy to integrate the Air and Missile Defense Radar into the Arleigh Burke-class destroyers and the addition of these Flight III ships to the current Arleigh Burke-class multiyear procurement contract. (Pages 608-609)

Section 125 of H.R. 1735 states:

SEC. 125. Procurement of additional Arleigh Burke class destroyer.

(a) Procurement authority.—

(1) ADDITIONAL DESTROYER.—The Secretary of the Navy may procure one Arleigh Burke class destroyer, in addition to any other procurement of such ships otherwise authorized by law, to be procured either—

(A) as an addition to the contract covering the 10 Arleigh Burke class destroyers authorized to be procured under section 123 of the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112–239; 126 Stat. 1655); or

(B) under a separate contract in fiscal year 2018.

(2) INCREMENTAL FUNDING.—The Secretary may employ incremental funding for the procurement authorized under paragraph (1).

(b) Condition on Out-year Contract Payments.—A contract entered into under subsection (a) shall provide that any obligation of the United States to make a payment under such contract for any fiscal year after fiscal year 2016 is subject to the availability of appropriations for that purpose for such fiscal year.

New Version (Following Veto)

Following the President's veto of the conference version of H.R. 1735 (see above), a new version of the FY2016 National Defense Authorization Act was prepared. S. 1356 is the expected legislative vehicle for this new version. Compared to the vetoed version of H.R. 1735, this new version of the FY2016 National Defense Authorization Act recommends increasing by $250 million (rather than $400 million, as in the vetoed version of H.R. 1735) the Navy's FY2016 request for procurement funding for the DDG-51 program, with the increase being for "Incremental funding for one DDG–51." (Section 4101, Shipbuilding & Conversion, Navy, line 008.)

FY2016 DOD Appropriations Act (H.R. 2685/S. 1558)

House

The House Appropriations Committee, in its report (H.Rept. 114-139 of June 5, 2015) on H.R. 2685, recommends reducing by $136.799 million the Navy's FY2016 request for procurement funding for the DDG-51 program, with the reduction being for

- "Basic construction cost growth" ($31.488 million);
- "Change orders" ($83.903 million);
- "Main reduction gear contract savings" ($18.855 million); and
- "SPQ-9B [radar] cost growth" ($2.553 million). (Page 161)

The report recommends approving the Navy's FY2016 request for cost-to-complete procurement funding for the DDG-51 program procurement funding for the DDG-1000 program (page 160), and reducing by $18.035 million the Navy's FY2016 request for research and development funding for the AMDR, with the reduction being for "Program execution" (page 237, line 118).

Senate

The Senate Appropriations Committee, in its report (S.Rept. 114-63 of June 11, 2015) on S. 1558, recommends increasing by $1 billion the Navy's FY2016 request for procurement funding for the DDG-51 program, with the increase being for "Program increase: Funding to support incremental funding authorization for an additional DDG-51" (page 100, line 8), approving the Navy's FY2016 request for procurement funding for the DDG-1000 program (page 98, line 7), and approving the Navy's FY2016 request for research and development funding for the AMDR (page 160, line 118).

S.Rept. 114-63 states:

> *Shipbuilding Industrial Base and Workload Allocation*.—As expressed in the report accompanying the Senate version of the fiscal year 2015 Department of Defense Appropriations Bill (Senate Report 113–211), the Committee remains concerned about the overall health of the shipbuilding industrial base and specifically about the health of the non-nuclear surface combatant shipbuilding industry. In compliance with Senate Report 113–211, the Navy submitted a report to Congress dated February 25, 2015, titled ''Shipbuilding Industrial Base and Workload Allocation''. The Committee was disappointed when this report failed to describe how the Navy intended to meet its remaining obligations under a 2002 workload allocation agreement that the Navy reaffirmed in 2009 and still considers ''in full force and effect.'' While Congress is not a party to this agreement, the Committee finds it unacceptable that the Navy is unable ''to determine the extent to which its obligations relating to the workload allocation provision

remain unfulfilled.'' The Committee also finds it troubling that the Navy communicated to Congress that it ''has not fully considered all of the options'' related to the agreement.

Consistent with the intent of the agreement signed by the Navy, funding for an additional DDG–51 Arleigh Burke-class destroyer would preserve options for maintaining an efficient and stable nonnuclear shipbuilding industrial base. It would also mitigate unfulfilled combatant commander requirements for large surface combatants. In addition, according to section 117 of S. 1376, the National Defense Authorization Act for Fiscal Year 2016, as reported, the Secretary of the Navy is authorized to incrementally fund an additional DDG–51 Arleigh Burke-class destroyer. Therefore, the Committee recommends an increase of $1,000,000,000 in incremental funding for one Arleigh Burke-class destroyer in addition to the ten DDG–51s in the fiscal year 2013–2017 multiyear procurement contract. (Page 101)

Appendix A. Additional Background Information on DDG-1000 Program

This appendix presents additional background information on the DDG-1000 program.

Program Origin

The program known today as the DDG-1000 program was announced on November 1, 2001, when the Navy stated that it was replacing a destroyer-development effort called the DD-21 program, which the Navy had initiated in the mid-1990s, with a new Future Surface Combatant Program aimed at developing and acquiring a family of three new classes of surface combatants:[41]

- **a destroyer called DD(X)** for the precision long-range strike and naval gunfire mission;
- **a cruiser called CG(X)** for the air defense and ballistic missile mission; and
- **a smaller combatant called the Littoral Combat Ship (LCS)** to counter submarines, small surface attack craft (also called "swarm boats"), and mines in heavily contested littoral (near-shore) areas.[42]

On April 7, 2006, the Navy announced that it had redesignated the DD(X) program as the DDG-1000 program. The Navy also confirmed in that announcement that the first ship in the class, DDG-1000, is to be named the *Zumwalt*, in honor of Admiral Elmo R. Zumwalt, the Chief of Naval operations from 1970 to 1974. The decision to name the first ship after Zumwalt was made by the Clinton Administration in July 2000, when the program was still called the DD-21 program.[43]

New Technologies

The DDG-1000 incorporates a significant number of new technologies, including a wave-piercing, tumblehome hull design for reduced detectability,[44] a superstructure made partly of large sections of composite (i.e., fiberglass-like) materials rather than steel or aluminum, an integrated electric-drive propulsion system,[45] a total-ship computing system for moving information about

[41] The DD-21 program was part of a Navy surface combatant acquisition effort begun in the mid-1990s and called the SC-21 (Surface Combatant for the 21st Century) program. The SC-21 program envisaged a new destroyer called DD-21 and a new cruiser called CG-21. When the Navy announced the Future Surface Combatant Program in 2001, development work on the DD-21 had been underway for several years, while the start of development work on the CG-21 was still years in the future. The current DDG-1000 destroyer CG(X) cruiser programs can be viewed as the descendants, respectively, of the DD-21 and CG-21. The acronym SC-21 is still used in the Navy's research and development account to designate the line item (i.e., program element) that funds development work on both the DDG-1000 and CG(X).

[42] For more on the LCS program, see CRS Report RL33741, *Navy Littoral Combat Ship (LCS)/Frigate Program: Background and Issues for Congress*, by Ronald O'Rourke.

[43] For more on Navy ship names, see CRS Report RS22478, *Navy Ship Names: Background for Congress*, by Ronald O'Rourke.

[44] A tumblehome hull slopes inward, toward the ship's centerline, as it rises up from the waterline, in contrast to a conventional flared hull, which slopes outward as it rises up from the waterline.

[45] For more on integrated electric-drive technology, see CRS Report RL30622, *Electric-Drive Propulsion for U.S. Navy Ships: Background and Issues for Congress*, by Ronald O'Rourke.

the ship, automation technologies enabling its reduced-sized crew, a dual-band radar, a new kind of vertical launch system (VLS) for storing and firing missiles, and two copies of a 155mm gun called the Advanced Gun System (AGS). The AGS is to fire a new rocket-assisted 155mm shell, called the Long Range Land Attack Projectile (LRLAP), to ranges of more than 60 nautical miles. The DDG-1000 can carry 600 LRLAP rounds (300 for each gun), and additional rounds can be brought aboard the ship while the guns are firing, creating what Navy officials call an "infinite magazine."

Planned Quantity

When the DD-21 program was initiated, a total of 32 ships was envisaged. In subsequent years, the planned total for the DD(X)/DDG-1000 program was reduced to 16 to 24, then to 7, and finally to 3.

Construction Shipyards

Under a DDG-1000 acquisition strategy approved by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD AT&L) on February 24, 2004, the first DDG-1000 was to have been built by HII/Ingalls, the second ship was to have been built by GD/BIW, and contracts for building the first six were to have been equally divided between HII/Ingalls[46] and GD/BIW.

In February 2005, Navy officials announced that they would seek approval from USD AT&L to instead hold a one-time, winner-take-all competition between HII/Ingalls and GD/BIW to build all DDG-1000s. On April 20, 2005, the USD AT&L issued a decision memorandum deferring this proposal, stating in part, "at this time, I consider it premature to change the shipbuilder portion of the acquisition strategy which I approved on February 24, 2004."

Several Members of Congress also expressed opposition to Navy's proposal for a winner-take-all competition. Congress included a provision (§1019) in the Emergency Supplemental Appropriations Act for 2005 (H.R. 1268/P.L. 109-13 of May 11, 2005) prohibiting a winner-take-all competition. The provision effectively required the participation of at least one additional shipyard in the program but did not specify the share of the program that is to go to the additional shipyard.

On May 25, 2005, the Navy announced that, in light of Section 1019 of P.L. 109-13, it wanted to shift to a "dual-lead-ship" acquisition strategy, under which two DDG-1000s would be procured in FY2007, with one to be designed and built by HII/Ingalls and the other by GD/BIW.

Section 125 of the FY2006 defense authorization act (H.R. 1815/P.L. 109-163) again prohibited the Navy from using a winner-take-all acquisition strategy for procuring its next-generation destroyer. The provision again effectively requires the participation of at least one additional shipyard in the program but does not specify the share of the program that is to go to the additional shipyard.

On November 23, 2005, the USD AT&L granted Milestone B approval for the DDG-1000, permitting the program to enter the System Development and Demonstration (SDD) phase. As part of this decision, the USD AT&L approved the Navy's proposed dual-lead-ship acquisition

[46] At the time of the events described in this section, HII was owned by Northrop Grumman and was called Northrop Grumman Shipbuilding (NGSB).

strategy and a low rate initial production quantity of eight ships (one more than the Navy subsequently planned to procure).

On February 14, 2008, the Navy awarded contract modifications to GD/BIW and HII/Ingalls for the construction of the two lead ships. The awards were modifications to existing contracts that the Navy has with GD/BIW and HII/Ingalls for detailed design and construction of the two lead ships. Under the modified contracts, the line item for the construction of the dual lead ships is treated as a cost plus incentive fee (CPIF) item.

Until July 2007, it was expected that HII/Ingalls would be the final-assembly yard for the first DDG-1000 and that GD/BIW would be the final-assembly yard for the second. On September 25, 2007, the Navy announced that it had decided to build the first DDG-1000 at GD/BIW, and the second at HII/Ingalls.

On January 12, 2009, it was reported that the Navy, HII/Ingalls, and GD/BIW in the fall of 2008 began holding discussions on the idea of having GD/BIW build both the first and second DDG-1000s, in exchange for HII/Ingalls receiving a greater share of the new DDG-51s that would be procured under the Navy's July 2008 proposal to stop DDG-1000 procurement and restart DDG-51 procurement.[47]

On April 8, 2009, it was reported that the Navy had reached an agreement with HII/Ingalls and GD/BIW to shift the second DDG-1000 to GD/BIW, and to have GD/BIW build all three ships. HII/Iingalls will continue to make certain parts of the three ships, notably their composite deckhouses. The agreement to have all three DDG-1000s built at GD/BIW was a condition that Secretary of Defense Robert Gates set forth in an April 6, 2009, news conference on the FY2010 defense budget for his support for continuing with the construction of all three DDG-1000s (rather than proposing the cancellation of the second and third).

Procurement Cost Cap

Section 123 of the FY2006 defense authorization act (H.R. 1815/P.L. 109-163 of January 6, 2006) limited the procurement cost of the fifth DDG-1000 to $2.3 billion, plus adjustments for inflation and other factors. Given the truncation of the DDG-1000 program to three ships, this unit procurement cost cap appears moot.

2010 Nunn-McCurdy Breach, Program Restructuring, and Milestone Recertification

On February 1, 2010, the Navy notified Congress that the DDG-1000 program had experienced a critical cost breach under the Nunn-McCurdy provision. The Nunn-McCurdy provision (10 U.S.C. 2433a) requires certain actions to be taken if a major defense acquisition program exceeds (i.e., breaches) certain cost-growth thresholds and is not terminated. Among other things, a program that experiences a cost breach large enough to qualify under the provision as a critical cost breach has its previous acquisition system milestone certification revoked. (In the case of the DDG-1000 program, this was Milestone B.) In addition, for the program to proceed rather than be terminated, DOD must certify certain things, including that the program is essential to national

[47] Christopher P. Cavas, "Will Bath Build Second DDG 1000?" *Defense News*, January 12, 2009: 1, 6.

security and that there are no alternatives to the program that will provide acceptable capability to meet the joint military requirement at less cost.[48]

The Navy stated in its February 1, 2010, notification letter that the DDG-1000 program's critical cost breach was a mathematical consequence of the program's truncation to three ships.[49] Since the DDG-1000 program has roughly $9.3 billion in research and development costs, truncating the program to three ships increased to roughly $3.1 billion the average amount of research and development costs that are included in the average acquisition cost (i.e., average research and development cost plus procurement cost) of each DDG-1000. The resulting increase in program acquisition unit cost (PAUC)—one of two measures used under the Nunn-McCurdy provision for measuring cost growth[50]—was enough to cause a Nunn-McCurdy critical cost breach.

In a June 1, 2010, letter (with attachment) to Congress, Ashton Carter, the DOD acquisition executive (i.e., the Under Secretary of Defense for Acquisition, Technology and Logistics), stated that he had restructured the DDG-1000 program and that he was issuing the certifications required under the Nunn-McCurdy provision for the restructured DDG-1000 program to proceed.[51] The letter stated that the restructuring of the DDG-1000 program included the following:

- A change to the DDG-1000's design affecting its primary radar.
- A change in the program's Initial Operational Capability (IOC) from FY2015 to FY2016.
- A revision to the program's testing and evaluation requirements.

Regarding the change to the ship's design affecting its primary radar, the DDG-1000 originally was to have been equipped with a dual-band radar (DBR) consisting of the Raytheon-built X-band SPY-3 multifunction radar (MFR) and the Lockheed-built S-band SPY-4 Volume Search Radar (VSR). (Raytheon is the prime contractor for the overall DBR.) Both parts of the DBR have been in development for the past several years. An attachment to the June 1, 2010, letter stated that, as a result of the program's restructuring, the ship is now to be equipped with "an upgraded multifunction radar [MFR] and no volume search radar [VSR]." The change eliminates the Lockheed-built S-band SPY-4 VSR from the ship's design. The ship might retain a space and weight reservation that would permit the VSR to be backfitted to the ship at a later point. The Navy states that

> As part of the Nunn-McCurdy certification process, the Volume Search Radar (VSR) hardware was identified as an acceptable opportunity to reduce cost in the program and thus was removed from the current baseline design....
>
> Modifications will be made to the SPY-3 Multi-Function Radar (MFR) with the focus of meeting ship Key Performance Parameters. The MFR modifications will involve

[48] For more on the Nunn-McCurdy provision, see CRS Report R41293, *The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress*, by Moshe Schwartz.

[49] Source: Letter to congressional offices dated February 1, 2010, from Robert O. Work, Acting Secretary of the Navy, to Representative Ike Skelton, provided to CRS by Navy Office of Legislative Affairs on February 24, 2010.

[50] PAUC is the sum of the program's research and development cost and procurement cost divided by the number of units in the program. The other measure used under the Nunn-McCurdy provision to measure cost growth is average program unit cost (APUC), which is the program's total procurement cost divided by the number of units in the program.

[51] Letter dated June 1, 2010, from Ashton Carter, Under Secretary of Defense (Acquisition, Technology and Logistics) to the Honorable Ike Skelton, with attachment. The letter and attachment were posted on InsideDefense.com (subscription required) on June 2, 2010.

> software changes to perform a volume search functionality. Shipboard operators will be able to optimize the SPY-3 MFR for either horizon search or volume search. While optimized for volume search, the horizon search capability is limited. Without the VSR, DDG 1000 is still expected to perform local area air defense....
>
> The removal of the VSR will result in an estimated $300 million net total cost savings for the three-ship class. These savings will be used to offset the program cost increase as a result of the truncation of the program to three ships. The estimated cost of the MFR software modification to provide the volume search capability will be significantly less than the estimated procurement costs for the VSR.[52]

Regarding the figure of $300 million net total cost savings in the above passage, the Navy during 2011 determined that eliminating the SPY-4 VSR from the DDG-1000 increased by $54 million the cost to integrate the dual-band radar into the Navy's new Gerald R. Ford (CVN-78) class aircraft carriers.[53] Subtracting this $54 million cost from the above $300 million savings figure would bring the net total cost savings to about $246 million on a Navy-wide basis.

A July 26, 2010, press report quotes Captain James Syring, the DDG-1000 program manager, as stating: "We don't need the S-band radar to meet our requirements [for the DDG-1000]," and "You can meet [the DDG-1000's operational] requirements with [the] X-band [radar] with software modifications."[54]

An attachment to the June 1, 2010, letter stated that the PAUC for the DDG-1000 program had increased 86%, triggering the Nunn-McCurdy critical cost breach, and that the truncation of the program to three ships was responsible for 79 of the 86 percentage points of increase. (The attachment stated that the other seven percentage points of increase are from increases in development costs that are primarily due to increased research and development work content for the program.)

Carter also stated in his June 1, 2010, letter that he had directed that the DDG-1000 program be funded, for the period FY2011-FY2015, to the cost estimate for the program provided by the Cost Assessment and Program Evaluation (CAPE) office (which is a part of the Office of the Secretary of Defense [OSD]), and, for FY2016 and beyond, to the Navy's cost estimate for the program. The program was previously funded to the Navy's cost estimate for all years. Since CAPE's cost estimate for the program is higher than the Navy's cost estimate, funding the program to the CAPE estimate for the period FY2011-FY2015 will increase the cost of the program as it appears in the budget for those years. The letter states that DOD "intends to address the [resulting] FY2011 [funding] shortfall [for the DDG-1000 program] through reprogramming actions."

An attachment to the letter stated that the CAPE in May 2010 estimated the PAUC of the DDG-1000 program (i.e., the sum of the program's research and development costs and procurement costs, divided by the three ships in the program) as $7.4 billion per ship in then-year dollars ($22.1 billion in then-year dollars for all three ships), and the program's average procurement unit cost (APUC), which is the program's total procurement cost divided by the three ships in the program, as $4.3 billion per ship in then-year dollars ($12.8 billion in then-year dollars for all three ships). The attachment stated that these estimates are at a confidence level of about 50%,

[52] Source: Undated Navy information paper on DDG-51 program restructuring provided to CRS and CBO by Navy Office of Legislative Affairs on July 19, 2010.

[53] Source: Undated Navy information paper on CVN-78 cost issues, provided by Navy Office of Legislative Affairs to CRS on March 19, 2012.

[54] Cid Standifer, "Volume Radar Contracted For DDG-1000 Could Be Shifted To CVN-79," *Inside the Navy*, July 26, 2010.

meaning that the CAPE believes there is a roughly 50% chance that the program can be completed at or under these cost estimates, and a roughly 50% chance that the program will exceed these cost estimates.

An attachment to the letter directed the Navy to "return for a Defense Acquisition Board (DAB) review in the fall 2010 timeframe when the program is ready to seek approval of the new Milestone B and authorization for production of the DDG-1002 [i.e., the third ship in the program]."

On October 8, 2010, DOD reinstated the DDG-1000 program's Milestone B certification and authorized the Navy to continue production of the first and second DDG-1000s and commence production of the third DDG-1000.[55]

Under Secretary of Defense Ashton Carter's June 1, 2010, letter and attachment restructuring the DDG-1000 program and DOD's decision on October 8, 2010, to reinstate the DDG-1000 program's Milestone B certification raise the following potential oversight questions for Congress:

- Why did DOD decide, as part of its restructuring of the DDG-1000 program, to change the primary radar on the DDG-1000?
- What are the potential risks to the DDG-1000 program of changing its primary radar at this stage in the program (i.e., with the first ship under construction, and preliminary construction activities underway on the second ship)?
- How will the upgraded MFR differ in cost, capabilities, and technical risks from the baseline MFR included in the original DDG-1000 design?
- What is the net impact on the capabilities of the DDG-1000 of the change to the DDG-1000's primary radar (i.e., of removing the VSR and upgrading the MFR)?
- Given change to the DDG-1000's primary radar and the May 2010 CAPE estimates of the program's program acquisition unit cost (PAUC) and average program unit cost (APUC), is the DDG-1000 program still cost effective?
- What impact on cost, schedule, or technical risk, if any, will the removal of the VSR from the DDG-1000 design have on the Navy's plan to install the dual-band radar (DBR), including the VSR, on the Ford (CVN-78) class aircraft carriers CVN-78 and CVN-79?[56]

March 2014 GAO Report

A March 2014 GAO report assessing selected major DOD weapon acquisition programs stated the following of the DDG-1000 program:

> **Technology Maturity**
>
> The DDG-1000 program has made progress in developing its critical technologies. However, only 3 of 11 are mature and the remaining 8 will not be demonstrated in a realistic environment until after installation on the lead ship. Guided flight tests of the gun system's long-range land-attack projectile were successfully completed in October

[55] Christopher J. Castelli, "Pentagon Approves Key Milestone For Multibillion-Dollar Destroyer," *Inside the Navy*, November 22, 2010.

[56] For more on these aircraft carriers, see CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by Ronald O'Rourke.

2013. After significant cost growth and development challenges, all six software releases for the total ship computing environment have been completed and certified to support lead ship activation and delivery and a software spiral update is under contract timed to support initial operating capability. Following a critical Nunn-McCurdy unit-cost breach in 2010, DOD restructured the program and removed the volume search radar from the ship's design. A modified multifunction radar is expected to begin land based testing in 2014, followed by at- sea testing in 2015.

Design and Production Maturity

The DDG 1000 design is largely mature. According to the program manager and ship builder, as of October 2013, production and test efforts for the first two ships were 88 and 70 percent complete, respectively. While few design changes have resulted from lead ship construction, shipbuilders have experienced challenges with the manufacture and integration of the composite deckhouse for the first and second ships, resulting in rework and schedule delays particularly on the first ship. The Navy has emphasized a joint inspection process whereby the prime contractors and the Navy validate product quality and completeness prior to integration with the hull. After assessing alternatives and conducting a competition, the Navy decided to build the third ship's deckhouse and hangar with steel as a cost saving measure as the program manager noted that the Navy has better cost insights into the long-term maintenance of steel compared to composite materials.

Other Program Issues

Delivery of the lead ship (hull, mechanical and electrical systems) may slip past the currently scheduled date of September 2014 and the Navy is in the process of assessing the delivery date. If delivery slips past October 2014, the program will breach its acquisition program baseline schedule requirements. According to the Navy, the delay is the result of difficulties in completing the ship's electrical systems, which is impacting test and activation events.

The program has awarded all major contracts for the three ships in the DDG 1000 class among four prime contractors. As the integrator, the Navy is responsible for ensuring on-time delivery of products and bears the costs of schedule delays that affect another contractor. Bath Iron Works is now producing the hull for all three ships. In August 2013, the Navy awarded a fixed price contract to Bath Iron Works for a steel deckhouse, hangar, and aft peripheral vertical launching system for the third ship. According to the program manager, the shipbuilder negotiated a 5- and 10-month delivery delay for the second and third ship, respectively.

Program officials also reported that the program absorbed sequestration reductions of $70 million in fiscal year 2013 by delaying testing and the award of contracts for mission-related equipment. The program is also incorporating technical configuration changes resulting from the configuration steering board and Nunn-McCurdy annual cost review aimed at maintaining capability and minimizing costs. For example, the program manager told us the program assessed alternatives to the close in gun system and chose a legacy system that met requirements with about half the weight and cost.

Program Office Comments

In commenting on a draft of this assessment the Navy noted that the DDG 1000 lead ship was successfully launched in October 2013, a christening is scheduled for April 2014, and activation activities continue. For the second ship, keel laying and hangar erection have occurred, hull integration is underway, and deckhouse delivery is scheduled for spring 2014. The Navy noted that significant integration efforts between four prime

contractors continue with a focus on cost reduction and schedule performance. The Navy also provided technical comments, which were incorporated where deemed appropriate.[57]

[57] Government Accountability Office, *Defense Acquisitions[:] Assessments of Selected Weapon Programs*, GAO-14-340SP, March 2014, p. 60.

Appendix B. Additional Background Information on CG(X) Cruiser Program

Background Information on CG(X) Program

The CG(X) cruiser program was announced by the Navy on November 1, 2001.[58] The Navy wanted to procure as many as 19 CG(X)s as replacements for its 22 CG-47s, which are projected to reach the end of their 35-year service lives between 2021 and 2029. The CG-47s are multi-mission ships with an emphasis on AAW and (for some CG-47s) BMD, and the Navy similarly wanted the CG(X) to be a multi-mission ship with an emphasis on AAW and BMD. The CG(X) was to carry the Air and Missile Defense Radar (AMDR), a new radar that was to be considerably larger and more powerful than the SPY-1 radar carried on the Navy's Aegis ships. Some press reports suggested that a nuclear-powered version of the CG(X) might have had a full load displacement of more than 20,000 tons and a unit procurement cost of $5 billion or more.[59]

The Navy's FY2009 budget called for procuring the first CG(X) in FY2011. Beginning in late 2008, however, it was reported that the Navy had decided to defer the procurement of the first CG(X) by several years, to about FY2017.[60] Consistent with these press reports, on April 6, 2009,

[58] The Navy on that date announced that that it was launching a Future Surface Combatant Program aimed at acquiring a family of next-generation surface combatants. This new family of surface combatants, the Navy stated, would include three new classes of ships:

- a destroyer called the DD(X)—later redesignated DDG-1000—for the precision long-range strike and naval gunfire mission,
- a cruiser called the CG(X) for the AAW and BMD mission, and
- a smaller combatant called the Littoral Combat Ship (LCS) to counter submarines, small surface attack craft, and mines in heavily contested littoral (near-shore) areas.

The Future Surface Combatant Program replaced an earlier Navy surface combatant acquisition effort, begun in the mid-1990s, called the Surface Combatant for the 21st Century (SC-21) program. The SC-21 program encompassed a planned destroyer called DD-21 and a planned cruiser called CG-21. When the Navy announced the Future Surface Combatant Program in 2001, development work on the DD-21 had been underway for several years, but the start of development work on the CG-21 was still years in the future. The DD(X) program, now called the DDG-1000 or Zumwalt-class program, is essentially a restructured continuation of the DD-21 program. The CG(X) might be considered the successor, in planning terms, of the CG-21. After November 1, 2001, the acronym SC-21 continued for a time to be used in the Navy's research and development account to designate a line item (i.e., program element) that funded development work on the DDG-1000 and CG(X).

[59] For a discussion of nuclear power for Navy surface ships other than aircraft carriers, see CRS Report RL33946, *Navy Nuclear-Powered Surface Ships: Background, Issues, and Options for Congress*, by Ronald O'Rourke.

[60] Zachary M. Peterson, "Navy Awards Technology Company $128 Million Contract For CG(X) Work," *Inside the Navy*, October 27, 2008. Another press report (Katherine McIntire Peters, "Navy's Top Officer Sees Lessons in Shipbuilding Program Failures," *GovernmentExecutive.com*, September 24, 2008) quoted Admiral Gary Roughead, the Chief of Naval Operations, as saying: "What we will be able to do is take the technology from the DDG-1000, the capability and capacity that [will be achieved] as we build more DDG-51s, and [bring those] together around 2017 in a replacement ship for our cruisers." (Material in brackets in the press report.) Another press report (Zachary M. Peterson, "Part One of Overdue CG(X) AOA Sent to OSD, Second Part Coming Soon," *Inside the Navy*, September 29, 2008) quoted Vice Admiral Barry McCullough, the Deputy Chief of Naval Operations for Integration of Capabilities and Resources, as saying that the Navy did not budget for a CG(X) hull in its proposal for the Navy's budget under the FY2010-FY2015 Future Years Defense Plan (FYDP) to be submitted to Congress in early 2009.

An earlier report (Christopher P. Cavas, "DDG 1000 Destroyer Program Facing Major Cuts," *DefenseNews.com*, July 14, 2008) stated that the CG(X) would be delayed until FY2015 or later. See also Geoff Fein, "Navy Likely To Change CG(X)'s Procurement Schedule, Official Says," *Defense Daily*, June 24, 2008; Rebekah Gordon, "Navy Agrees CG(X) By FY-11 Won't Happen But Reveals Little Else," *Inside the Navy*, June 30, 2008.

Secretary of Defense Robert Gates announced—as part of a series of recommendations for the then-forthcoming FY2010 defense budget—a recommendation to "delay the CG-X next generation cruiser program to revisit both the requirements and acquisition strategy" for the program.[61] The Navy's proposed FY2010 budget deferred procurement of the first CG(X) beyond FY2015.

Cancellation of CG(X) Program

The Navy's FY2011 budget proposed terminating the CG(X) program as unaffordable. The Navy's desire to cancel the CG(X) and instead procure Flight III DDG-51s apparently took shape during 2009: at a June 16, 2009, hearing before the Seapower Subcommittee of the Senate Armed Services Committee, the Navy testified that it was conducting a study on destroyer procurement options for FY2012 and beyond that was examining design options based on either the DDG-51 or DDG-1000 hull form.[62] A January 2009 memorandum from the Department of Defense acquisition executive had called for such a study.[63] In September and November 2009, it was reported that the Navy's study was examining how future requirements for AAW and BMD operations might be met by a DDG-51 or DDG-1000 hull equipped with a new radar.[64] On December 7, 2009, it was reported that the Navy wanted to cancel its planned CG(X) cruiser and instead procure an improved version of the DDG-51.[65] In addition to being concerned about the projected high cost and immature technologies of the CG(X),[66] the Navy reportedly had concluded that it does not need a surface combatant with a version of the AMDR as large and capable as the one envisaged for the CG(X) to adequately perform projected AAW and BMD missions, because the Navy will be able to augment data collected by surface combatant radars with data collected by space-based sensors. The Navy reportedly concluded that using data collected by other sensors would permit projected AAW and BMD missions to be performed adequately with a radar smaller enough to be fitted onto the DDG-51.[67] Reports suggested that the

[61] Source: Opening remarks of Secretary of Defense Robert Gates at an April 6, 2009, news conference on DOD recommendations for the then-forthcoming FY2010 defense budget.

[62] Source: Transcript of spoken remarks of Vice Admiral Bernard McCullough at a June 16, 2009, hearing on Navy force structure shipbuilding before the Seapower subcommittee of the Senate Armed Services Committee.

[63] A January 26, 2009, memorandum for the record from John Young, the then-DOD acquisition executive, stated that "The Navy proposed and OSD [the Office of the Secretary of Defense] agreed with modification to truncate the DDG-1000 Program to three ships in the FY 2010 budget submission." The memo proposed procuring one DDG-51 in FY2010 and two more FY2011, followed by the procurement in FY2012-FY2015 (in annual quantities of 1, 2, 1, 2) of a ship called the Future Surface Combatant (FSC) that could be based on either the DDG-51 design or the DDG-1000 design. The memorandum stated that the FSC might be equipped with a new type of radar, but the memorandum did not otherwise specify the FSC's capabilities. The memorandum stated that further analysis would support a decision on whether to base the FSC on the DDG-51 design or the DDG-1000 design. (Memorandum for the record dated January 26, 2009, from John Young, Under Secretary of Defense [Acquisition, Technology and Logistics], entitled "DDG 1000 Program Way Ahead," posted on InsideDefense.com [subscription required].)

[64] Zachary M. Peterson, "Navy Slated To Wrap Up Future Destroyer Hull And Radar Study," *Inside the Navy*, September 7, 2009. Christopher P. Cavas, "Next-Generation U.S. Warship Could Be Taking Shape," *Defense News*, November 2, 2009: 18, 20.

[65] Christopher J. Castelli, "Draft Shipbuilding Report Reveals Navy Is Killing CG(X) Cruiser Program," *Inside the Navy*, December 7, 2009.

[66] Christopher J. Castelli, "Draft Shipbuilding Report Reveals Navy Is Killing CG(X) Cruiser Program," *Inside the Navy*, December 7, 2009.

[67] Amy Butler, "STSS Prompts Shift in CG(X) Plans," *Aerospace Daily & Defense Report*, December 11, 2009: 1-2.

new smaller radar would be a scaled-down version of the AMDR originally intended for the CG(X).[68]

The Navy's February 2010 report on its FY2011 30-year (FY2011-FY2040) shipbuilding plan, submitted to Congress in conjunction with the FY2011 budget, states that the 30-year plan:

> Solidifies the DoN's [Department of the Navy's] long-term plans for Large Surface Combatants by truncating the DDG 1000 program, restarting the DDG 51 production line, and continuing the Advanced Missile Defense Radar (AMDR) development efforts. Over the past year, the Navy has conducted a study that concludes a DDG 51 hull form with an AMDR suite is the most cost-effective solution to fleet air and missile defense requirements over the near to mid-term....
>
> The Navy, in consultation with OSD, conducted a Radar/Hull Study for future destroyers. The objective of the study was to provide a recommendation for the total ship system solution required to provide Integrated Air and Missile Defense (IAMD) (simultaneous ballistic missile and anti-air warfare (AAW) defense) capability while balancing affordability with capacity. As a result of the study, the Navy is proceeding with the Air and Missile Defense Radar (AMDR) program....
>
> As discussed above, the DDG 51 production line has been restarted. While all of these new-start guided missile destroyers will be delivered with some BMD capability, those procured in FY 2016 and beyond will be purpose-built with BMD as a primary mission. While there is work to be done in determining its final design, it is envisioned that this DDG 51 class variant will have upgrades to radar and computing performance with the appropriate power generation capacity and cooling required by these enhancements. These upgraded DDG 51 class ships will be modifications of the current guided missile destroyer design that combine the best emerging technologies aimed at further increasing capabilities in the IAMD arena and providing a more effective bridge between today's capability and that originally planned for the CG(X). The ships reflected in this program have been priced based on continuation of the existing DDG 51 re-start program. Having recently completed the Hull and Radar Study, the Department is embarking on the requirements definition process for these AMDR destroyers and will adjust the pricing for these ships in future reports should that prove necessary.[69]

In testimony to the House and Senate Armed Services Committees on February 24 and 25, 2010, respectively, Admiral Gary Roughead, the Chief of Naval Operations, stated:

> Integrated Air and Missile Defense (IAMD) incorporates all aspects of air defense against ballistic, anti-ship, and overland cruise missiles. IAMD is vital to the protection of our force, and it is an integral part of our core capability to deter aggression through conventional means....
>
> To address the rapid proliferation of ballistic and anti-ship missiles and deep-water submarine threats, as well as increase the capacity of our multipurpose surface ships, we restarted production of our DDG 51 Arleigh Burke Class destroyers (Flight IIA series). These ships will be the first constructed with IAMD, providing much-needed Ballistic Missile Defense (BMD) capacity to the Fleet, and they will incorporate the hull, mechanical, and electrical alterations associated with our mature DDG modernization

[68] Cid Standifer, "NAVSEA Plans To Solicit Contracts For Air And Missile Defense Radar," *Inside the Navy*, December 28, 2009; "Navy Issues RFP For Phase II of Air And Missile Defense Radar Effort," *Defense Daily*, December 24, 2009: 4.

[69] U.S. Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, February 2010, pp. 12, 13, 19. The first reprinted paragraph, taken from page 12, also occurs on page 3 as part of the executive summary.

> program. We will spiral DDG 51 production to incorporate future integrated air and missile defense capabilities....
>
> The Navy, in consultation with the Office of the Secretary of Defense, conducted a Radar/Hull Study for future surface combatants that analyzed the total ship system solution necessary to meet our IAMD requirements while balancing affordability and capacity in our surface Fleet. The study concluded that Navy should integrate the Air and Missile Defense Radar program S Band radar (AMDR-S), SPY-3 (X Band radar), and Aegis Advanced Capability Build (ACB) combat system into a DDG 51 hull. While our Radar/Hull Study indicated that both DDG 51 and DDG 1000 were able to support our preferred radar systems, leveraging the DDG 51 hull was the most affordable option. Accordingly, our FY 2011 budget cancels the next generation cruiser program due to projected high cost and risk in technology and design of this ship. I request your support as we invest in spiraling the capabilities of our DDG 51 Class from our Flight IIA Arleigh Burke ships to Flight III ships, which will be our future IAMD-capable surface combatant. We will procure the first Flight III ship in FY 2016.[70]

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[70] Statement of Admiral Gary Roughead, Chief of Naval Operations, before the House Armed Services Committee on 24 February, 2010, pp. 10-11; and Statement of Admiral Gary Roughead, Chief of Naval Operations, before the Senate Armed Services Committee on 25 February 2010, pp. 10-11.