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

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Summary

Consistent with a proposal announced by the Navy in July 2008, the Administration's FY2010 defense budget proposed ending procurement of DDG-1000 (Zumwalt) class destroyers with the third ship, which was authorized and partially funded in FY2009, and restarting procurement DDG-51 (Arleigh Burke) class Aegis destroyers, which were last procured in FY2005. The proposed FY2010 defense budget requested procurement funding to complete the cost of the third DDG-1000 and to procure one DDG-51, and advance procurement funding for two more DDG-51s that the Navy wants to procure in FY2011.

The Navy's plans for destroyer procurement in FY2012 and beyond have been unclear. The Navy since July 2008 has spoken on several occasions about a desire to build a total of 11 or 12 DDG-51s between FY2010 and FY2015, but the Navy also testified to the Seapower subcommittee of the Senate Armed Services Committee on June 16, 2009, that it is conducting a study on destroyer procurement options for FY2012 and beyond that is examining design options based on either the DDG-51 or DDG-1000 hull form. A January 2009 memorandum from the Department of Defense acquisition executive called for such a study. A November 2009 press report stated that the study was begun in late Spring 2009, that it was nearing completion, that it examined options for equipping the DDG-51 and DDG-1000 designs with an improved radar, and that preliminary findings from the study began to be briefed to "key parties on Capitol Hill and in industry" in October 2009.

On December 7, 2009, it was reported that the Navy wants to cancel its planned CG(X) cruiser and instead procure an improved version of the Arleigh Burke (DDG-51) class Aegis destroyer. The improved DDG-51 that the Navy reportedly now wants to procure would be considerably less expensive to procure than the CG(X). The improved DDG-51 would have more AAW and BMD capability than the current DDG-51 design, but less AAW and BMD capability than what was envisioned for the CG(X). Potential issues for Congress arising from the Navy's reported new plan include the following:

- Is there an adequate analytical basis for canceling the CG(X) and instead procuring improved DDG-51s? Should an analysis of alternatives (AOA) or the equivalent of an AOA be performed before committing to this course of action?
- Is there adequate stability in Navy planning for acquisition of surface combatants?
- Would an improved DDG-51 be an adequate substitute for the CG(X)?
- What would be the potential operational implications of a Navy equipped with improved DDG-51s instead of CG(X)s?
- What would be the potential industrial-base consequences of canceling the CG(X) and instead procuring improved DDG-51s?
- What would be some potential alternatives to canceling the CG(X) and instead procuring improved DDG-51s?

Contents

Figures

Tables

Appendixes

Contacts

Introduction

Consistent with a proposal announced by the Navy in July 2008, the Administration's FY2010 defense budget proposed ending procurement of DDG-1000 (Zumwalt) class destroyers with the third ship, which was authorized and partially funded in FY2009, and restarting procurement DDG-51 (Arleigh Burke) class Aegis destroyers, which were last procured in FY2005. The proposed FY2010 defense budget requested procurement funding to complete the cost of the third DDG-1000 and to procure one DDG-51, and advance procurement funding for two more DDG-51s that the Navy wants to procure in FY2011.

The Navy's plans for destroyer procurement in FY2012 and beyond have been unclear. The Navy since July 2008 has spoken on several occasions about a desire to build a total of 11 or 12 DDG-51s between FY2010 and FY2015, but the Navy also testified to the Seapower subcommittee of the Senate Armed Services Committee on June 16, 2009, that it is conducting a study on destroyer procurement options for FY2012 and beyond that is examining design options based on either the DDG-51 or DDG-1000 hull form. A January 2009 memorandum from the Department of Defense (DOD) acquisition executive called for such a study. A November 2009 press report stated that the study was begun in late Spring 2009, that it was nearing completion, that it examined options for equipping the DDG-51 and DDG-1000 designs with an improved radar, and that preliminary findings from the study began to be briefed to "key parties on Capitol Hill and in industry" in October 2009.[1]

On December 7, 2009, it was reported that the Navy wants to cancel its planned CG(X) cruiser and instead procure an improved version of the Arleigh Burke (DDG-51) class Aegis destroyer.[2] Earlier press reporting had suggested that the Navy might be heading toward such a change in plans.[3] The Navy reportedly was concerned about the projected high cost of the CG(X), and has concluded that it does not need a ship as capable as the CG(X) to adequately perform future anti-air warfare (AAW) and ballistic missile defense (BMD) missions. The Navy's desire to cancel the CG(X) and instead procure improved DDG-51s reportedly will be reflected in the Navy's proposed FY2011 budget, which is to be submitted to Congress in early February 2010.

Prior to this reported change in plans, the Navy had wanted to procure as many as 19 CG(X)s. The Navy had wanted to procure the first CG(X) around FY2017 and have it enter service around 2023.[4]

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[1] Christopher P. Cavas, "Next-Generation U.S. Warship Could Be Taking Shape," *Defense News*, November 2, 2009: 18, 20.

[2] Christopher J. Castelli, "Draft Shipbuilding Report Reveals Navy Is Killing CG(X) Cruiser Program," *Inside the Navy*, December 7, 2009. A November 2009 press report on a recent Navy "Hull/Radar" study suggested the Navy wanted to procure an improved destroyer featuring a new radar. (Christopher P. Cavas, "Next-Generation U.S. Warship Could Be Taking Shape," *Defense News*, November 2, 2009: 18, 20.) Given the potential difficulty for the Navy to finance, more or less simultaneously, the development and procurement of both an improved destroyer and the CG(X), this press report raised the question of whether the Navy now wanted to cancel the CG(X).

[3] Christopher P. Cavas, "Next-Generation U.S. Warship Could Be Taking Shape," *Defense News*, November 2, 2009: 18, 20.

[4] For more on the CG(X) program, see CRS Report RL34179, *Navy CG(X) Cruiser Program: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke

The improved DDG-51 that the Navy reportedly now wants to procure would be considerably less expensive to procure than the CG(X). The improved DDG-51 would have more AAW and BMD capability than the current DDG-51 design, but less AAW and BMD capability than what was envisioned for the CG(X).

Potential issues for Congress include the following:

- Is there an adequate analytical basis for canceling the CG(X) and instead procuring improved DDG-51s? Should an analysis of alternatives (AOA) or the equivalent of an AOA be performed before committing to this course of action?
- Is there adequate stability in Navy planning for acquisition of surface combatants?
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- What would be the potential operational implications of a Navy equipped with improved DDG-51s instead of CG(X)s?
- What would be the potential industrial-base consequences of canceling the CG(X) and instead procuring improved DDG-51s?
- What would be some potential alternatives to canceling the CG(X) and instead procuring improved DDG-51s?

Decisions that Congress reaches about destroyer and cruiser acquisition could significantly affect Navy capabilities and funding requirements, and the surface combatant industrial base.

Background

Navy Destroyer and Cruiser Acquisition Programs

DDG-51 Program

Program Origin

The DDG-51 (Arleigh Burke) Aegis destroyer program was initiated in the late 1970s 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.

Mission Orientation and Design Features

The DDG-51 is a multi-mission surface combatant with an emphasis on air defense (which the Navy refers as anti-air warfare, or AAW) and blue-water (mid-ocean) operations. DDG-51s, like CG-47s, 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 current version of the DDG-51 design, called the Flight IIA version, has a full load displacement of about 9,500 tons, which is similar to that of the CG-47.

The DDG-51 design has been changed over time to incorporate various improvements. The Flight IIA design, which was first procured in FY1994, was a significant change that included, among other things, the addition of a helicopter hangar. The Aegis system installed on new DDG-51s has been updated several times.

DDG-51s (and also some CG-47s) are being modified to receive an additional capability for ballistic missile defense (BMD) operations. 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.[5]

Total Procured Through FY2005 and Construction Shipyards

The first DDG-51 was procured in FY1985, and a total of 62 were procured through FY2005. The first ship entered service in 1991, a total of 54 were in service as of the end of FY2008, and the 62nd is scheduled to enter service in 2011. Of the 62 DDG-51s procured through FY2005, General Dynamics Bath Iron Works (GD/BIW) of Bath, ME, is the builder of 34, and the Ingalls shipyard that forms part of Northrop Grumman Shipbuilding (NGSB) is the builder of 28.[6]

The Navy has initiated a program for modernizing existing DDG-51s so as maintain their mission and cost effectiveness out to the end of their projected 35-year service lives.[7] In August 2008, it was reported that the Navy had decided to expand the scope of this program to include the installation of a BMD capability, so that every DDG-51 would eventually have a BMD capability.[8]

Older CRS reports provide additional historical and background information on the DDG-51 program.[9]

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[5] For more on Navy BMD programs, CRS Report RL33745, *Sea-Based Ballistic Missile Defense—Background and Issues for Congress*, by Ronald O'Rourke.

[6] In the earlier years of the DDG-51 program, when as many as four or five DDG-51s per year were being procured, Bath Iron Works (BIW) of Bath, ME (now a part of General Dynamics) and Ingalls Shipbuilding of Pascagoula, MS (now a part of Northrop Grumman Shipbuilding) competed on an annual basis for contracts to build DDG-51s. In FY1994, when the annual DDG-51 procurement rate dropped to about three ships per year, the Navy ended annual competition between the firms for the purpose of allocating DDG-51 construction contracts and began to allocate DDG-51s between them. Two years later, in FY1996, the Navy began using Profit Related to Offer (PRO) bidding, which granted a higher profit rate to the shipyard that submitted the lower-cost bid for its work. PRO bidding permits the Navy to employ a degree of competition in the acquisition of DDG-51s even though DDG-51s are allocated rather than competitively awarded to the two shipyards.

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

[8] Otto Kreisher, "BMD Boost," Seapower, August 2008: 12-14. Equipping all DDG-51s with a BMD capability would substantially expand the current program of record for Navy BMD platforms, which currently calls for 15 DDG-51s (and 3 Aegis cruisers) to be equipped for BMD operations.

[9] 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]

DDG-1000 Program

Program Origin and Names

The Navy initiated the DDG-1000 (Zumwalt) destroyer program in the early 1990s under the name DD-21, which meant destroyer for the 21st Century. In November 2001, the program was restructured and renamed the DD(X) program, 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.

Mission Orientation and Design Features

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 was intended in part 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.[10] The DDG-1000 was also intended to improve the Navy's general capabilities for operating in defended littoral waters, to introduce several new technologies that would be available for use on future Navy ships, and to serve as the basis for the Navy's planned CG(X) cruiser.

The DDG-1000 is to have a reduced-size crew of 142 sailors (compared to roughly 300 on the Navy's current destroyers and cruisers) so as reduce its operating and support (O&S) costs. The ship is to incorporate a significant number of new technologies, including a wave-piercing, tumblehome hull design for reduced detectability,[11] 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,[12] a total-ship computing system for moving information about the ship, automation technologies for the 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."

With an estimated full load displacement of 14,987 tons, the DDG-1000 design is roughly 55% 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.

[10] 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.

[11] 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.

[12] 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.

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, and then to 7. Under the Administration's proposed FY2010 budget, the planned total is to be reduced to three.

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

Estimated Costs and Prior-Year Funding

The first two DDG-1000s were procured in FY2007 and split-funded (i.e., funded with two-year incremental funding) in FY2007-FY2008. In the FY2009 budget, the Navy estimated their combined procurement cost at $6,324.5 million. In the FY2010 budget, the Navy estimates their combined procurement cost at $6,634.2 million—an increase of $309.7 million, or about 4.9%. The Navy states that this increase is not due to growth in the estimated cost to build the ships themselves, but rather to a reallocation to the first two ships of some class-wide program-support costs that were to have been included in the procurement costs of the fourth through seventh ships.[13] To cover this cost growth, the Navy's proposed FY2010 budget requests $309.6 million in procurement funding in a line item in the Navy's shipbuilding account that requests funding to cover cost growth on ships procured in prior fiscal years.[14]

The third DDG-1000 was authorized and partially funded in FY2009. The FY2009 budget estimated the procurement cost of the third DDG-1000 at $2,652.6 million. The FY2010 budget estimates the ship's procurement cost at $2,738.3 million—an increase of $85.7 million, or about 3.2%. The third DDG-1000 received $149.8 million in advance procurement funding in FY2008, and $1,504.3 million in procurement funding in FY209. The Navy's proposed FY2010 budget requests $1,084.2 million to complete the cost of the ship.

The DD-21/DD(X)/DDG-1000 program has received a total of about $15.3 billion in funding from FY1995 through FY2009. This total includes about $7.4 billion in research and development funding, and about $8.0 billion in procurement funding.

Construction Shipyards

Until July 2007, it was expected that NGSB 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 NGSB.

On January 12, 2009, it was reported that the Navy, NGSB, 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 NGSB 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.[15]

[13] Source: Navy briefing on DDG-1000 to CRS and Congressional Budget Office (CBO), June 10, 2009.

[14] The difference between the $309.7 million figure and the $309.6 million figure appears to be a consequence of rounding figures to the nearest tenth of a million.

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

On April 8, 2009, it was reported that the Navy had reached an agreement with NGSB and GD/BIW to shift the second DDG-1000 to GD/BIW, and to have GD/BIW build all three ships. NGSB 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).

CG(X) Program

Program Origin

The CG(X) program was announced on November 1, 2001, when the Navy stated 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:[16]

- **a destroyer called the DD(X)**—later renamed the DDG-1000 or Zumwalt class—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.[17]

The Navy wanted to procure as many as 19 CG(X)s as replacements for its 22 Ticonderoga (CG-47) class Aegis cruisers, which are projected to reach their retirement age of 35 years between 2021 and 2029.[18]

[16] 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).

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

[18] CG-47s are equipped with the Aegis combat system and are therefore referred to as Aegis cruisers. 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. The Navy is currently modernizing the remaining 22 to maintain their mission effectiveness to age 35; for more information, see CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

Mission Orientation and Potential Design Features

The Navy's 22 Aegis cruisers are highly capable multi-mission ships with an emphasis on AAW and (as a more recent addition) BMD. The Navy similarly wanted the CG(X) to be a highly capable multi-mission ship with an emphasis on AAW and BMD. BMD has emerged in recent years as a significant new mission for the Navy. Navy surface ships in coming years may face a threat from anti-ship ballistic missiles (ASBMs)—theater-range ballistic missiles (TBMs) equipped with maneuvering re-entry vehicles (MaRVs) that are capable of hitting moving ships at sea—a kind of threat the Navy has not previously faced.[19] Navy BMD capabilities could also be used to defend allied or friendly ports, airfields, cities, or forces ashore against enemy TBMs, or to defend the United States against enemy intercontinental ballistic missiles (ICBMs).[20]

The CG(X) was expected to feature a new radar, called the Air and Missile Defense Radar (AMDR), that would be larger and more powerful than the SPY-1 radar on the Navy's current Aegis cruisers and destroyers.[21]

The Navy originally intended to use the DDG-1000 hull design as the basis for the CG(X) design.[22] The potential for reusing the DDG-1000 hull design for the CG(X) was one of the Navy's arguments for moving ahead with the DDG-1000 program. In more recent years, however, the Navy appeared to back away from the idea of reusing the DDG-1000 hull design as the basis for the CG(X).[23]

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[19] For a discussion of potential MaRV-equipped TBMs capable of hitting moving ships at sea, see CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by Ronald O'Rourke.

[20] For further discussion of the Navy's BMD program, CRS Report RL33745, *Sea-Based Ballistic Missile Defense—Background and Issues for Congress*, by Ronald O'Rourke.

[21] The Navy testified in 2007 that the power requirement of the CG(X) combat system, including the new radar, could be about 30 or 31 megawatts, compared with about 5 megawatts for the Aegis combat system. (Source: Spoken testimony of Navy officials to the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee, March 1, 2007.) The CG(X) radar's greater power would be intended, among other things, to give the CG(X) more capability for BMD operations than Navy's Aegis cruisers and destroyers.

[22] For example, at an April 5, 2006, hearing, a Navy admiral in charge of shipbuilding programs, when asked what percentage of the CG(X) design would be common to that of the DDG-1000, stated that:

> [W]e haven't defined CG(X) in a way to give you a crisp answer to that question, because there are variations in weapons systems and sensors to go with that. But we're operating under the belief that the hull will fundamentally be—the hull mechanical and electrical piece of CG(X) will be the same, identical as DD(X). So the infrastructure that supports radar and communications gear into the integrated deckhouse would be the same fundamental structure and layout. I believe to accommodate the kinds of technologies CG(X) is thinking about arraying, you'd probably get 60 to 70 percent of the DD(X) hull and integrated (inaudible) common between DD(X) and CG(X), with the variation being in that last 35 percent for weapons and that sort of [thing]....
>
> The big difference [between CG(X) and DDG-1000] will likely [be] the size of the arrays for the radars; the numbers of communication apertures in the integrated deckhouse; a little bit of variation in the CIC [Combat Information Center—in other words, the] command and control center; [and] likely some variation in how many launchers of missiles you have versus the guns.
>
> (Source: Transcript of spoken testimony of Rear Admiral Charles Hamilton II, Program Executive Officer For Ships, Naval Sea Systems Command, before the Projection Forces Subcommittee of House Armed Services Committee, April 5, 2006. The inaudible comment may have been a reference to the DDG-1000's integrated electric-drive propulsion system. Between the two paragraphs quoted above, the questioner (Representative Gene Taylor) asked: "So the big difference [between CG(X) and DDG-1000] will be what?")

[23] A July 2, 2008, letter from John Young, the Department of Defense (DOD) acquisition executive (the Under (continued...)

Section 1012 of the FY2008 defense authorization act (H.R. 4986/P.L. 110-181 of January 28, 2008) makes it U.S. policy to construct the major combatant ships of the Navy, including ships like the CG(X), with integrated nuclear power systems, unless the Secretary of Defense submits a notification to Congress that the inclusion of an integrated nuclear power system is not in the national interest. The Navy studied nuclear power as a design option for the CG(X), but did not announce whether it would prefer to procure the CG(X) as a nuclear-powered ship. Some press reports have suggested that a nuclear-powered version of the CG(X) might have a full load displacement of more than 20,000 tons and a unit procurement cost of $5 billion or more. The issue of nuclear power for Navy surface ships is discussed in more detail in another CRS report.[24]

Planned Procurement Schedule

The Navy's FY2009 budget had 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.[25] Consistent with these press reports, on April 6, 2009, Secretary of Defense Robert Gates announced—as part of a series of decisions concerning the Department of Defense's (DOD's) proposed FY2010 defense budget—a decision to "delay the CG-X next generation cruiser program to revisit both the requirements and acquisition strategy" for the program.[26] The Navy's proposed FY2010 budget deferred procurement of the first CG(X) beyond FY2015.

(...continued)

Secretary of Defense for Acquisition, Technology and Logistics) to Representative Gene Taylor, the chairman of the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee, stated: "I agree that the Navy's preliminary design analysis for the next-generation cruiser indicates that, for the most capable radar suites under consideration [for the CG(X)], the DDG-1000 [hull design] cannot support the radar." In addition, it is not clear that the DDG-1000 can accommodate one-half of the twin-reactor plant that the Navy has designed for its new Gerald R. Ford (CVN-78) class nuclear-powered aircraft carriers. If the DDG-1000 hull cannot accommodate one-half of the Ford-class plant, then the Navy might face a choice of either designing a new hull for the CG(X) that can accommodate one-half of the Ford-class plant or designing a new reactor plant that can fit into the DDG-1000 hull.

[24] CRS Report RL33946, *Navy Nuclear-Powered Surface Ships: Background, Issues, and Options for Congress*, by Ronald O'Rourke.

[25] 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.

[26] Source: Opening remarks of Secretary of Defense Robert Gates at an April 6, 2009, news conference on DOD decisions relating to DOD's proposed FY2010 defense budget.

Analysis of Alternatives (AOA)

The Navy assessed CG(X) design options in a study called the CG(X) Analysis of Alternatives (AOA), known more formally as the Maritime Air and Missile Defense of Joint Forces (MAMDJF) AOA. The CG(X) AOA was begun in mid-2006 and completed at the end of 2007. The Navy did not publicly release the results of the CG(X) AOA .

Shifts in Navy Destroyer and Cruiser Acquisition Plans

Rationale for 2008-2009 Shift in Destroyer Procurement Plans

The Navy announced its desire to end DDG-1000 procurement and restart DDG-51 procurement at a July 31, 2008, hearing before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee. (For the Navy's prepared statement for the hearing, see **Appendix B**.) In testimony at that hearing and subsequent hearings, and in other remarks since July 2008, Navy officials have stated that they decided to propose ending DDG-1000 procurement and restarting DDG-51 procurement because of a reassessment of threats that Navy forces are likely to face in coming years. As a result of this reassessment, Navy officials have stated, the service wants destroyer procurement over the next several years to emphasize three mission capabilities – area-defense AAW, BMD, and open-ocean ASW. Navy officials have 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 state 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 DDG-1000s over the next several years for the same total amount of funding. In addition, the Navy no longer appears 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.

A May 11, 2009, letter from Admiral Gary Roughead, the Chief of Naval Operations, to Senator Edward Kennedy, the chairman of the Seapower subcommittee of the House Armed Services Committee, stated:

> In response to your letter of October 24, 2008 concerning the Navy's Long-Range Shipbuilding Plan and the decision to truncate the DDG-1000 program, I stated in my letter on January 5, 2009 that I would provide the cost estimates comparisons you requested when they were developed in conjunction with the Fiscal Year (FY) 2010 Budget.
>
> Specifically, you requested a comparison of "Acquisition Costs for DDG-51s and Modified DDG-1000s" with design specifications for the Modified DDg-1000 reflecting nominally equal capability. Table 1 provides a comparison of acquisition cost of Fiscal Year 2010 ship and average follow ship for a DDG-51 and Modified DDG-1000 based on a multi-hull procurement in constant FY10 dollars. The cost of 10 additional DDG-51s is less than a 7 ship class of DDG-1000s.

Table 1. [In Navy letter to Congress] Acquisition Costs for DDG-51s and Modified DDG-1000s

(Costs in CY2010 $B)

	FY10	Total FY 11 and Out	Avg Follow (FY11-16)
DDG-1000			
RDT&E	0.14	1.76	—
SCN	2.73		2.55
Total	2.87		
DDG 51			
RDT&E	0.01	0.15	—
SCN	2.24		1.90
Total	2.25		

*** Acquisition costs reflect Rough Order of Magnitude (ROM) estimates which reflect uncertainty in some categories of cost (e.g., amount of software reuse). The acquisition costs do not reflect the recent DDG 1000/DDG 51 swap agreement.**

It is important to discuss the assumptions used in formulating Table 1. Specifically:

- Advanced Gun Systems and associated magazines in the current DDG-1000 design deleted and additional missile-launch tubes installed in their place.

- Ship and missile modifications as needed for the ship to successfully employ SM-2, SM-3, and SM-6 missiles and otherwise give the ship a Ballistic Missile Defense (BMD) and are-defense AAW capability not less than that of Flight IIA DDG-51 with Advanced Capability 12.

- The primary system differences between the DDG-51 and DDG-1000 ships with respect to ASW are the bow mounted sonars, the Periscope Detection Radar (PDR) planned for DDG-1000, and the DDG-1000's planned lower ship self noise characteristics. There is a known performance difference at the sensor level between the hull mounted sonars on the DDG-51 and DDG-1000 ships due to physical size and source level differences between the ships. The DDG-51 has slightly better performance, but when factoring the PDR and quieter self noise characteristics, the DDG-1000 could be expected to perform as well as, or possibly better than the DDG-51 under certain scenarios and acoustic conditions. At the campaign level when the ship is utilized in fleet ASW tactics in conjunction with other ship and air assets the magnitude of the performance difference is unclear. Due to the probability that the difference in performance levels at the campaign level would be low, I will forgo the detailed analysis and assess the two ships as equal in this area without modification.

The 10 additional DDG-51s would join an existing fleet force structure of 22 CGs and 62 DDGs. These follow-on DDG-51s build on a common hull and stable combat system configuration incorporating advanced Integrated Air and Missile Defense (IAMD) and Anti Submarine Warfare suite optimized for blue water sea base defense. Besides the enhancements required to gain IAMD capability in DDG-1000, the technical risk and acquisition costs associated with DDG-1000 are not as well defined as the known cost for the DDG-51 hull and combat system. Therefore, the additional capacity and capability gained through continuation of DDG-51s with lower technical risk and defined cost, couple with the

risks associated with the DDG-1000 make the restart of the DDG-51 line the preferred choice for affordable warfighting capability and capacity.

Table 2 provides data for your request to compare "Annual O & S Costs for a DDG-51 and a Modified DDG-1000" in constant FY10 dollars. Although DDG-1000 requires a smaller crew, comparing the individual element of manning costs between the two ships can be misleading. DDG-1000 was able to decrease its crew size through increased automation and by growing shore support primarily to complete maintenance traditionally performed by ship's company. Navy is committee to increasing the shore infrastructure to perform this maintenance however; those added maintenance costs generally negate the savings generated by the smaller crew size.

Table 2. [In Navy Letter to Congress] Annual O & S Costs for a DDG-51 and a Modified DDG-1000

(Average O&S/Ship/Year in CY10 $M)

Cost Element	DDG-51	Modified DDG-1000	Difference (DDG-51 – DDG-1000)
Operating (steaming), assuming crude [oil] cost of:			
$50 per barrel	$6.07	$8.42	$(2.35)
$100 per barrel	$12.14	$16.84	$(4.70)
$150 per barrel	$18.20	$25.26	$(7.05)
Maintenance	$20.39	$33.39	$(13.00)
Manpower*	$37.34	$17.32	$20.02
Total, Assuming crude oil cost of:			
$50 per barrel	$63.80	$59.13	$4.67
$100 per barrel	$69.87	$67.55	$2.32
$150 per barrel	$75.93	$75.97	$(0.04)
Total Crew Size	254 Enlisted, 25 Officers	108 Enlisted, 15 Officers	

* Does not account for increased ashore maintenance costs associated with DDG-1000s decreased crew size

Assumptions used in compiling Table 2 included:

- All costs are expressed in constant FY 2010 dollars
- Reflects average annual cost per ship, calculated on a 35 year service life basis. Includes periodic depot maintenance and fact of life upgrades.
- Annual Fuel Usage rate of 87,373 barrels for DDG-51 and 121,233 barrels for DDG-1000
- Crew Size is based on the following manning documents:
    - DDG-51 FLT IIA Part 3 (DDG 91 – DDG 102) Final Ship Manpower Document, 9 April 2007

- DDG-1000 Program Preliminary Ship Manpower Document, DCDRL-C.12 Rev b, Attachment 2, 31 August 2007
- Three additional crew members added to each ship class for BMD
- Reduced manning benefits are best realized over a large class of ships such as LCS with 55 ships.

> In my role as Chief of Naval Operations, I will continue to develop a shipbuilding program which provides affordable combat capability in sufficient capacity to maintain our position as the dominant naval power in the world. For less cost and risk, truncating DDG-1000 and building additional DDG-51s is the clearest path to that end.
>
> Thank you for your continued interest in our shipbuilding program and for your unwavering support of our Navy. If I can be of any further assistance, please let me know.[27]

Study of Destroyer Procurement Options for FY2012 and Beyond

The Navy wants to procure one DDG-51 in FY2010 and two more DDG-51s in FY2011. The Navy's plans for destroyer procurement in FY2012 and beyond have been unclear. The Navy since July 2008 has spoken on several occasions about a desire to build a total of 11 or 12 DDG-51s between FY2010 and FY2015, but the Navy also testified to the Seapower subcommittee of the Senate Armed Services Committee on June 16, 2009, that it is conducting a study on destroyer procurement options for FY2012 and beyond that is examining design options based on either the DDG-51 or DDG-1000 hull form.[28] A January 2009 memorandum from the Department of Defense acquisition executive called for such a study.[29]

A September 7, 2009, press report stated:

> A Navy-commissioned study slated to wrap up this month will determine the required combination of hull form and radar to combat anti-ship ballistic missiles, a finding that could lead to the future use of the DDG-1000 platform truncated by the service last year, according to an August briefing slide by Rear Adm. Frank Pandolfe, the director of surface warfare.
>
> The "DDG hull and radar study" is looking at the "required capability against emerging threats" and proper "hull/radar combination to meet the requirement," Pandolfe's brief states.

[27] Letter dated May 11, 2009 from Admiral Gary Roughead to Senator Edward Kennedy, posted on InsideDefense.com (subscription required) on June 26, 2009.

[28] 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.

[29] 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].)

> Last summer, the Navy announced its intentions to truncate the DDG-1000 destroyer program at three hulls and instead buy additional DDG-51 vessels—a decision Chief of Naval Operations Adm. Gary Roughead touts in his 2010 guidance released last week.
>
> However, in January, then-Defense Department acquisition czar John Young sent a memorandum to senior Pentagon and Navy officials arguing the Navy's future destroyer fleet beyond fiscal year 2011 remained unclear.
>
> "From FY-12 through FY-15, the [Defense Department] will procure guided-missile destroyers based on either the DDG-51 hull or the DDG-1000 hull," Young wrote in the Jan. 26 memo, marked "For Official Use Only—Pre-decisional" and sent to senior service and DOD officials.
>
> Young dubbed the undefined destroyer as the "future surface combatant."
>
> In June, Navy requirements chief Vice Adm. Barry McCullough told a Senate panel that a study on future surface ship capabilities was under way, led by Johns Hopkins University. This study is described in Pandolfe's brief, a Navy official at the Pentagon confirmed late last week.
>
> "Along with the [defense secretary] and [the office of the secretary of defense], we've embarked on a study that's being led by Johns Hopkins University that's addressing that right now," he said. "And from that study, we will see what capability is achievable to get us at the heart of the threat with limited technical risk and where that best fits with respect to hull form and then what the best path for the replacement cruiser is to come out of that study."
>
> The future surface combatant is not an actual ship, McCullough explained to reporters following the June hearing.
>
> "When we determine what radar capability we need, then we'll determine what's the best hull form" for future destroyers purchased in FY-12 and beyond, the three-star admiral said.
>
> According to the August briefing, the study will determine the future threat of anti-ship ballistic missiles and next-generation anti-ship cruise missiles and the required hull and radar necessary to combat the threat. This will compare the capabilities of the DDG-51 class of destroyers versus the DDG-1000 class.[30]

A November 2, 2009, press report stated:

> The shape of the U.S. Navy's next large combatant surface ship could be coming closer into view, but a key study group working on the question isn't quite ready to present its findings.
>
> One issue, however, does seem decided: Support for a very large, nuclear-powered cruiser to carry and power a new ballistic missile defense (BMD) radar may have evaporated, largely due to its extravagant price tag.
>
> Work on the Hull/Radar Study began in late spring. The effort, carried out under the office of the chief of naval operations (OP-NAV), was meant to determine the maximum BMD capability that could be put into a destroyer hull.

[30] Zachary M. Peterson, "Navy Slated To Wrap Up Future Destroyer Hull And Radar Study," *Inside the Navy*, September 7, 2009. Material in brackets as in original.

Concurrent with that analysis, the Navy has tasked industry with developing concept studies for a new radar for the ships, called the Air and Missile Defense Radar (AMDR). Northrop Grumman, Lockheed Martin and Raytheon are the prime contenders.

The Hull/Radar Study is one of several efforts initiated earlier this year by the Navy to examine alternatives for the next big warship, latterly called the Future Surface Combatant and, before that, the CG(X) cruiser. The studies, including efforts by the Johns Hopkins Advanced Physics Laboratory and the Massachusetts Institute of Technology's Lincoln Laboratory, are looking at ways to meet the Navy's requirements for sea-based ballistic missile defense, as well as traditional surface warships roles including defense of carrier and expeditionary strike groups.

But the Hull/Radar Study has, according to sources, become the centerpiece of Chief of Naval Operations Adm. Gary Roughead's effort to choose a capable and affordable ship to meet the Navy's needs. Those same sources also caution about an internal Pentagon debate over the various studies.

The Hull/Radar Study has, said one source, been viewed by the Navy as the "decisional study" for the question of the next surface combatant.

But staffers working for Ashton Carter, the Pentagon's top weapon buyer, reportedly "believe the right answer will be from the sum of all the studies," the source said.

Work on the AMDR, the source added, largely is being done under directives laid out by John Young, whom Carter replaced in April.

The issue could be put to the test soon. Over the past three weeks, Navy officials have been briefing key parties on Capitol Hill and in industry on the state of the Hull/Radar Study. No timetable has been revealed for completion of the study, but one Pentagon source said Oct. 30, "it's real close." The issues at stake are complex.

The costs to design and develop a new hull are high, and Naval Sea Systems Command is working to base future ships on as few hull designs as possible. Hull choices on which to build the new ship are the DDG 51 destroyer hull developed in the 1980s, and the DDG 1000 hull designed over the past decade for the new Zumwalt-class destroyers.

The basic DDG 51 hull is just over 500 feet long and 67 feet wide, while the DDG 1000 hull is 600 feet long with a beam of 81 feet. The characteristics of the DDG 51 hull are well understood, while the tumblehome hull of the DDG 1000, meant to slice through waves rather than ride over them, has stirred controversy in some quarters. No similar hull has been constructed, and some engineers worry about potential stability problems, although Navy designers maintain steadfastly that extensive computer and test-tank modeling has shown no stability concerns.

Radar To Combat Missiles

The new radar is meant to form the basis for the next-generation combat system, intended from the outset to combat ballistic missiles.

Northrop Grumman, Lockheed Martin and Raytheon each were awarded $9.9 million contracts on June 26 to conduct concept stud-ies for the AMDR, but those agreements expire in December. For the work's next phase, the Navy on Oct. 26 posted a notice of its intent to solicit up to three technology development contracts for the AMDR.

> The notice, posted on the Federal Business Opportunities Web site, calls the effort a "full and open competition," but Navy and industry sources said the three original contractors would likely each receive a request for pro-posal for the new contract.
>
> The new radar system is a dual-band radar system, including S-band and X-band radars and their Radar Suite Controller (RSC). The S-band AMDR-S is to provide volume search, tracking, BMD discrimination and missile communications. The AMDR-X will provide horizon search, precision tracking, missile communication and terminal illumination.
>
> The new solicitation announced Oct. 26 will cover the RSC and the AMDR-S radar.
>
> The Hull/Radar Study's decision to move away from the big, nuclear cruiser—dubbed CGNX—was based on a reassessment of the threat, said one source briefed by the Navy.
>
> "They can't afford it, nor do they think they need it," the Capitol Hill source said. "They don't think the scenarios on which the big cruiser was the answer are realistic." Those scenarios, the source said, envisioned "very large-sized raids of incoming missiles," a threat now considered less likely.
>
> The potential price tag for such a ship—which would be the biggest surface warship built by the U.S. Navy since World War II—is also exceptionally daunting, with unofficial estimates running as high as $7 billion a copy, or nearly the price of an aircraft carrier.
>
> The study so far is "strictly an analytical effort," the source said, with "no conclusions or recommendations yet." As to which hull would get the go-ahead nod, another source re-ported the study concluded that the "DDG 51 couldn't provide the power and cooling" capacity for a large and sensitive radar.
>
> But the Capitol Hill source said that "both ships are equally in the running, although I think they're steering themselves toward the DDG 51. It's cheaper and no less capable in a number of dimensions—detection, intercept capability, combat system. And it's considered less technically risky."[31]

Reported Plan to Stop CG(X) in Favor of Procuring Improved DDG-51s

On December 7, 2009, it was reported that the Navy wants to cancel the CG(X) and instead procure improved DDG-51s. Earlier press reporting had suggested that the Navy might be heading toward such a change in plans. The Navy reportedly was concerned about the projected high cost of the CG(X), and has concluded that it does not need a ship as capable as the CG(X) to adequately perform future anti-air warfare (AAW) and ballistic missile defense (BMD) missions. The improved DDG-51 that the Navy reportedly now wants to procure would be considerably less expensive to procure than the CG(X). The improved DDG-51 would have more AAW and BMD capability than the current DDG-51 design, but less AAW and BMD capability than what was envisioned for the CG(X).

A December 7, 2009, press report stated:

[31] Christopher P. Cavas, "Next-Generation U.S. Warship Could Be Taking Shape," *Defense News*, November 2, 2009: 18, 20.

The Navy will kill the CG(X) cruiser program and instead develop new warships based on the design of Arleigh Burke-class DDG-51 destroyers, according to a draft report the service is preparing for Congress.

The long-term shipbuilding report, due to Congress in February, says unaffordable cost estimates and immature technology doomed the CG(X) program, which was supposed to fill a critical role in integrated air and missile defense. Inside the Navy reviewed a copy of the draft, which is labeled "for official use only—pre-decisional information—not for release outside the Navy."

The Navy's fiscal year 2009 budget plan called for buying the first CG(X) cruiser in FY-11, but eight months ago Defense Secretary Robert Gates announced officials would delay the program to revisit its requirements and acquisition strategy. This summer, Chief of Naval Operations Adm. Gary Roughead asserted the Navy might still buy CG(X) cruisers.

"I would say that CG(X) could be the next surface combatant," the admiral told reporters June 30 after a speech in Washington, DC.

But that is not going to happen, according to the new draft report. Due to "the ship's projected high cost and [the] immaturity of its combat systems technology and design, the Navy has determined that it is not in the department's best interest to pursue CG(X) procurement," the report states.

"However, it will be critical to pursue the technology development and combat system design for application on a smaller combatant such as a DDG-51 variant," the report continues.

The new move to kill CG(X) follows the Navy's dramatic decision last year to truncate the Zumwalt-class DDG-1000 destroyer program. The DDG-1000s were intended to support integrated air and missile defense but the service decided it was more affordable and efficient to restart the DDG-51 program.

The Navy is buying nine DDG-51s from FY-10 to FY-15 and anticipates adding an integrated air and missile defense capability to new DDG-51s as early as FY-16, the report states. These upgraded DDG-51s will be modifications of the current design, combining the "best emerging technologies" aimed at further increasing integrated air and missile defense capabilities and providing a "more effective bridge between today's capability and what had been planned for CG(X), the service writes.

While the Navy has "much work" to do to determine the final design, the service envisions the DDG-51 variant having "upgrades to radar and computing performance with the increased power-generation capacity and cooling required by these enhancements," the report states. The report also states procurement of a new class of DDG(X) destroyers will begin in FY-23 "and is anticipated to be a modification to legacy ship designs."...

Future destroyers will have upgraded radar technologies leveraging development of the Advanced Missile Defense Radar (AMDR) that will provide increased integrated air and missile defense capability and will be "much more capable" than today's DDG-51s, the report states. Northrop Grumman, Lockheed and Raytheon are the prime contractors for this radar. The AMDR envisioned for DDG-51s will be physically smaller than the system previously planned for CG(X), said the source.[32]

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

A December 11, 2009, press report stated:

> Improved confidence in the performance of the U.S. Missile Defense Agency's (MDA) new midcourse tracking anti-ballistic missile satellites is allowing Navy officials to curtail ambitious requirements for their next-generation cruiser program.
>
> This will allow for development of a less expensive system, which is more likely to garner support as the Pentagon is stretched to continue funding wars in Iraq and Afghanistan. In September, MDA launched the first two Northrop Grumman Space Tracking and Surveillance Satellites (STSS), designed to plug the persistent gap in tracking ballistic missiles in their midcourse of flight. This is when warheads separate from their hot boosters, which are easier to track with infrared sensors. The warheads, which are far cooler, arc through space and begin to re-enter the atmosphere, and this phase of flight has been a challenge for U.S. defenses.
>
> STSS originally began as the Space-Based Infrared System Low and was renamed when it shifted from the Air Force to MDA. Parts for the satellites had been in storage as the program shifted hands, but MDA later threw its support behind the effort. Officials are still checking the performance of the satellites in orbit, but expectations are high.
>
> "MDA picked up the bucket of bolts, they put it together and they launched it," said Vice Adm. Barry McCullough, the Navy's new cyber command chief, speaking last week at an Aviation Week/Credit Suisse Aerospace & Defense Finance conference here. "I have a lot more faith in the ability of that program to mature and produce than I did three-and-a-half years ago." At the time he conducted his interview with Aviation Week at the conference, McCullough was the chief of naval operations for integration of capabilities and resources.
>
> "When we started the [analysis of alternatives] for CG(X), we laid out as an initial condition or assumption that it would have to operate autonomously because the STSS was in total disarray," McCullough said, noting the technology was "immature" for a radar sophisticated enough to identify and track high-end targets by itself. "For us to assume we could put it into a ship and get a radar system delivered to a ship in 2014 or 2015—it just wasn't going to happen," he says. During his presentation to Wall Street analysts, McCullough noted that the objective radar would be massive—at least 2 feet larger than the Aegis SPY-1 radar at roughly 22 ft. in diameter. The cost for this system was estimated at $5 billion per unit.[33] "Given [STSS] and given what happened with other parts of the sensor architecture, we think we could go with a lesser sensitivity radar," he adds.
>
> This will call for a less costly approach and the program will be more likely to deliver ships when needed. McCullough says Navy officials are now looking at a ship radar roughly 12-14 feet in diameter.[34]

For additional information on potential DDG-51 and DDG-1000 design variants, including variants with an improved radar, see **Appendix D**.

(...continued)

Navy, December 7, 2009.

[33] This figure appears to refer to the projected unit procurement cost of the entire CG(X), not unit procurement cost of the CG(X) radar.

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

Surface Combatant Construction Industrial Base

Shipyards

All cruisers, destroyers, and frigates procured since FY1985 have been built at GD/BIW of Bath, ME, and the Ingalls shipyard in Pascagoula, MS, that forms part of NGSB.[35] 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, NGSB, other private-sector U.S. shipyards, and government-operated naval shipyards (NSYs).

Combat System Manufacturers

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-100 combat system, and Raytheon has a share of the DDG-51 combat system.

Supplier Firms

The surface combatant industrial base also includes hundreds of additional firms that supply materials and components. Many of the suppliers for the DDG-1000 program are not suppliers for the DDG-51 program, and vice versa. 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.

FY2010 Funding Request

DDG-51 Program

The Navy's proposed FY2010 budget requested $1,912.3 million for the procurement of a DDG-51. The Navy estimates the total cost of this ship at $2,240.3 million. The ship received $199.4 million in FY2009 advance procurement funding, and the Navy plans to request approval to transfer or reprogram $128.6 million in prior-year funding to help complete the ship's cost. The Navy's proposed FY2010 budget also requested $329.0 million in advance procurement funding for two more DDG-51s to be procured in FY2011.

[35] NGSB also includes the Avondale shipyard near New Orleans, Newport News Shipbuilding of Newport News, VA, and a fourth facility, used for manufacturing ship components and structures made from composites, at Gulfport, MS.

DDG-1000 Program

The Navy's proposed FY2010 budget requested $1,084.2 million to complete the cost of the third DDG-1000, and $309.6 million in additional procurement funds to cover cost growth on the first two DDG-1000s, which were authorized in FY2007 and funded in FY2007-FY2008. The Navy estimates the combined procurement cost of the first two DDG-1000s at $6,634.2 million, or an average of $3,317.1 million each, and the procurement cost of the third ship at $2,738.3 million. The Navy's proposed FY2010 budget also requested $539.1 million in research and development funding for the DDG-1000 program.[36]

CG(X) Program

The Navy's proposed FY2010 budget requested $340.0 million in research and development funding for the CG(X) program. Of this total, $190.0 million is for developing the CG(X)'s new radar (the AMDR), and $150.0 million is for research and development work on the ship in general.

Issues for Congress

Potential issues for Congress arising from the Navy's reported desire to cancel the CG(X) and instead procure improved DDG-51s include the following:

- Is there an adequate analytical basis for canceling the CG(X) and instead procuring improved DDG-51s? Should an analysis of alternatives (AOA) or the equivalent of an AOA be performed before committing to this course of action?
- Is there adequate stability in Navy planning for acquisition of surface combatants?
- Would an improved DDG-51 be an adequate substitute for the CG(X)?
- What would be the potential operational implications of a Navy equipped with improved DDG-51s instead of CG(X)s?
- What would be the potential industrial-base consequences of canceling the CG(X) and instead procuring improved DDG-51s?
- What would be some potential alternatives to canceling the CG(X) and instead procuring improved DDG-51s?

Each of these is discussed below.

[36] DDG-1000 research and development funding is located in the Navy's research and development account in Program Element (PE) 0204202N, entitled DDG-1000. This PE is line item 135 in the Navy's FY2010 research and development account.

Analytical Basis for Canceling CG(X) in Favor of Improved DDG-51s

Is there an adequate analytical basis for canceling the CG(X) and instead procuring improved DDG-51s? Should an analysis of alternatives (AOA) or the equivalent of an AOA be performed before committing to this course of action?

The issue of whether there is an adequate analytical basis for canceling the CG(X) and instead procuring improved DDG-51s is somewhat similar to an issue raised by CRS several years ago as to whether there was an adequate analytical basis for the Navy's decision that a ship like the LCS—a small, fast ship with modular payload packages—would be the best or most cost-effective way to fill gaps the Navy had identified in its capabilities for countering submarines, small surface attack craft, and mines in heavily contested littoral areas.[37] The Navy eventually acknowledged that, on the question of what would be the best approach to fill these capability gaps, "the more rigorous analysis occurred after the decision to move to LCS."[38]

Those who believe there is an adequate analytical basis for canceling the CG(X) and instead procuring improved DDG-51s could argue that procuring improved DDG-51s would represent an extension of the proposal debated by DOD and Congress in 2008-2009 to end procurement of DDG-1000 destroyers and restart procurement of DDG-51 destroyers, and therefore does not amount to the initiation of a new shipbuilding program that would require an AOA or the equivalent of an AOA. They can also argue that the Navy's desire to cancel the CG(X) and instead procure improved DDG-51s reflects substantial analytical work in the form of the CG(X) AOA, additional Navy studies that were done to support the 2008-2009 proposal to end DDG-1000 procurement and restart DDG-51 procurement, and a recent Navy destroyer Hull/Radar study that examined options for improving the AAW and BMD capabilities of the DDG-51 and DDG-1000 destroyer designs through the installation of an improved radar and combat system modifications.

Those who question whether there is an adequate analytical basis for the Navy's reported new plan could argue that procuring modified DDG-51s until FY2023 represents a significant change from the plan debated in 2008-2009 to procure non-modified DDG-51s until about FY2017. Given the scope of modifications to the DDG-51 design and the number of years that the modified DDG-51s would be procured, they could argue, the Navy's reported new plan amounts to the initiation a new shipbuilding program that would require an AOA or the equivalent of an

[37] See, for example, the September 5, 2002, update of CRS Report RS21305, *Navy Littoral Combat Ship (LCS): Background and Issues for Congress*, by Ronald O'Rourke, or the October 28, 2004, and the October 28, 2004, update of CRS Report RL32109, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*, by Ronald O'Rourke.

[38] Spoken testimony of Vice Admiral John Nathman, Deputy Chief of Naval Operations (Warfare Requirements and Programs), at an April 3, 2003 hearing on Navy programs before the Projection Forces subcommittee of the House Armed Services Committee. At this hearing, the chairman of the subcommittee, Representative Roscoe Bartlett, asked the Navy witnesses about the Navy's analytical basis for the LCS program. The witnesses defended the analytical basis of the LCS program but acknowledged that "The more rigorous analysis occurred after the decision to move to LCS." See U.S. Congress, House Committee on Armed Services, Subcommittee on Projection Forces, *Hearing on National Defense Authorization Act for Fiscal Year 2004—H.R. 1588, and Oversight of Previously Authorized Programs*. 108th Cong., 1st sess., Mar. 27, and Apr. 3, 2003, (Washington: GPO, 2003), p. 126. For an article discussing the exchange, see Jason Ma, "Admiral: Most LCS Requirement Analysis Done After Decision To Build," *Inside the Navy*, Apr. 14, 2003.

AOA. They could also argue that the CG(X) AOA focused mainly on examining radar and hull-design options for a cruiser with a large and powerful radar, as opposed to radar- and hull-design options for a smaller modified destroyer with a smaller and less powerful radar, and that Navy studies supporting its 2008-2009 proposal to stop DDG-1000 procurement and restart DDG-51 procurement were challenged by outside observers (particularly DDG-1000 supporters). They could argue that the Navy's recent destroyer Hull/Radar study was focused on answering a somewhat narrowly defined question: What would be the lowest-cost option for improving the AAW and BMD performance of a DDG-51 or DDG-1000 by a certain amount through the installation of an improved radar and an associated modified combat system? An adequate analytical basis for a proposed program change of this magnitude, they could argue, would require an AOA or equivalent study that rigorously examined a broader question: Given projected Navy roles and missions, and projected Navy and DOD capabilities to be provided by other programs, what characteristics of all kinds (not just AAW and BMD capability) are needed in surface combatants in coming years, and what is the most cost-effective acquisition strategy to provide such ships?

Stability in Navy Surface Combatant Acquisition Planning

Is there adequate stability in Navy planning for acquisition of surface combatants?

Navy plans for acquisition of surface combatants have experienced multiple shifts since the mid-1990s. The sequence can be summarized as follows:

- **From the mid-1990s until November 1, 2001**, Navy plans called for a family of surface combatants called SC-21 (meaning Surface Combatant for the 21st Century) that included a new destroyer called DD-21 and a projected eventual new cruiser called CG-21. Navy plans did not include a ship like the LCS, and the Navy politely resisted proposals that were made starting in the late 1990s for the service to acquire a small, fast surface ship that was called Streetfighter.
- **On November 1, 2001**, the Navy announced a plan for a new family of ships that included the DDG-1000 (a restructured version of the DD-21 program), the CG(X), and the LCS. The Navy over the next several years argued strongly in favor of stopping DDG-51 procurement and starting DDG-1000 procurement.
- **On July 31, 2008**, the Navy essentially reversed itself by announcing that it wanted to stop DDG-1000 procurement, which had begun in FY2007, and restart DDG-51 procurement, which had ended in FY2005. The DDG-51s the Navy wanted to procure would not feature significant design modifications, and they would be procured until the start of CG(X) procurement around FY2017.
- **On December 2, 2009**, it was reported that the Navy now wants to cancel the CG(X) program and instead procure modified DDG-51s until FY2023.

Given the Navy's 2008-2009 proposal to stop DDG-1000 procurement, the reported new Navy proposal to cancel the CG(X), if implemented, would represent a change of mind by the Navy regarding two of the three programs the Navy announced on November 1, 2001. While the Navy remains committed to the third program announced on November 1, 2001—the LCS—that program has experienced multiple shifts in procurement profile and acquisition strategy. The above sequence of events, combined with the shifts that have occurred in the LCS procurement

profile and acquisition strategy, raise a question as to whether there is adequate stability in Navy planning for acquisition of surface combatants.

Those who believe that there is adequate stability in Navy planning for acquisition of surface combatants could argue that changes in Navy plans since the mid-1990s were made to adapt those plans to changing strategic and budgetary circumstances, including the identification of capability gaps for littoral warfare (which led to the LCS program), a change in threat assessments and thus in the kinds of mission capabilities that would need to be emphasized in future destroyers (which led to the 2008-2009 proposal to stop DDG-1000 procurement and restart DDG-51 procurement), and a revised understanding of what the Navy needed, and could afford, in terms of a future ship with improved AAW and BMD capability (which led to the reported proposal to cancel the CG(X) and instead procure modified DDG-51s). They could argue that although these changes caused turbulence in Navy planning for acquisition of surface combatants, they were each well-considered, and that the alternative of not implementing these changes would have led to a bigger problem—a future surface combatant force that was both unaffordable and poorly aligned with projected mission needs.

Those who believe that there is inadequate stability in Navy planning for acquisition of surface combatants could argue that although there have been shifts in strategic and budgetary circumstances since the mid-1990s, the Navy's responses to these shifts have been unnecessarily turbulent, in part because the Navy was slow to recognize the prospective unaffordability of its baseline plans. They could argue that given the changes in strategic and budgetary circumstances that have accumulated since the mid-1990s, the Navy should now step back and examine on a holistic basis what kind of surface combatant force it needs to have in the future, and what the most cost-effective path would be to achieve that force, before committing to any further changes in plans.

Adequacy of Improved DDG-51 as Substitute for CG(X)

Would an improved DDG-51 be an adequate substitute for the CG(X)?

The improved DDG-51 that the Navy reportedly now wants to procure 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), in large part because the improved DDG-51 would be equipped with a new radar that would have more sensitivity than the radar on current DDG-51s, but less sensitivity than the large and powerful new radar envisioned for the CG(X). The CG(X) was also envisioned as likely having more missile-launch tubes than the DDG-51 or improved DDG-51.

Supporters of the Navy's reported plan to cancel the CG(X) and instead procure improved DDG-51s could argue that a radar as large and powerful as the one envisioned for the CG(X) is no longer needed because the projected enemy missile raid size—the number of simultaneous or near-simultaneous enemy anti-ship missiles to be countered—has been revised downward, and because recent improvements in the management of a U.S. program to provide a network of space-based radars permits the Navy to now have more confidence that these space-based radars will be available to supplement the Navy's ship-based radars for purposes of conducting AAW and BMD operations. (See the November 2, 2009, and December 11, 2009, press reports that are reprinted above in the section entitled ""Shifts in Navy Destroyer and Cruiser Acquisition Plans.")

Skeptics of the Navy's reported plan to cancel the CG(X) and instead procure improved DDG-51s could argue that this plan poses potentially unacceptable risks because its provides less cushion against the possibility of an adversary increasing missile raid size above newly projected levels by building additional missiles, and because the plan is dependent on space-based radars and radar-data communications links that could be vulnerable to enemy attack. Skeptics could also argue that the improved DDG-51 the Navy reportedly is contemplating could not be fitted in the future with a high-power directed-energy weapon (DEW), such as a laser, because the ship would lack the electrical power such a weapon would require. Skeptics could argue that since DEWs could be critical to the Navy's long-term ability to affordably counter enemy anti-ship cruise missiles (ASCMs) and anti-ship ballistic missiles (ASBMs),[39] improved DDG-51s, though less expensive to procure than CG(X)s, could lock the Navy into a DEW-less approach to AAW and BMD that might ultimately be unaffordable for the Navy to sustain in a competition against a wealthy and determined adversary.

An improved DDG-51 might have a larger radar cross section (i.e., be less stealthy) than a CG(X). In a surface combatant, having a larger radar cross section can reduce the effectiveness of ship-launched decoys that are intended to confuse the radars in the nose cones of incoming ASCMs and ASBMs. An improved DDG-51 might also have less survivability than a CG(X) (i.e., less capacity for withstanding battle damage).

Potential Operational Implications

What would be the potential operational implications of a Navy equipped with improved DDG-51s instead of CG(X)s?

Supporters of the Navy's reported plan to cancel the CG(X) and instead procure improved DDG-51s could argue that procuring improved DDG-51s rather than CG(X) could enhance the Navy's operational flexibility because the lower unit capability offered by each improved DDG-51 would be more than offset by the higher number of improved DDG-51s that could be procured for a given amount of funding. Skeptics could argue that the Navy's reported plan could reduce the Navy's operational flexibility because the Navy would lack a ship capable of operating in certain very high-threat locations that might be of interest, and because the Navy in general might need to exercise greater overall caution about where and when it operates its surface combatants. In addition, as discussed in the previous section, a fleet equipped with improved DDG-51s rather than CG(X)s might have less operational resiliency in the event of enemy attacks on U.S. space-based radars or radar-data communications links.

The Navy's 22 Aegis cruisers are equipped with flag command facilities for coordinating certain operations, and the CG(X) likely would have included an updated version of such facilities. The current DDG-51 design does not include such facilities, and it is not clear that an improved DDG-51 would have them, since these facilities require a certain amount of interior volume. If an

[39] The cost for an adversary to build and field an additional land-based ASCM or ASBM might be much less than the cost for the Navy to build and field an additional sea-based missile-launch tube and procure an additional interceptor missile to place in that tube. If so, then it might become unaffordable for the Navy at some point in the future to match each additional ASCM and ASBM that a wealthy and determined adversary might field with an additional launch tube and interceptor missile. DEWs, if successfully developed, promise to reverse this unfavorable cost equation by lowering the marginal cost per shot for intercepting ASCMs and ASBMs to a level well below what it costs an enemy to build an additional ASCM or ASBM.

improved DDG-51 does not include such facilities, then replacing the 22 Aegis cruisers with improved DDG-51s could lead to a future surface combatant force with reduced numbers of ships with flag command facilities for coordinating certain kinds of operations.

Potential Industrial-Base Consequences

What would be the potential industrial-base consequences of canceling the CG(X) and instead procuring improved DDG-51s?

Radar and Combat System Makers

Procuring the CG(X) would provide an opportunity for the Navy to conduct a competition between Lockheed and Raytheon (and perhaps other firms) to be the lead contractor on the CG(X) combat system. Canceling the CG(X) and instead procuring improved DDG-51s would mean that Lockheed would continue its current status as the lead contractor of Navy cruiser and destroyer combat systems.

Procuring the CG(X) would provide the Navy with an opportunity to conduct a competition between Lockheed, Raytheon, and Northrop to build the CG(X)'s large and powerful new radar. Procuring an improved DDG-51 would provide the Navy with an opportunity to conduct a similar competition between these three firms for the improved DDG-51's somewhat smaller and less powerful new radar.

Shipyards

Some, and perhaps much, of the shipyard work associated with building a nuclear-powered version of the CG(X) could be assigned to Grumman Newport News (NGNN)—a shipyard in Newport News, VA , that forms part of NGSB—because NNGN is currently the only shipyard in the country certified to build nuclear-powered surface ships for the Navy. (NGNN builds nuclear-powered aircraft carriers and nuclear-powered attack submarines, the latter along with General Dynamics' Electric Boat Division of Groton, CT, and Quonset Point, RI.) All of the shipyard work associated with building either a conventionally powered CG(X) or an improved DDG-51 (which, like the current DDG-51, would be conventionally powered) could be performed by GD/BIW and the Ingalls yard that forms part of NGSB.

The ultimate volume of work performed by various shipyards as a result of building either nuclear-powered CG(X)s, conventionally powered CG(X), or improved DDG-51s would depend in part on the numbers of such ships that the Navy could afford to procure for a given portion of the Navy's shipbuilding budget. Although building a single conventionally powered CG(X) would likely provide GD/BIW and/or the Ingalls yard more work than building a single improved DDG-51, the Navy would likely be able to procure a larger number of DDG-51s for a given portion of the Navy's shipbuilding budget.

Nuclear Propulsion Component Manufacturers

Procuring a nuclear-powered version of the CG(X) would provide additional work for nuclear propulsion component manufacturers. It would increase economies of scale in the production of

nuclear propulsion components for all Navy ships, reducing by a few or several percent the cost of nuclear propulsion components manufactured for the Navy's aircraft carriers and submarines.

Potential Alternatives to Reported Navy Plan

What would be some potential alternatives to canceling the CG(X) and instead procuring improved DDG-51s?

Potential alternatives to canceling the CG(X) and instead procuring improved DDG-51s include but are not limited to those discussed below.

Continue CG(X) program

This option would maintain the Navy's previous plan of procuring non-modified DDG-51s until the start of CG(X) procurement around FY2017.

Procure a More Highly Modified DDG-51

This option would cancel the CG(X) and procure a version of the DDG-51 with more substantial modifications than what the Navy appears to be contemplating. This more highly modified DDG-51 would have enough electrical power to support the future installation of a high-power directed energy weapon (DEW) such as a laser. It might also include features for reducing crew size, which would reduce the ship's annual operating and support (O&S) cost. Installing enough electrical power to support the future installation of a high-power DEW such as a laser might well require lengthening the DDG-51 hull so as to provide the additional space and weight-carrying capacity that the added electrical-generating capacity might require. As discussed in **Appendix D**, the current DDG-51 hull might be lengthened by as much as 55 or 56 feet.

Procure a Modified DDG-1000

This option would cancel the CG(X) and procure a modified version of the DDG-1000 destroyer with an improved radar and combat system modifications for improved AAW and BMD capability. A modified DDG-1000 would have enough electrical power to support the future installation of a high-power DEW such as a laser. The idea of a modified DDG-1000 with an improved radar and combat system modifications for improved AAW and BMD capability is discussed in **Appendix D**.

Procure a Cost-Constrained New-Design Destroyer

This option would cancel the CG(X) and procure non-modified DDG-51s while developing a cost-constrained new-design destroyer that might begin procurement around FY2017. The new-design destroyer would be less expensive to procure and have less AAW and BMD capability than the CG(X), but more AAW and BMD capability than the modified DDG-51 and enough electrical power to support the future installation of a high-power DEW such as a laser. **Table 3** outlines one possible approach for developing a cost-constrained new-design destroyer.

Table 3. Possible Approach for a Cost-Constrained New-Design Destroyer

Cost or Ship Characteristic	New-Design Destroyer
Development cost	Minimize all development costs: Minimize hull-design cost by leveraging, where possible, existing surface combatant hull designs. Minimize combat system development cost by using a modified version of the DDG-51 or DDG-1000 combat system. Minimize other development costs by using no technologies not already on, or being developed for, the DDG-51, the reported modified DDG-51, or the DDG-1000. A possible exception would be technologies, such as motor and power-electronics technologies, that would enable an integrated electric drive system that is more compact than that on the DDG-1000.
Procurement cost	Constrain unit procurement cost: Establish a unit procurement cost target that is not more than 10% above the unit procurement cost of the current DDG-51 design. In support of this goal, limit the new destroyer's full load displacement to 10,000 to 11,000 tons (compared to 9,500 tons for the DDG-51), and incorporate design features (such as those employed in the DDG-1000 design) for enhancing producibility and reducing construction cost per ton.
Annual operation and support (O&S) cost	Constrain annual O&S cost: Establish an annual O&S cost target that is not more than, and perhaps less than, the annual O&S cost of the current DDG-51 design. In support of this goal, incorporate design features (such as those employed in the DDG-1000 design) to reduce crew size.
Radar size and power, and resulting AAW and BMD capability	Design the ship to accommodate a radar that is larger and more powerful than what can be accommodated on the DDG-51, but smaller and less powerful than what was envisioned for the CG(X), so as to achieve an AAW and BMD capability greater than that of the reported modified DDG-51, but less than that of the CG(X).
Electrical power	Design the ship with sufficient electrical power to support future installation of a high-power directed-energy weapon (DEW), such as a laser.
Radar cross section	Design the ship to have a radar cross section not greater than that of DDG-51, and possibly less than that of a DDG-51, if the latter can be achieved without increasing development and procurement cost..
Survivability (ability to withstand battle damage)	Design the ship with a level of survivability not less than that of the DDG-51.

Source: Prepared by CRS based on Navy data and press reports.

A cost-constrained new-design destroyer might be considered broadly analogous to the Virginia (SSN-774) class attack submarine, which the Navy developed in the 1990s as a more affordable successor to the Seawolf (SSN-21) attack submarine design. The Virginia-class design is smaller and more affordable than the Seawolf class design, but more capable than the Improved Los Angeles (Improved SSN-688 or 688I) class attack submarine that was procured prior to the Seawolf class. Procurement of the Seawolf-class design was stopped after three ships due to the design's high unit procurement cost and questions about the need for such a heavily armed attack submarine in the post-Cold War era—an assessment that might be considered somewhat similar to the Navy's reported concerns about the CG(X)'s projected high unit procurement cost and the Navy's reported new belief that it no longer needs a ship with a very high amount of autonomous AAW and BMD capability. Following the decision to end of Seawolf procurement, the Navy,

rather than developing and procuring improved version of the 688I design, instead developed and procured a cost-constrained new-design attack submarine—the Virginia class.[40]

Backfit Existing DDG-51s with Improved Radars

This option would backfit existing DDG-51s with the improved radar and combat system modifications that the Navy appears to be contemplating for the modified DDG-51s that it reportedly wants to build in coming years. This option could be combined with the Navy's reported plan to cancel the CG(X) and procure modified DDG-51s with these same changes, or with any of the above-described potential alternatives to that plan.

FY2010 Legislative Activity

Summary of Action on Funding Request

Table 4 summarizes action on FY2010 funding requests for the DDG-1000 and DDG-51 programs.

Table 4. Summary of Action on FY2010 Funding Request

Millions of dollars

Item	Request	HASC	SASC	Authorization conference	HAC	SAC	Appropriation conference
Procurement funding							
Procurement of third DDG-1000 in FY2010	1,084.2	1,084.2	1,084.2	1,084.2	1073.2	1,393.8[a]	1,382.8[a]
Cost growth on first two DDG-1000s	309.6	159.6	309.6	309.6	309.6	0[a]	0[a]
Procurement of one DDG-51 in FY2010	1,912.3	1,912.3	1,912.3	1,912.3	1,912.3	3,650.0[b]	1,912.3
Advance procurement funding for two DDG-51s in FY2011	329.0	429.0	329.0	329.0	329.0	329.0	579.0
Research and development funding							
DDG-1000 program	539.1	539.1	539.1	539.1	539.1	526.5	526.5

Sources: Bill language, committee reports, and conference reports. HASC is House Armed Services Committee; SASC is Senate Armed Services Committee,; HAC is House Appropriations Committee,; SAC is Senate Appropriations Committee.

a. Transfers the $309.6 million requested for cost growth on the first two DDG-1000s to the line item for procurement of the third DDG-1000.

b. The SAC report recommends funding for the procurement of two DDG-51s.

[40] For more on the Virginia-class program, see CRS Report RL32418, *Navy Attack Submarine Procurement: Background and Issues for Congress*, by Ronald O'Rourke.

FY2010 Defense Authorization Act (H.R. 2647/P.L. 111-84)

House

In addition to the funding recommendations noted in **Table 4**, Section 125 of H.R. 2647 as reported by the House Armed Services Committee (H.Rept. 111-166 of June 18, 2009) would authorize a multiyear procurement (MYP) arrangement for the procurement of DDG-51s beginning in FY2010.

The committee's report states: "The committee supports the re-start of the DDG 51 class and believes that a minimum of two of these vessels should be requested per year." (Page 72). The report also states:

> The committee notes that the Secretary of Defense has decided to truncate the DDG 1000 program to three ships and restart the Burke class destroyer (DDG 51) program. The committee agrees with this decision and understands the agreement reached between the Department and the prime shipbuilding contractors for construction of the three DDG 1000 ships and the re-start of the first three DDG 51 ships will ensure industrial stability at both of the surface combatant construction shipyards while the Department plans for future surface combatant capability and force structure. (Pages 72-73)

The report also states:

> *Surface combatants*
>
> The committee will closely monitor the costs to complete the DDG 1000 class. The committee is encouraged by the robustness of design completion prior to the start of fabrication of the first ship. The committee expects the extra effort to complete design prior to the start of construction and the significant investment in infrastructure at the construction yard will set a new standard for first of class vessels in meeting target cost. However, the committee notes that approximately $1.5 billion in research and development efforts still need to be completed to realize the full combat capability of the ship.
>
> The committee supports the re-start of procurement of DDG 51 class destroyers. The committee supports the views of the Chief of Naval Operations that these vessels are required to counter emerging ballistic missile threats and for the conduct of deep ocean antisubmarine warfare. Therefore, the committee includes in title I of this Act, a provision that would authorize the Secretary of the Navy to enter into a multi-year procurement contract for additional DDG 51 destroyers. (Page 76)

Senate

In addition to the funding recommendations noted in **Table 4**, Section 113 of the FY2010 defense authorization bill (S. 1390) as reported by the Senate Armed Services Committee (S.Rept. 111-35 of July 2, 2009) would, among other things, prohibit the Navy from obligating or expending funds for surface combatants procured in FY2012 or subsequent years until certain conditions are met. The text of Section 113 is as follows:

> SEC. 113. PROCUREMENT PROGRAMS FOR FUTURE NAVAL SURFACE COMBATANTS.

(a) Limitation on Availability of Funds Pending Reports About Surface Combatant Shipbuilding Programs- The Secretary of the Navy may not obligate or expend funds for the construction of, or advanced procurement of materials for, a surface combatant to be constructed after fiscal year 2011 until the Secretary has submitted to Congress each of the following:

(1) An acquisition strategy for such surface combatants that has been approved by the Department of Defense.

(2) The results of reviews by the Joint Requirements Oversight Council for an Acquisition Category I program that supports the need for an acquisition strategy to procure surface combatants after fiscal year 2011.

(3) A verification by an independent review panel convened by the Secretary of Defense that, in evaluating the shipbuilding program concerned, the Secretary of the Navy considered each of the following:

(A) Modeling and simulation, including war gaming conclusions regarding combat effectiveness for the selected ship platforms as compared to other reasonable alternative approaches.

(B) Assessments of platform operational availability.

(C) Life cycle costs from vessel manning levels to accomplish missions.

(4) An intelligence analysis reflecting a coordinated threat assessment of the Defense Intelligence Agency that provides the basis for deriving the mix of platforms in the shipbuilding program concerned when compared with the surface combatants in the 2009 shipbuilding plan.

(5) The differences in cost and schedule arising from the need to accommodate new sensors and weapons in future surface combatants to counter the future threats referred to in paragraph (4) when compared with the cost and schedule arising from the need to accommodate sensors and weapons on surface combatants as contemplated by the 2009 shipbuilding plan for the vessels concerned.

(6) A verification by the commanders of the combatant commands that the shipbuilding program for the vessels concerned would be preferable to the surface combatants included in the 2009 shipbuilding plan for the vessels concerned in meeting all of their future mission requirements.

(7) A joint review by the Navy and the Missile Defense Agency setting forth additional requirements for investment in Aegis ballistic missile defense (BMD) beyond the number of DDG-51 and CG-47 vessels planned to be equipped for this mission area in the budget of the President for fiscal year 2010 (as submitted to Congress pursuant to section 1105 of title 31, United States Code).

(b) Future Surface Combatant Acquisition Strategy- Not later than the date upon which President submits to Congress the budget for fiscal year 2012 (as so submitted), the Secretary of the Navy shall submit to the congressional defense committees a plan to provide for full and open competition on the combat systems for surface combatants proposed in the future-years defense program submitted to Congress under section 221 of title 10, United States Code, together with such budget. The plan shall include specifics on the intent of the Navy to satisfy criteria described in subsection (a) and evaluate applicable technologies during the request for proposal and selection process.

(c) Naval Surface Fire Support- Not later than 120 days after the enactment of this Act, the Secretary of the Navy shall submit to the congressional defense committees an update to the March 2006 Report to Congress on Naval Surface Fire Support. The update shall identify how the Department of Defense intends to address any shortfalls between required naval surface fire support capability and the plan of the Navy to provide that capability. The update shall include addenda by the Chief of Naval Operations and Commandant of the Marine Corps, as was the case in the 2006 report.

(d) Technology Roadmap for Future Surface Combatants and Fleet Modernization-

(1) IN GENERAL- Not later than 120 days after the date of the enactment of this Act, the Secretary of the Navy shall develop a plan to incorporate into surface combatants constructed after 2011, and into fleet modernization programs, the technologies developed for the DDG-1000 destroyer and the DDG-51 and CG-47 Aegis ships, including the following:

(A) For the DDG-1000 destroyer—

(i) combat system;

(ii) multi-function and dual-band radars;

(iii) hull, mechanical and electrical systems achieving significant manpower savings; and

(iv) integrated electric propulsion technologies.

(B) For the DDG-51 and CG-47 Aegis ships—

(i) combat system, including missile defense capability;

(ii) hull, mechanical and electrical systems achieving manpower savings; and

(iii) anti-submarine warfare sensor systems designed for operating in open ocean areas.

(2) SCOPE OF PLAN- The plan required by paragraph (1) shall include sufficient detail for systems and subsystems to ensure that the plan—

(A) avoids redundant development for common functions;

(B) reflects implementation of Navy plans for achieving an open architecture for all naval surface combat systems; and

(C) fosters full and open competition.

(e) Definition- In this section:

(1) The term `2009 shipbuilding plan' means the 30-year shipbuilding plan submitted to Congress pursuant to section 231, title 10, United States Code, together with the budget of the President for fiscal year 2009 (as submitted to Congress pursuant to section 1105 of title 31, United States Code).

(2) The term `surface combatant' means a cruiser, a destroyer, or any naval vessel under a program currently designated as a future surface combatant program.

Regarding Section 113, the committee's report states:

The committee recommends a provision [Section 113] that would prevent the Navy from obligating any funds for building surface combatants after 2011 until the Navy conducts particular analyses, and completes certain tasks that should be required at the beginning of major defense acquisition programs (MDAP).

For at least the past couple of years, the Navy's strategy for modernizing the major surface combatants in the fleet has been in upheaval. The Navy was adamant that the next generation cruiser had to begin construction in the 2011–2012 timeframe. After 15 years of consistent, unequivocal support of the uniformed Navy for the fire support requirement, and for the DDG–1000 destroyer that was intended to meet that requirement (i.e., gun fire support for Marine Corps or Army forces ashore), the Navy leadership, in the middle of last year, decided that they should truncate the DDG–1000 destroyer program and buy DDG–51 destroyers instead.

The Defense Department has announced that the Navy will complete construction of the three DDG–1000 vessels and will build three DDG–51 destroyers, one in fiscal year 2010 and two in fiscal year 2011. Beyond that, the plan is less well defined, and includes building only a notional ''future surface combatant,'' with requirements, capabilities, and costs to be determined.

Notwithstanding Navy protests to the contrary, this was mainly due to the Navy's affordability concerns. The committee notes with no little irony that this sudden change of heart on the DDG–1000 program is at odds with its own consistent testimony that ''stability'' in the shipbuilding programs is fundamental to controlling costs and protecting the industrial base.

The Navy claims the change of heart on the DDG–1000 program was related to an emerging need for additional missile defense capability that would be provided by DDG–51s and is being requested by the combatant commanders, and would be used to protect carrier battle groups against new threats.

The committee certainly believes that the services should have the ability to change course as the long-term situation dictates. However, since we are talking about the long-term and hundreds of billions of dollars of development and production costs for MDAPs, the committee believes that the Defense Department should exercise greater rigor in making sure such course corrections are made with full understanding of the alternatives and the implications of such decisions, rather than relying on inputs from a handful of individuals. The committee has only to look at the decision-making behind the major course correction in Navy shipbuilding that yielded the Littoral Combat Ship (LCS) to be concerned by that prospect.

Before deciding on a course of action regarding acquisition of surface combatants after 2011, we collectively have time to perform the due diligence that should be and must be performed at the beginning of any MDAP. That is what this section will ensure.

In addition, in order to deter any delaying action on conducting and completing the activities required by this section before 2011, the committee directs that the Secretary of the Navy obligate no more than 50 percent of the funds authorized for fiscal year 2010 in PE 24201N, CG(X), until the Navy submits a plan for implementing the requirements of this section to the congressional defense committees. (Pages 13-14)

Conference

In addition to the funding recommendations noted in **Table 4**, Section 125 of the conference report (H.Rept. 111-288 of October 7, 2009) on the FY2010 defense authorization act (H.R. 2647/P.L. 111-84 of October 28, 2009) prohibits the Navy from obligating or expending funds for surface combatants procured in FY2012 or subsequent years until certain conditions are met. The text of Section 125 is as follows:

> SEC. 125. PROCUREMENT PROGRAMS FOR FUTURE NAVAL SURFACE COMBATANTS.
>
> (a) LIMITATION ON AVAILABILITY OF FUNDS PENDING REPORTS ABOUT SURFACE COMBATANT SHIPBUILDING PROGRAMS.—The Secretary of the Navy may not obligate or expend funds for the construction of, or advanced procurement of materials for, a surface combatant to be constructed after fiscal year 2011 until the Secretary has submitted to Congress each of the following:
>
> (1) An acquisition strategy for such surface combatants that has been approved by the Under Secretary of Defense for Acquisition, Technology, and Logistics.
>
> (2) Certification that the Joint Requirements Oversight Council—
>
> (A) has been briefed on the acquisition strategy to procure such surface combatants; and
>
> (B) has concurred that such strategy is the best preferred approach to deliver required capabilities to address future threats, as reflected in the latest assessment by the defense intelligence community.
>
> (3) A verification by, and conclusions of, an independent review panel that, in evaluating the program or programs concerned, the Secretary of the Navy considered each of the following:
>
> (A) Modeling and simulation, including war gaming conclusions regarding combat effectiveness for the selected ship platforms as compared to other reasonable alternative approaches.
>
> (B) Assessments of platform operational availability.
>
> (C) Life cycle costs, including vessel manning levels, to accomplish missions.
>
> (D) The differences in cost and schedule arising from the need to accommodate new sensors and weapons in surface combatants to be constructed after fiscal year 2011 to counter the future threats referred to in paragraph (2), when compared with the cost and schedule arising from the need to accommodate sensors and weapons on surface combatants as contemplated by the 2009 shipbuilding plan for the vessels concerned.
>
> (4) The conclusions of a joint review by the Secretary of the Navy and the Director of the Missile Defense Agency setting forth additional requirements for investment in Aegis ballistic missile defense beyond the number of DDG–51 and CG–47 vessels planned to be equipped for this mission area in the budget of the President for fiscal year 2010 (as submitted to Congress pursuant to section 1105 of title 31, United States Code).
>
> (b) FUTURE SURFACE COMBATANT ACQUISITION STRATEGY.—Not later than the date upon which the President submits to Congress the budget for fiscal year 2012 (as so submitted), the Secretary of the Navy shall submit to the congressional defense committees

an update to the open architecture report to Congress that reflects the Navy's combat systems acquisition plans for the surface combatants to be procured in fiscal year 2012 and fiscal years thereafter.

(c) NAVAL SURFACE FIRE SUPPORT.—Not later than 120 days after the enactment of this Act, the Secretary of the Navy shall submit to the congressional defense committees an update to the March 2006 Report to Congress on Naval Surface Fire Support. The update shall identify how the Department of Defense intends to address any shortfalls between required naval surface fire support capability and the plan of the Navy to provide that capability. The update shall include addenda by the Chief of Naval Operations and Commandant of the Marine Corps, as was the case in the 2006 report.

(d) TECHNOLOGY ROADMAP FOR FUTURE SURFACE COMBATANTS AND FLEET MODERNIZATION.—

(1) IN GENERAL.—Not later than 120 days after the date of the enactment of this Act, the Secretary of the Navy shall develop a plan to incorporate into surface combatants constructed after 2011, and into fleet modernization programs, the technologies developed for the DDG–1000 destroyer and the DDG–51 and CG–47 Aegis ships, including technologies and systems designed to achieve significant manpower savings.

(2) SCOPE OF PLAN.—The plan required by paragraph (1) shall include sufficient detail for systems and subsystems to ensure that the plan—

(A) avoids redundant development for common functions;

(B) reflects implementation of Navy plans for achieving an open architecture for all naval surface combat systems; and

(C) fosters competition.

(e) DEFINITIONS.—In this section:

(1) The term ''2009 shipbuilding plan'' means the 30-year shipbuilding plan submitted to Congress pursuant to section 231, title 10, United States Code, together with the budget of the President for fiscal year 2009 (as submitted to Congress pursuant to section 1105 of title 31, United States Code).

(2) The term ''surface combatant'' means a cruiser, a destroyer, or any naval vessel, excluding Littoral Combat Ships, under a program currently designated as a future surface combatant program.

Regarding Section 125, the conference report states:

Procurement programs for future naval surface combatants (sec. 125)

The Senate amendment contained a provision (sec. 113) that would prevent the Navy from obligating any funds for building surface combatants after 2011 until the Navy conducts particular analyses, and completes certain tasks that should be required at the beginning of major defense acquisition programs. The committee report (S. Rept. 111–35) also would direct that the Secretary of the Navy obligate no more than 50 percent of the funds authorized for fiscal year 2010 in PE 24201N, CG(X), until the Navy submits a plan for implementing the requirements of this section to the congressional defense committees.

The House bill contained no similar provision.

The House recedes with technical amendments. The conferees agree to direct that the Secretary submit the plan for implementing the requirements of this section to the congressional defense committees at the same time as the President submits the budget request for fiscal year 2011. (Pages 679-680)

FY2010 DOD Appropriations Act (H.R. 3326/P.L. 111-118)

House

As shown in **Table 4**, the House Appropriations Committee, in its report (H.Rept. 111-230 of July 24, 2009) on H.R. 3326, recommends an $11-million reduction to the Navy's request for procurement funding for the DDG-1000 program. Page 164 of the report states that the recommended reduction is for "Excess change order funding." In addition to the funding recommendations noted in **Table 4**, the committee's report states:

SURFACE COMBATANTS

The Committee is concerned with the Navy's apparent lack of a surface combatant acquisition plan. In recent years, the Navy has halted production of the DDG–51 guided missile destroyer program to start production of the DDG–1000 guided missile destroyer. After awarding only two construction contracts for DDG–1000 class ships, the Navy announced the termination of that program at three ships and made plans to restart the DDG–51 production line with no clear path for future surface combatant acquisition. The Committee is aware that surface combatants will be reviewed as part of the Quadrennial Defense Review and directs the Navy to review, as part of the Quadrennial Defense Review, the feasibility of using the technologies developed as part of the DDG–1000 program on future surface combatants to ensure the taxpayers get the maximum benefit from the significant funding that was sunk into the research and development phase of the DDG–1000 program. (Pages 165-166)

Senate

As shown in **Table 4**, the Senate Appropriations Committee, in its report (S.Rept. 111-74 of September 10, 2009) on H.R. 3326, recommends funding for the procurement of two DDG-51s in FY2010, and recommends that the $309.6 million requested to cover cost growth on the first two DDG-1000s be transferred to the main line item for DDG-1000 procurement. (Pages 112 and 113) The committee's report states:

DDG–51 Class Destroyer.—The fiscal year 2010 budget request included $1,912,267,000 for the construction of one DDG–51 destroyer and $328,996,000 in advance procurement funding for two ships in fiscal year 2011. The Committee fully supports the restart of the DDG–51 program. Therefore, in order to restart the DDG–51 program in the most efficient and cost effective way possible, the Committee recommends an additional $1,737,733,000 for the procurement of a second DDG–51 destroyer in fiscal year 2010. The Committee expects that the addition of a second ship in fiscal 2010 will allow the Navy to benefit from economies of scale and improve stability the Nation's shipbuilding industrial base....

Completion of Prior Year Shipbuilding Programs.—The fiscal year 2010 budget request included $454,586,000 in the Completion of Prior Year Shipbuilding Programs budget line.

> The Committee understands that $309,636,000 of this request is for the DDG 1000 program to address class-wide costs that are not specific to individual hulls but rather required to complete all remaining ships in construction. These costs are usually budgeted across all planned ships in construction and not in the cost to complete budget line. Therefore, the Committee recommends transfer of $309,636,000 to the DDG 1000 new construction budget line. Fiscal year 2011 and beyond requirements should be addressed as program shutdown line items in future budget requests. (Pages 113 and 114)

As also shown in **Table 4**, the committee's report recommends a $12.6-million reduction to the Navy's request for FY2010 research and development funding for the DDG-1000 program. The report states that the reduction is for "FSST alternative initiative." (Page 184)

Final Version

In lieu of a conference report, the House Appropriations Committee on December 15, 2009, released an explanatory statement on a final version of H.R. 3326. This version was passed by the House on December 16, 2009, and by the Senate on December 19, 2009, and signed into law on December 19, 2009, as P.L. 111-118. The explanatory statement states on page 1 that it "is an explanation of the effects of Division A [of H.R. 3326], which makes appropriations for the Department of Defense for fiscal year 2010. As provided in Section 8124 of the consolidated bill, this explanatory statement shall have the same effect with respect to the allocation of funds and the implementation of this as if it were a joint explanatory statement of a committee of the conference."

The explanatory statement approves the Administration's request for FY2010 procurement funding for the DDG-51 program, increases by $250 million the Administration's request for FY2010 advance procurement (AP) funding for the DDG-51 program, reduces by $11 million (for "Excess change order funding") the Administration's request for FY2010 procurement funding for the DDG-1000 program, and approves the Administration's FY2010 request for procurement funding to cover cost growth on the first two DDG-1000s (while transferring this funding into the DDG-1000 procurement line). (Page 166). The explanatory statement reduces by $12.6 million (for "FSST alternative initiative") the Administration's FY2010 request for research and development funding for the DDG-1000 program. (Page 278)

The explanatory statement states:

> DDG-51 GUIDED MISSILE DESTROYER
>
> The recommendation includes $578,996,000, an increase of $250,000,000 above the budget request, for advance procurement of components for the two DDG-51 destroyers planned in fiscal year 2011. The recommendation fully supports re-start ofthe DDG-51 program and provides additional funding in an effort to re-start the program in a more efficient and cost effective manner. (Page 170)

The explanatory statement also states:

> SHIPBUILDING
>
> The fiscal year 20 I0 shipbuilding budget request from the Department once again falls short of the quantity often ships nominally required to reach and maintain the required fleet size of313 ships. Further, the Department's revised acquisition strategy for the Littoral Combat Ship, solidified after the submission of the budget, has reduced the requested number of

ships from a quantity of eight to a quantity of seven. In an effort to position the Department to request additional ship quantities in fiscal year 2011, the recommendation includes an additional $170,000,000 of advance procurement funding for the LHA (Replacement) helicopter assault ship and $250,000,000 of additional advance procurement funding for the DDG-51 Guided Missile Destroyer program. (Page 167)

Appendix A. Additional Background Information on DDG-1000 Program

This appendix presents additional background information on the DDG-1000 program. It presents information on the DDG-1000 program *as it existed just prior to the Navy's July 2008 change in position on future destroyer procurement.*

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]

[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) Program: Background, Issues, and Options 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.

Acquisition Strategy

Navy Management

Since September 30, 2005, the Navy has managed the DDG-1000 program through a series of separate contracts with major DDG-1000 contractors, including Northrop Grumman Shipbuilding (NGSB), General Dynamics Bath Iron Works (GD/BIW), Raytheon, and BAE Systems (the maker of the AGS). Under this arrangement, the Navy is acting as the overall system integrator for the program.

Earlier Proposal for Winner-Take-All Acquisition Strategy

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 NGSB, 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 NGSB 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 NGSB 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 (Section 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 NGSB 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.

Milestone B Approval for Dual-Lead-Ship Strategy

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

Contract Award For Two Lead Ships

On February 14, 2008, the Navy awarded contract modifications to GD/BIW and NGSB for the construction of the two lead ships. The awards were modifications to existing contracts that the Navy has with GD/BIW and NGSB 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.

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.

Appendix B. Navy Testimony of July 31, 2008

This appendix reprints in its entirety the text of the Navy's prepared statement for the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee.[44] The text states:

> Chairman Taylor, Ranking Member Bartlett, and distinguished Members of the Seapower and Expeditionary Forces Subcommittee, the Department is committed to executing the Cooperative Maritime Strategy, modernizing our fleet, and building the fleet of tomorrow. The Navy urges your support to fully fund the Department's 2009 shipbuilding request. The Navy requests the Committee's support for the Navy's recent plan to truncate the DDG 1000 program at two ships and reopen the DDG 51 line to better align our surface combatant investment strategy with our nation's warfighting needs. The Navy continues to address the dynamic capability requirements of the Fleet while balancing the demands placed on limited resources and producing a plan that provides maximum stability for the industrial base. Modernizing the Fleet's cruisers and destroyers and executing an affordable shipbuilding plan are crucial to constructing and maintaining a 313 ship Navy with the capacity and capability to meet our country's global maritime needs. In an age of rapidly evolving threats and fiscal constraints, we must ensure we are building only to our highest priority requirements and that the mission sets we envision for the future represent the most likely of those potential futures.
>
> Surface combatants are the workhorses of our Fleet and central to our traditional Navy core capabilities. Our cruisers, destroyers, and the new littoral combat ships bring capabilities to the fleet, that enable us to deter our enemies, project power, deploy forward and control the seas.
>
> **Strategic Environment**
>
> Rapidly evolving traditional and asymmetric threats continue to pose increasing challenges to Combatant Commanders. State actors and non-state actors who, in the past, have only posed limited threats in the littoral are expanding their reach beyond their own shores with improved capabilities in blue water submarine operations, advanced anti-ship cruise missiles and ballistic missiles. A number of countries who historically have only possessed regional military capabilities are investing in their Navy to extend their reach and influence as they compete in global markets. Our Navy will need to outpace other Navies in the blue water ocean environment as they extend their reach. This will require us to continue to improve our blue water anti-submarine and anti-ballistic missile capabilities in order to counter improving anti-access strategies.
>
> The Navy remains committed to having the capability and capacity to win our Nation's wars and prevent future wars. The rise of violent extremism has become a greater threat as it rapidly evolves with diverse and adaptive capabilities. These often stateless organizations pose further challenges with their aspirations of weapons of mass destruction development and desire to proliferate missiles and other highly, technologically advanced weapons. All of these threats require the Navy to have the capacity to build partnerships and continue our efforts of investing in maritime domain awareness; intelligence, surveillance, and

[44] Statement of Vice Admiral Barry McCullough, Deputy Chief of Naval Operations for Integration of Capabilities and Resources, and Ms. Allison Stiller, Deputy Assistant Secretary of the Navy (Ship Programs), before the Subcommittee on Seapower and Expeditionary Forces of the House Armed Services Committee, on Surface Combatant Requirements and Acquisition Strategies, July 31, 2008, 11 pp.

reconnaissance programs; and having both kinetic and non-kinetic effects capabilities. We call on our surface combatants to conduct these operations and execute the Maritime Strategy today, and we will continue to call on them to provide maritime supremacy from the ungoverned spaces of the littorals to vast expanses of our world's oceans.

Challenges

The challenge for the Navy is to maintain traditional core naval capabilities while simultaneously enhancing our ability to conduct expanded core roles and missions to ensure naval power and influence can be applied on the sea, across the littorals, and ashore. It is no longer feasible or affordable to purchase the most capable, multi-mission platform and then limit its use to execute tailored mission areas or focus on specific threats. As asymmetric threats continue to evolve, so will traditional threats. The Navy must find affordable and adaptable ways to fill current and future warfighting gaps.

Beyond addressing capability requirements, the Navy needs to have the right capacity to remain a global deterrent and meet Combatant Commander warfighting requirements. Combatant Commanders continue to request more surface ships and increased naval presence to expand our cooperation with new partners in Africa, the Black Sea, the Baltic Region, and the Indian Ocean and maintain our relationships with our allies and friends. Therefore, we must increase surface combatant capacity in order to meet Combatant Commander demands today for ballistic missile defense, theater security cooperation, steady state security posture and to meet future demands as we standup Africa Command (AFRICOM) and the FOURTH Fleet in SOUTHERN Command. The Navy also continues to remain committed to our Ballistic Missile Defense partners around the globe, including Japan, Korea, the Netherlands, and Spain.

Future Force

The 30 year ship building plan was designed to field the force structure to meet the requirements of the national security strategy and the Quadrennial Defense Review meeting the FY 2020 threat. The 313-ship force floor represents the maximum acceptable risk in meeting the security demands of the 21st century. In the balance of capability and capacity, the Navy has found that there are increased warfighting gaps, particularly in the area of integrated air and missile defense capability. Capacity also matters, and capacity is capability for the Irregular War we are in today.

The DDG 1000 program is developing a capable ship which meets the requirements for which it was designed. The DDG 1000, with its Dual Band Radar and sonar suite design are optimized for the littoral environment. However, in the current program of record, the DDG 1000 cannot perform area air defense; specifically, it cannot successfully employ the Standard Missile-2 (SM-2), SM-3 or SM-6 and is incapable of conducting Ballistic Missile Defense. Although superior in littoral ASW, the DDG 1000 lower power sonar design is less effective in the blue water than DDG-51 capability. DDG 1000's Advanced Gun System (AGS) design provides enhanced Naval Fires Support capability in the littorals with increased survivability. However, with the accelerated advancement of precision munitions and targeting, excess fires capacity already exists from tactical aviation and organic USMC fires. Unfortunately, the DDG 1000 design sacrifices capacity for increased capability in an area where Navy already has, and is projected to have sufficient capacity and capability.

The DDG 51 is a proven, multi-mission guided missile destroyer. She is the Navy's most capable ship against ballistic missile threats and adds capacity to provide regional ballistic missile defense. DDG 51 spirals will better bridge the ballistic missile defense gap to the next generation Cruiser. Production costs of DDG 51s are known. The risks associated with

re-opening the DDG 51 line are less than the risks of continuing the DDG 1000 class beyond 2 ships when balanced with the capability and capacity of pursuing the 313 ship fleet.

Current Execution

The Department is committed to executing the acquisition plan for our future force. Acquisition Professionals and Requirements Officers are working closely to maintain the Department's commitment to an affordable shipbuilding and modernization plan.

DDG 51 Destroyer Program and Production Restart Assessment

The capability of DDG 51 Class ships being built today is markedly more advanced than the initial ships of the class. The DDG 51 Class was developed in three incremental flights, with upgraded technology and capability built into each subsequent hull. Ships are currently being constructed at both General Dynamics (GD) Bath Iron Works (BIW) and Northrop Grumman Shipbuilding (NGSB). 62 ships have previously been authorized and appropriated, with the most recent procurement of three ships in FY 2005. A total of 53 ships have been delivered to the Navy. Five ships remain under construction at GD BIW, and 4 at NGSB. The last ship currently under construction, DDG 112, is scheduled for delivery in FY 2011. All material for DDG 51 Class ships currently under construction has been procured, with the majority of the long lead material purchased in an Economic Order Quantity buy in FY 2002.

DDG 51 class production has been extremely stable, with successful serial production at both shipbuilders. Despite some setbacks, such as the impacts of Hurricane Katrina at NGSB, the costs associated with DDG 51 class shipbuilding are well understood. The Aegis Weapon System has been incrementally developed successfully to add increased capabilities and transition to the use of open architecture and increased use of commercial systems.

Additionally, the DDG 51 modernization program is currently modernizing the Hull, Mechanical, and Electrical (HM&E) and Combat Systems. These combined upgrades support a reduction in manpower and operating costs, achieve expected service life, and allow the class to pace the projected threat well into the 21st century.

Based upon a Navy assessment, including discussions with both current shipbuilders, to explore any subcontractor issues, a restart of DDG 51 procurement in FY 2009 is feasible. However, several ship and Government Furnished Equipment vendor base issues (including configuration change issues and production line re-starts) must be addressed in order to award and construct additional ships, which will increase ship costs above the most recently procured ships. The most notable being the restart of the DDG 51 reduction gear production. The Navy is confident that these issues can be resolved to support a FY 2009 restart. DDG 51 class restart beyond FY 2009 presents significant risks and therefore additional costs.

However, both shipbuilders have indicated to the Navy that these lead time challenges can be mitigated with advance procurement and an adjusted build sequence, and that DDG 51 restart in FY 2009 is executable in both shipyards. Regarding the combat systems, the last production contracts were awarded in 2006. The cost and ease of restarting those production lines is a function of time, and part availability on military specification items which would need to be addressed.

Given the truncation of the DDG 1000 program at two ships, the Navy estimate for procurement of a single DDG 51 class ship in FY 2009 is $2.2 billion. This estimate utilizes the latest audited Forward Pricing Rate Agreements (FPRAs) rates. Impacts for production line restart and contractor furnished equipment/government furnished equipment obsolescence are included. The Navy has not finalized the acquisition strategy for a FY 2009

DDG 51 and follow-on procurements. The Navy will carefully consider stability of the industrial base during the planning of the specific strategy.

DDG 1000 Class Destroyer Program

The Navy remains ready to begin construction of DDG 1000. A rigorous systems engineering approach for the program has been employed to mitigate the risk involved with building a complex lead ship surface combatant. This approach included successful building and testing of the 10 critical technologies via Engineering Development Models. Naval Vessel Rules were also fully incorporated prior to commencing detail design. Design of the Mission Systems is now nearly 100 percent complete. Detail design will be approximately 85 percent complete prior to the start of fabrication, and will be more complete than any other previous surface warship.

The systems engineering approach for DDG 1000 has been well conceived and well executed. However, overall, the remaining program risk involved in integrating the Mission Systems, 10 EDM's, and the ship detail design is still moderate. Particularly, the Dual Band Radar and Integrated Power System have further land-based testing to complete, and the software development for the Total Ship Computing Environment continues. Careful planning has been conducted so that where further development does continue on systems, these have been partially tested to the point that any potential changes are not likely to affect software or system interfaces, with a low risk of affecting either detail design or software development.

As such, the maturity of the ship design, critical technologies, and mission systems support commencement of production. However, it is accurate that the integration of a complex, lead ship, surface combatant with significant new technologies always entails risk. And though the Navy cost estimate for DDG 1000 is based on a detailed, bottoms-up approach, this complex integration does increase the cost risk.

Truncation of the program at two ships will result in cost impacts due to program shutdown, continuation of required class service tasks, and potential increased costs for DDG 1000 and 1001 and other programs. Additionally, the RDT&E efforts for the DDG 1000 program, which include software development and other critical efforts, must continue in order to deliver completed ships and in the CVN 78 Class.

Conclusion

Your Navy remains committed to building the fleet of the future and modernizing our current fleet. The Navy's top shipbuilding priority remains achieving a surface combatant shipbuilding program that is equally capable of assuring peace today and access to the global economy tomorrow regardless of the threats posed in an uncertain future. To accomplish this, we are steadfast in our intention to not use procurement accounts for other Navy program offsets. Procurement and R&D investments made today will serve our country and fleet well beyond 2020 as we modernize the fleet we have and build the fleet we need. Continuing to build DDG 51s enables us to expand warfighting capacity and capability in areas needed by Combatant Commanders and allows us to reach the 313 ship level sooner. Meeting evolving blue water and near-land threats that the DDG 51 can match provides less risk to the joint warfighter. There is less risk associated with the affordability of maintaining DDG 51 line versus continuing the DDG 1000 line. The Navy is ready to restart DDG 51 production, and is committed to successfully delivering DDG 1000 and 1001 from which, we will inform new ship class designs. The Navy has not finalized the acquisition strategy for FY 2009 DDG 51 and follow-on procurements, however acquisition planning is fully underway to execute this change in the Navy's shipbuilding requirements. The Department urges the Committee's support for full funding of the surface combatant procurement

account for FY 2009 and approving our proposal regarding DDG's. Thank you for your continued support and commitment to our Navy. I look forward to continuing to work closely with you to make our maritime services and nation more secure and prosperous.

Appendix C. Comparisons of DDG-51 and DDG-1000

This appendix provides information on the capabilities and costs of the DDG-51 and DDG-1000 designs. It includes information presented by the Navy and DOD on five occasions prior to the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee at which the Navy announced its change in destroyer procurement plans:

- at a June 10, 2005, Navy briefing to CRS;
- in July 19, 2005, Navy testimony before the Projection Forces subcommittee of the House Armed Services Committee;
- at an April 10, 2008, Navy briefing to CRS and CBO; and
- in a May 7, 2008, Navy letter to Senator Kennedy; and
- in a July 2, 2008, DOD letter to Representative Taylor.

Overview

The DDG-1000 and DDG-51 are both multimission destroyers, but they have somewhat different mission emphases. The DDG-1000 design features a stronger emphasis on land-attack operations and operations in littoral waters. The DDG-51 design is more oriented toward blue-water operations.

Consistent with its larger size, higher procurement cost, and greater use of new technologies, the DDG-1000, the Navy believes, is more capable than the DDG-51 design in several respects. The Navy states that it designed the DDG-1000 for "full-spectrum littoral dominance" and believes the DDG-1000 would be considerably more capable than the DDG-51 in littoral operations. The Navy believes that because of its reduced signatures, defensive systems, number of gun shells in its magazine, and ability to resupply gun shells while underway, the DDG-1000 would have considerably more capability than the DDG-51 to enter defended littoral waters and conduct sustained operations there. The Navy believes that because of its guns, aviation capabilities, special operations forces (SOF) support capabilities, and small-boat capabilities, the DDG-1000 would be able to perform more littoral missions than the DDG-51. The Navy believes that because of its radars and C4I/networking capabilities, replacing a DDG-51 with a DDG-1000 in a carrier strike group would increase the strike group's anti-air warfare (AAW) capabilities by about 20%. The Navy believes that because of differences in their sonar capabilities, the DDG-51 has more blue-water anti-submarine warfare (ASW) capability than the DDG-1000.

June 10, 2005, Navy Briefing to CRS

The following comparison of DDG-1000 and DDG-51 capabilities is based on information provided by the Navy to CRS at a briefing on June 1, 2005. The information has been updated in some places to account for changes since 2005.

Growth Margin

The DDG-51 and DDG-1000 designs each have about a 10% growth margin. For the roughly 9,000-ton DDG-51, this equates to about 900 tons of growth margin, while for the 14,987-ton DDG-1000, this equates to about 1,400 tons of growth margin.

Ship Mobility

The two designs are roughly equivalent in terms of maximum sustained speed, cruising endurance, and seakeeping (i.e., stability in rough seas). The DDG-1000's draft (28 feet) is somewhat less than the DDG-51's (31 feet). Other things held equal, this might give the DDG-1000 an ability to operate in (or be berthed at) places where the water depth is sufficient for the DDG-1000 but not for the DDG-51. The DDG-1000's length (600 feet) is greater than the DDG-51's (505 feet). Other things held equal, this might give the DDG-51 an ability to be berthed in spaces that are long enough for the DDG-51 but not for the DDG-1000.

Electrical Power for Weapons and Systems

The DDG-51 has 7.5 megawatts (MW) of electrical power for its weapon systems, while the DDG-1000 design, with its integrated electric-drive system, can provide up to 78 MW for its weapons and power systems by diverting power from propulsion to weapons and systems.

Signatures and Detectability

The DDG-1000 has a smaller radar cross-section and lower infrared, acoustic, and magnetic signatures than the DDG-51. The two designs are roughly equivalent in terms of the detectability of their radar and other electromagnetic emissions. The DDG-1000's reduced signatures, DDG-1000 supporters, will make the DDG-1000 harder to detect, localize, classify, and target, giving the DDG-1000 a significant advantage in engagements against enemy forces.

Survivability and Damage Control

The Navy states that the DDG-1000 would be able to keep fighting after an attack like the one that disabled the USS Cole (DDG-67) on October 12, 2000.

The two designs are roughly equivalent in terms of degree of compartmentalization and ship stability when flooded. The DDG-1000's vertical launch system (VLS) is more heavily armored than the DDG-51's. The DDG's fire-suppression system is automated only in the engine room and magazine, while the DDG-1000's system is automated throughout the ship, making it safer and more effective. The DDG-51's flood-control system is not automated, while the DDG-1000's is, which the Navy believes will make it more effective. The DDG-1000's electrical power distribution system is an "integrated fight-through" system, meaning that it is designed to automatically isolate damaged areas and reroute electrical power around them. All critical DDG-1000 systems are dual-fed, meaning that if power from one source is cut off, it can be routed through a second source. The DDG-51's electrical power distribution system lacks these features.

C4I/Networking Bandwidth

The C4I[45] and networking systems on the DDG-1000 would have five times as much bandwidth as those on the DDG-51. The C4I/networking capability of the DDG-1000 is equivalent to that on the LHD-8 amphibious assault ship. In addition to improved warfighting capability, this increased bandwidth would provide sailors aboard the DDG-1000 a better ability to "reach back" to information sources ashore when conducting at-sea maintenance of shipboard equipment, potentially increasing the availability rates of shipboard equipment.

Flag-Level Command Facilities

The DDG-1000 has facilities for embarking and supporting a flag-level officer and his staff, so that they could use the ship as platform for commanding a group of ships. The DDG-51 does not have such facilities.

Anti-Air Warfare/Ballistic Missile Defense (AAW/BMD)

The radars on the two ships are roughly equivalent in terms of dB gain (sensitivity) and target resolution. The firm track range of the DDG-1000's dual-band radar—the range at which it can maintain firm tracks on targets—is 25% greater for most target types than the firm track range of the DDG-51's SPY-1 radar. The DDG-1000's AAW combat system would be able to maintain about 10 times as many tracks as the DDG-51's Aegis system. The DDG-1000's radar has much more capability for resisting enemy electronic countermeasures and for detecting targets amidst littoral "clutter." As a result of the better performance amidst littoral clutter, the Navy believes that ships escorted by the DDG-1000 in defended littoral waters would have three times as much survivability as ships escorted by the DDG-51.

The two designs would use the same types of area-defense and point-defense interceptor missiles.[46] They would also use the same flares, chaff, and decoys to confuse enemy anti-ship cruise missiles, but the Navy believes these devices would be more effective on the DDG-1000 because of the DDG-1000's reduced signatures.

Anti-Surface Warfare/Strike Warfare

The DDG-1000 would have considerably more naval surface fire support (NSFS) capability than the DDG-51. The DDG-51 has one 5-inch gun, while the DDG-1000 has two 155mm Advanced Gun Systems (AGSs). The DDG-51's gun can fire an initial salvo of 20 rounds per minute and can subsequently fire at a sustained rate of four rounds per minute (20/4). The DDG-1000's two guns have a combined firing rate of 20/20. The shells currently fired by the DDG-51's gun have a range of 13 nm. Future shells are to have a range of up to 50 nm. The shells to be fired by the DDG-1000's guns are to have a range of 63 to 74 nm, and consequently could cover (at 74 nm) more than three times as much area ashore (assuming a 25 nm standoff from shore) as a shell with a range of 50 nm. The shells fired by the DDG-51 carry 8 pounds of explosive, while those fired

[45] C4I stands for command and control, communications, computers, and intelligence.

[46] As discussed earlier, the Navy, as part of its testimony at the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee, stated that the DDG-1000 cannot successfully employ the SM-2 or perform area-defense AAW.

by the DDG-1000 are to carry 24 pounds of explosive. When fired at less than maximum range, the shells fired by the DDG-1000 can alter their flight paths so that six to eight of them can hit a target at the same time; the shells to be fired by the DDG-51 do not have this capability. The DDG-51 carries 600 of the 13nm-range shells or 230 of 62nm-range shells, while the DDG-1000 carries a total of 600 of its shells. It might be possible to fit the DDG-51 with one of the 155mm guns to be carried by the DDG-1000; it would likely require the removal of both the DDG-51's 5-inch gun and its forward (32-cell) VLS. In this configuration, the DDG-51 might carry about 120 of the gun's 155mm shells.

The 155mm guns on the DDG-1000 could be replaced in the future with an electromagnetic rail gun or directed-energy weapon. The DDG-51 does not have enough electrical power to support such weapons.

Antisubmarine Warfare (ASW)

The DDG-51's sonar system is more capable for blue-water ASW operations, while the DDG-1000's system is more capable for littoral ASW operations. The DDG-1000's bow-mounted sonar and towed array can interact to more rapidly triangulate targets. The Flight IIA DDG-51 lacks a towed array. The DDG-1000's radar would have more capability than the DDG-51's radar for detecting submarine periscopes.

The DDG-51 has six torpedo tubes for firing lightweight (12.75-inch diameter) anti-submarine torpedoes, while the DDG-1000 has none, but the Navy does not believe these tubes to be of significant operational value against potential future threats. Both ships can launch lightweight torpedoes from their helicopters or fire the Vertical Launch Antisubmarine Rocket (VLA), which is armed with a lightweight torpedo.

The ships would use the same countermeasures for confusing enemy torpedoes, but the Navy believes these countermeasures would be more effective on the DDG-1000 because of the DDG-1000's reduced signatures.

Mine Warfare (MIW)

The DDG-1000's bow-mounted sonar includes an in-stride mine-avoidance capability; the DDG-51's sonar suite has less capability for detecting mines. The DDG-51 can be built to a design that permits the ship to embark and operate the Remote Minehunting System (RMS); six ships in the DDG-51 program (DDGs 91 to 96) have been built to this design. The Navy says that the DDG-1000's reduced acoustic and magnetic signatures would translate into a significantly greater operating area in mined waters.

Missiles for Performing Above Missions

The DDG-51 has 90 missile-launching tubes in its VLS, while the DDG-1000 has 80. The DDG-51's VLS tubes can accommodate a missile up to 21 inches in diameter, 21 feet in length, and about 3,000 pounds in weight. The DDG-1000's VLS tubes can accommodate a missile up to 24 inches in diameter, 22 feet in length, and about 4,000 pounds in weight. The gas-management (i.e., heat-management) system of the DDG-1000's VLS tubes can accommodate a hotter-burning missile than the gas-management system of the DDG-51's VLS, so the DDG-1000 might be more capable of using future missiles if they are hotter-burning.

Aviation for Performing Above Missions

The DDG-51 can embark and operate two SH-60 helicopters but does not have electronics for launching and recovering unmanned aerial vehicles (UAVs). The DDG-1000 can embark, operate, and provide full maintenance for two SH-60 helicopters or one SH-60 helicopter and three UAVs. The DDG-1000's flight deck is larger than the DDG-51's and can accommodate all joint rotary-wing aircraft, including the MV-22, the CH-53, and the H-47. The DDG-1000's flight deck is 10 feet higher off the water and can therefore be used for full flight operations in a sea state (i.e., sea condition) that is at least one step higher (i.e., rougher) than is possible for the flight deck on the DDG-51.

Special Operations Forces (SOF) Support

The DDG-1000 has additional berthing for 20 SOF personnel (i.e., a platoon), as well as a space for SOF mission planning and spaces for stowing SOF gear. The DDG-51 lacks these features.

Boats

The DDG-51 can embark two seven-meter boats that are deployed and recovered with a davit. The DDG-1000 can embark two 11-meter boats and four rubber raiding craft that are deployed and recovered with a stern ramp, which permits faster and safer launching and recovering, and launch/recovery operations in higher sea states.

Habitability Features for Crew

On the DDG-51, enlisted crew berthing spaces accommodate 20 to 60 sailors each. On the DDG-1000, every sailor would have a stateroom, and each stateroom would accommodate four sailors. The Navy believes these features would improve crew quality of life, which can improve retention rates.

July 19, 2005, Navy Testimony

At the July 19 portion of a July 19-20, 2005, hearing before the Projection Forces subcommittee of the House Armed Services Committee, Navy officials testified that, compared to the DDG-51 design, the DDG-1000 design's capability improvements include, among other things,

- a threefold improvement in capability against anti-ship cruise missiles, including significantly better radar performance in situations involving near-land radar clutter;
- a 10-fold improvement in overall battle force defense capability, in part because of a 5-fold improvement in networking bandwidth capacity;
- 15% more capability to defend against group attacks by enemy surface craft (i.e., "swarm boats");
- a 50-fold improvement (i.e., reduction) in radar cross-section, which dramatically enhances survivability and reduces by half the total number of missiles that need to be fired in an intercept engagement;

- a 10-fold increase in operating area against mines in shallow-water regions;
- three times as much naval surface fire support capability, including an ability to answer 90% of Marine Corps calls for fire within five minutes, permitting the ship to meet stated Marine Corps firepower requirements—a capability otherwise unavailable in the surface fleet—giving the ship a capability roughly equivalent to one-half of an artillery battalion, and permitting a 65% reduction in Marine Corps artillery;
- a ship design that allows underway replenishment of gun shells, creating the equivalent of an almost-infinite ammunition magazine and permitting nearly continuous fire support;
- almost 10 times as much electrical capacity available for ship equipment, giving the ship an ability to support future electromagnetic rail guns and high-energy laser weapons; and
- features such as an automated fire-suppression system, peripheral vertical launch system, and integrated fight-through-damage power system that significantly increase ship survivability.[47]

April 10, 2008, Navy Briefing to CRS and CBO

At an April 10, 2008, briefing to CRS and CBO, Navy officials presented a briefing slide providing a comparison of the DDG-1000 design's capabilities relative to the DDG-51 design's capabilities. The briefing slide is reprinted below (with some editing changes for readability) as **Table C-1**.

Table C-1. DDG-1000 Capabilities Relative to DDG-51 Capabilities

Item	DDG-1000 compared to DDG-51
Radar cross section	Significantly smaller
Ship detectability by threat aircraft	Threat must fly lower and closer to detect the ship
Firm track range on enemy anti-ship cruise missiles	Significant improvement, especially in land-clutter environments
Performance against small boat swarm raids	Engage small boats at 3 times the effective range and engage 10 times more threats
Safe operating area in areas with enemy bottom mines	Significantly larger
Land attack capability	3 times as much lethality and 40% greater range than Extended Range Guided Munition (ERGM)[a]
Manning	50% less crew
Electrical power	Sufficient capacity for rail gun, laser weapons, and future radar upgrades

[47] Source: Points taken from Statement of Admiral Vern Clark, U.S. Navy, Chief of Naval Operations, Before The House Armed Services Committee Projection Forces Subcommittee, July 19th, 2005, and Statement of The Honorable John J. Young, Jr., Assistant Secretary of the Navy (Research, Development and Acquisition), and RADM Charles S. Hamilton, II, Program Executive Officer For Ships, Before the Projection Forces Subcommittee of the House Armed Services Committee on DD(X) Shipbuilding Program, July 19, 2005.

Source: Navy briefing slide #7, entitled "Multi-Mission Combatant," in Navy briefing to CRS and CBO, April 10, 2008. CRS has edited the words in the table to make them easier to understand.

a. ERGM was a 5-inch extended-range guided munition for the 5-inch guns on Navy cruisers and destroyers. The Navy in 2008 canceled development of ERGM.

In addition to the information presented in **Table C-1**, another slide in the Navy briefing stated that the DDG-1000's radar cross section will be similar to that of a fishing boat.[48] Navy officials have also stated separately that the DDG-1000's acoustic signature will be similar, at certain speeds, to that of certain U.S. Navy submarines.[49]

In elaborating on the point in **Table C-1** pertaining to the DDG-1000's electrical power, Navy officials stated at the briefing that at a speed of 20 knots, the DDG-1000 would have 58 megawatts of power available for powering non-propulsion shipboard systems. The briefing stated that the DDG-51, by comparison, has 7.5 megawatts of power available for non-propulsion systems.

May 7, 2008, Navy Letter to Senator Kennedy

A May 7, 2008, letter from Admiral Gary Roughead, the Chief of Naval Operations (CNO), to Senator Edward Kennedy that was obtained by a defense trade publication and posted on its website provided information on the comparative costs and capabilities of the DDG-1000 and DDG-51. The letter stated:

> Thank you for your letter of April 21, 2008, concerning cost estimates for the continuation of the DDG 51 program and the DDG 1000 program.
>
> As you indicated in your letter, without firm contracts for future ships of either class, we are only able to provide a best estimate of the costs we would incur in either of these programs. Since we are phasing out production of the DDG 51 class, there would be start-up costs associated with returning this line to production. As a result, the estimated end cost to competitively procure a lead DDG-51 (Flight IIa—essentially a repeat of the final ships currently undergoing construction) in Fiscal Year (FY) 2009 assuming a truncation of the DDG 1000 class after the two lead ships would be either $2.2B for a single ship or $3.5B for two lead ships (built at competing production yards). This estimate is based on a Profit Related to Offer (PRO) acquisition strategy. The average cost of subsequent DDG 51 Flight IIa class ships would be about $1.8B (FY09) per ship compared to the $2.6B estimated cost of subsequent DDG 1000 class ships. Below is the breakdown of the one and two ship FY09 DDG 51 estimates, compared to that of the DDG 1000 in the same year. DDG 1000 costs include FY08 advanced procurement funds:

[48] Navy briefing slide #8, entitled "Zumwalt Advantage," in Navy briefing to CRS and CBO, April 10, 2008.

[49] Source: Spoken testimony of Navy officials at hearing before Seapower subcommittee of Senate Armed Services Committee on April 8, 2008.

(FY$M)	DDG 51 (FY09)	DDG 51 (FY09)	DDG 1000 (FY09)
Qty	1	2	1
Plans/Basic [construction]	854.4	1607.8	1393.3
Change Orders	39.1	76.1	66.0
Government Furnished Equip	1138.2	1556.7	1126.8
Other	56.4	57.5	66.6
Total Ship Cost	2088.1	3298.1	2652.6

The table provided below compares the annual operations and support costs for the DDG 51 and DDG 1000 class ships.

(FY$M)	DDG 1000	DDG 51
Operating (steaming)	$18.5	$15.7
Maintenance	$10.3	$5.6
Manpower	$8.5	$19.9
Total	$37.3	$41.2
Crew Size	14 officers	24 Officers
	106 enlisted	272 Enlisted

The total annual cost for the DDG 51 is a class average based on 17 years of operations and maintenance, and does not include personnel reduction savings expected from the DDG Modernization program. While there are cost savings associated with the DDG 1000's smaller crew, they are largely offset by higher estimated maintenance costs for this significantly more complex ship.

Clearly the relative value of the DDG 1000 resides in the combat system (Dual-Band Radar, Volume Search Radar, ASW Suite, etc) that provide this ship with superior warfighting capability in the littoral. However, the DDG 51 can provide Ballistic Missile Defense capability against short and medium range ballistic missiles and area Anti-Air Warfare capability (required in an anti-access environment) where the DDG 1000 currently does not. Upgrading the DDG 1000 combat system with this capability would incur additional cost. The DDG 51 class also possesses better capability in active open ocean Anti-Submarine Warfare than does the DDG 1000.

On balance, the procurement cost of a single DDG 51 is significantly less than that of a DDG 1000, and the life-cycle costs of the two classes are similar. I appreciate the opportunity to share my perspective on these two alternatives with you. A similar letter has been sent to Senator Martinez. As always, if I can be of further assistance, please let me know.[50]

On June 3, 2008, John Young, the Under Secretary of Defense for Acquisition, Technology, and Logistics, in testimony to the Senate Armed Services Committee, questioned the accuracy of the cost figures in the May 7 letter, stating, among other things, that he believed the annual operating

[50] Source: Letter dated May 7, 2008, from Admiral G. Roughead to the Honorable Edward M. Kennedy, posted on the Internet at *InsideDefense.com* (subscription required) on May 30, 2008. Emboldening in the second table as in the original. See also Thomas Duffy, "Navy Says DDG-100, DDG-51 Annual Operating Costs Are Rated Even," *Inside the Navy*, June 2, 2008.

and support cost of the DDG-1000 would be about $10 million less than that of a DDG-51, and that the procurement cost figures in the letter relied on certain assumptions that might not prove accurate. Young's testimony was viewed as defending the DDG-1000 more strongly than did the CNO's May 7, 2008, letter.[51]

July 2, 2008, DOD letter to Representative Taylor

A July 2, 2008, letter from John Young, the Under Secretary of Defense for Acquisition, Technology and Logistics (i.e., the DOD acquisition executive), to Representative Gene Taylor that was obtained by a defense trade publication and posted on its website provides additional comments regarding the DDG-1000 and DDG-51, as well as information about the readiness of the DDG-1000 design to enter production. The letter stated:

> I agree that the Navy's preliminary design analysis for the next generation cruiser indicates that, for the most capable radar suites under consideration, the DDG 1000 hull cannot support the radar. This applies just as well to the DDG 51 hull. However, it is my understanding that engineering analysis shows that the existing DDG 1000 hull design can support significantly more capable radar suites than the existing DDG 51 hull design. Moreover, while it is not possible to quickly estimate the production cost of a redesigned DDG 51 alternative, I suspect that, given the dense and complex nature of the DDG 51 hull, as compared to that of the DDG 1000 hull, the cost of a redesigned DDG 51 very likely will be equal to or greater than that of a DDG 1000.
>
> Your letter also warns that cost over-runs for the DDG 1000 program might cripple the Navy's shipbuilding programs. I am equally concerned that restarting the DDG 51 program would pose risk to the shipbuilding budget and inject additional cost for the following reasons:
>
> —Direct production hours for one DDG 1000 ship are about 2.5 times that of one DDG 51 restart ship. This validates DOD's experience that two to three DDG 51 destroyers need to be purchased annually to sustain the production workload base for two surface combatant shipyards. That number of DDG 51 ships costs more per year than one DDG 1000 follow ship. The cost per year for modified DDG 51 ships would be even higher.
>
> —Several ship and vendor base issues, including equipment obsolescence, main reduction gears, configuration change issues, and re-start of production lines, would need to be resolved in order to award and construct additional DDG 51 class ships.
>
> —The costs for the two DDG 1000 ships would increase if that program is truncated to only two ships.
>
> —There will be program shutdown costs for the DDG 1000 program if the program is truncated to only two ships.
>
> —The Research, Development, Test, & Evaluation efforts for the DDG 1000 program must continue in order to deliver two complete lead ships and to support the Dual Band Radar for the CVN 21 program.

[51] See, for example, Emelie Rutherford, "Young Claims Inaccuracies, Assumptions In Navy Destroyer Cost Comparison," *Defense Daily*, June 5, 2008; and Dale Eisman, "Warning: Delay On Ship Will Run Up Navy's Costs," *Norfolk Virginian-Pilot,"* June 4, 2008: D1.

In reference to your concern that there is no Joint Requirements Oversight Council (JROC) or U.S. Marine Corps requirement for fire support that can only be provided by the DDG 1000, the JROC validated the Operational Requirements Document (ORD) for the DDG 1000 program. The ORD includes a requirement to provide precise and sustained naval fires at extended ranges. The DDG 1000 with its advanced Gun System firing the Long Range Land Attack Projectile is the only ship that can achieve that validated requirement.

I remain convinced that the DDG 1000 program is poised for proper execution. Unlike DDG 51, LPD 17, and LCS, where the level of concurrent design, development, and construction were critical flaws, leading to significant cost increases on the lead ships, the DDG 1000 program benefits from early technology maturation, and experienced design team using a mature design tool, proven production processes, and other factors as outlined below:

—Design Drawing Status: DDG 1000 is significantly more mature in detail design than was LPD 17 or DDG 51 at the same points in the program. For example, at the time of the Detail Design and Construction (DD&C) contract award, DDG 1000 detail design products were 55 percent complete, compared to 0 percent for LPD 17 and DDG 51. At the start of fabrication, DDG 1000 detail design products will be approximately 80-85 percent complete, compared to 20 percent for DDG 51 and 20-30 percent for the two LCS designs. While design products for the LPD 17 were also in the 80 percent complete range at the start of fabrication, this came about only after a long delay to fix and prove the design tool during the detail design phase, a lesson learned and avoided for the DDG 1000 program.

—Initial Module Construction: The jointly developed design of DDG 1000 is on schedule to be more mature than any previous shipbuilding program at start of construction. The design and build of the machinery block in advance of first ship construction completed in June 2008. This effort has been extremely beneficial as a risk reduction measure.

—Design Tool Maturity: The DDG 1000 team of contractors worked together on 3-D modeling during preliminary and system design for 6 years in advance of the DD&C phase.

—Early Technical Product Definition: Contractor-developed technical products enabled early development of design products (system diagrams, vendor statements of work, etc.), which are typically developed during the early stages of detail design. DDG 1000 leveraged these early developments to help the program reduce the risk of rework and poor quality than undermine early-start initiatives such as those experienced on other shipbuilding programs.

—Technology Maturity: The combined DDG 1000 design team learning and use of the 3-D Product Modeling Tool 6 years in advance of the DD&C ensures that the right quantity of qualified human capital resources are allocated in support of the DD&C phase.

—Phase III Cost Performance: Cost performance on DDG 1000 was within 2.5 percent of budget on the $2.7B development effort on Phase III, leading to the DD&C phase.

—Current Phase Cost Performance: The current design, development, and integration contract is performing at an overall cost performance index of 1.02 and a schedule performance index of 0.99 through April 2008. Detail design and transition to production are on cost and schedule.[52]

[52] Source: Letter dated July 2, 2008, from John J. Young, Jr., to the Honorable Gene Taylor, posted on the Internet at *InsideDefense.com* (subscription required) on July 11, 2008. See also Geoff Fein, "DDG-1000 Hull Can't Support Most Capable Radar Planned For CG(X), Pentagon Official Says," *Defense Daily*, July 11, 2008.

Appendix D. Potential DDG-51 and DDG-1000 Design Variants

This appendix presents information on potential variants of the DDG-51 and DDG-1000 destroyer designs that could reduce the O&S costs of DDG-51s procured in coming years or improve the capabilities for AAW and BMD (which are referred to collectively in this appendix as integrated air and missile defense, or IAMD) of DDG-51s or DDG-1000s procured in coming years. Parts of this appendix are adapted from CRS testimony at a July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee.[53]

DDG-51 Design Variants

Introduction

The Navy has procured different versions of the DDG-51 design over time. A significant change in the design occurred in FY1994, when the Navy shifted DDG-51 procurement to the Flight IIA version of the ship, which included, among other things, the addition of a helicopter hangar and the repositioning of the ship's aft SPY-1 radar arrays. Prior to implementing the Flight IIA design, the Navy seriously considered a version with even larger-scale changes, called the Flight III design, that would have included, among other things, lengthening the ship's hull to make room for additional mission systems. The Navy and industry in the past have studied options for lengthening the DDG-51 hull by various lengths to accommodate various capability upgrades;[54] the maximum possible hull extension might be 55 or 56 feet.[55]

Compared to procuring additional Flight IIA DDG-51s, procuring a modified version of the DDG-51 design would incur additional nonrecurring design and engineering costs, as well as additional recurring production costs due to loss of learning at the shipyard associated with changing the ship's design and (for some of the options discussed below) the enlargement of the

[53] Statement of Ronald O'Rourke, Specialist in Naval Affairs, Congressional Research Service, before the House Armed Services Committee Subcommittee on Seapower and Expeditionary Forces hearing on Surface Combatant Warfighting Requirements and Acquisition Strategy, July 31, 2008, 17 pp. This testimony was in turn based on information in the Navy program of record, past briefings and other information provided by the Navy and industry to CRS on the DDG-51 and DDG-1000 programs, industry briefings to CRS on DDG-51 and DDG-1000 design options that were done at CRS' request, and open-source information.

[54] For example, the Navy in 1988 studied design options for a Flight III version of the DDG-51 design that included hull extensions, in various locations along the hull, of 30 feet, 40 feet, and 46 feet. The CNO gave initial approval to a Flight III design concept incorporating a 40-foot extension (12 feet forward and 28 feet aft), and the design was intended to begin procurement in FY1994. (Source: Donald Ewing, Randall Fortune, Brian Rochon, and Robert Scott, *DDG 51 Flight III Design Development*, Presented at the Meeting of the Chesapeake Section of The Society of Naval Architects and Marine Engineers, December 12, 1989.) The Flight III design was canceled in late-1990/early-1991. Subsequent studies led to the current Flight IIA design, which does not include a hull extension. A 1994 CRS report discussed the option of lengthening the DDG-51 design by about 12 feet to increase the forward VLS battery from 32 cells to 64 cells. (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]), pp. CRS-27 to CRS-28.

[55] Sources: Recent discussions with industry officials and Navy information provided to CRS in 1997.

ship. Depending on the exact option pursued, the nonrecurring design and engineering costs could total in the hundreds of millions of dollars.

Potential variants of the DDG-51 design that could be procured in coming years include but are not limited to the following:

- a modified version with additional features for reducing O&S costs;
- a modified version with additional features for reducing O&S costs and additional vertical-launch tubes;
- a modified version with additional features for reducing O&S costs and an improved radar; and
- a modified version with additional features for reducing O&S costs, additional vertical-launch tubes, and an improved radar.

Each of these options is discussed below.

Version with Features for Reducing O&S Costs

This option would procure Flight IIA DDG-51s that were modified to include features for reducing the ships' annual O&S costs. Potential features of this kind include but are not limited to the following:

- adding automated equipment and making other changes to reduce crew size;
- adding some electric-drive equipment for interconnecting parts of the ship's mechanical-drive propulsion system so as to permit the system to operate more like an integrated electric drive system; and
- installing a near-surface bow bulb above the existing sonar dome to improve hydrodynamic efficiency.

The discussion below of how these three features could reduce DDG-51 O&S costs uses as its starting point the table below on annual DDG-1000 and DDG-51 O&S costs, which is reprinted from Admiral Gary Roughead's May 7, 2008, letter to Senator Kennedy on the DDG-1000 and DDG-51.[56]

(FY$M)	DDG 1000	DDG 51
Operating (steaming)	$18.5	$15.7
Maintenance	$10.3	$5.6
Manpower	$8.5	$19.9
Total	$37.3	$41.2
Crew Size	[Total 120]	[Total 296]
	14 officers	24 Officers
	106 enlisted	272 Enlisted

Source: Letter dated May 7, 2008, from Admiral G. Roughead to the Honorable Edward M. Kennedy, p. 2. The figures shown in brackets for total crew size were added to the table by CRS.

[56] Source: Letter dated May 7, 2008, from Admiral G. Roughead to the Honorable Edward M. Kennedy, posted on the Internet at InsideDefense.com (subscription required) on May 30, 2008.

Reducing Crew Size

Admiral Roughead's letter states that the above table "does not include personnel reduction savings expected from the DDG Modernization program." The Navy informed CRS on July 25, 2008, that the DDG-51 modernization is not expected to reduce DDG-51 crew size, but that the size of the DDG-51 crew has, for other reasons, been reduced recently from the figure of 296 shown in the table to 278, a reduction of 18 people.[57]

Additional actions might permit a further reduction in DDG-51 crew size: a 2003 industry briefing to CRS on DDG-51 modernization for reduced manning discussed various steps for reducing crew size by about 100.[58] The House Armed Services Committee's report (H.Rept. 108-491 of May 14, 2004) on the FY2005 defense authorization bill (H.R. 4200) similarly stated:

> The committee notes that the Navy is scheduled to commence a DDG-51 modernization plan in fiscal year 2005 with new construction and subsequently extend modernization to in-service destroyers. The committee is aware that the foundations for DDG-51 modernization are: increased warfighting capability, leverage of the DDG—51 shipbuilding program, reduction of total ship ownership costs, and use of open architecture. In addition to those factors, the committee believes that reduction in crew size from the present approximately 300 to an objective of 200 personnel should also be part of the foundation of an even more aggressive modernization program.
>
> According to the Navy, a DDG-51 class ship costs $25.0 million per year to operate, including $13.0 million for the crew. The Navy estimate is that its present modernization plan could reduce the crew cost per ship by $2.7 million per year. A larger reduction in crew size would clearly appear to result in significant savings over the estimated 18 years of remaining normal service life, especially noting that per capita personnel costs may be expected to increase during that period.[59]

Using the figures in the table from Admiral Roughead's May 7 letter, if additional steps can reduce ship crew size by another 32 people, for a total reduction of 50—one-half the figure of 100 mentioned in the 2003 industry briefing and the 2004 committee report—then annual manpower costs for the DDG-51 could be reduced from the figure of $19.9 million shown in the table to about $16.5 million, a reduction of about 17%.

Addition of Some Electric-Drive Equipment

As discussed in two CRS reports,[60] at least one maker of electric-drive propulsion equipment has proposed increasing the planned scope of the Navy's program for modernizing its DDG-51s to include adding some electric-drive propulsion equipment to the ships' existing mechanical-drive propulsion plants. The option could also be applied to new-construction DDG-51s. The added equipment would more fully interconnect the mechanical-drive components on each ship, producing what the firm refers to as a hybrid propulsion plant. The firm estimates that the

[57] Source: Navy information provided to CRS by telephone, July 25, 2008.

[58] Source: Industry briefing to CRS on DDG-51 modernization for reduced manning, August 8, 2003.

[59] H.Rept. 108-491, pp. 122-123.

[60] CRS Report RL33360, *Navy Ship Propulsion Technologies: Options for Reducing Oil Use—Background for Congress*, by Ronald O'Rourke, and CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

addition of this equipment would reduce DDG-51fuel use by about 16%. This option, the firm estimates, would have a non-recurring engineering cost of $17.1 million and a recurring cost (including both equipment cost and installation cost) of $8.8 million per ship.[61]

Using the figures in the table from Admiral Roughead's May 7 letter, reducing DDG-51 fuel use by 16% would reduce the ship's annual operating (steaming) cost from the figure of $15.7 million shown in the table to about $13.2 million—a reduction of about $2.5 million. The Navy has informed CRS that the operating (steaming) cost figures in the May 7 letter are based on fuel costs as of February 2008 and reflect a fuel cost of $112.14 per barrel.[62] If fuel in coming years costs more than $112.14 per barrel, the dollar savings associated with a 3.9% reduction in fuel use would be greater than $2.5 million per year. The obverse would be true if fuel in coming years costs less than $112.14 per barrel.

Adding a Near-Surface Bow Bulb

As discussed in a CRS report,[63] a study by the Navy's David Taylor Model Basin estimated that fitting a near-surface bow bulb—essentially a shaped piece of steel—onto a DDG-51class destroyer could reduce its fuel use by 3.9%.[64]

[61] Source: Briefing by the firm DRS dated December 19, 2007, with estimated percentage fuel-savings and cost figures reconfirmed by telephone call with CRS on July 17, 2008. DRS also stated in the phone call that one Navy official had stated that the reduction in fuel use could be greater than DRS estimates because the commanders of ships with this equipment would likely adjust ship speeds to operate the ship more often at the hybrid system's most-efficient speed points (i.e., the system's "sweet spots").

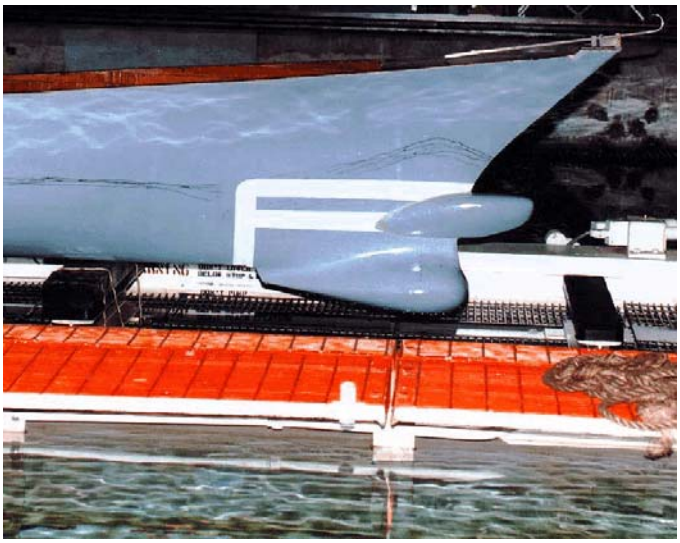
[62] Source: Navy information provided to CRS by telephone, July 25, 2008.

[63]CRS Report RL33360, *Navy Ship Propulsion Technologies: Options for Reducing Oil Use—Background for Congress*, by Ronald O'Rourke.

[64] Dominic S. Cusanelli, "Stern Flaps and Bow Bulbs for Existing Vessels, Reducing Shipboard Fuel Consumption and Emissions," available online at http://www.unep.fr/ozonaction/events/military/proceedings/Presentation%20Material/24%20-%20Cusanelli%20-%20SternFlaps.doc. The study is undated but refers to a test that was "recently completed in Dec. 2000." As also stated in CRS Report RL33360, *Navy Ship Propulsion Technologies: Options for Reducing Oil Use—Background for Congress*, by Ronald O'Rourke, an earlier (1994) study by the same organization estimated that 79 existing Navy cruisers and destroyers could be fitted with bow bulbs for a total development and installation cost of less than $30 million, and that the constant-dollar life-cycle fuel savings of the 79 ships would be $250 million. (Dominic S. Cusanelli, "Development of a Bow for a Naval Surface Combatant which Combines a Hydrodynamic Bulb and a Sonar Dome," paper presented at the American Society of Naval Engineers Technical Innovation Symposium, September 1994.) DOD stated in 2000 that fitting bulbous bows onto 50 DDG-51s (a total of 62 DDG-51s have been procured) could save $200 million in life-cycle fuel costs. (U.S. Department of Defense, *Climate Change, Energy Efficiency, and Ozone Protection, Protecting National Security and the Environment.* Washington, 2000. (Office of the Deputy Under Secretary of Defense (Environmental Security), November 2000) p. 5. Available online at https://www.denix.osd.mil/denix/Public/Library/Air/Climate_Change/dodclimatechange.pdf.)

Figure D-1. Near-Surface Bow Bulb Design for DDG-51

(bulb above, existing sonar dome below)



A document from the hydromechanics department of the Naval Surface Warfare Center Carderock Directorate summarizing efforts by that department through 1999 to improve the hydrodynamic and operational performance of the DDG-51 similarly states that in tests of this proposal:

> Ship performance improvement was projected for the entire ship speed range across all sea states tested, resulting in significant annual fuel savings.
>
> Analysis of seakeeping data and extreme sea wave load tests indicate that the bow bulb had no significant impact on ship motions or hull girder loads. Acoustic transfer function tests data from a vibracoustic model concluded that the bow bulb should have little noticeable impact on the sonar self-noise levels.[65]

Using the figures in the table from Admiral Roughead's May 7 letter, reducing DDG-51 use by an additional 3.9% would reduce the ship's annual operating (steaming) cost from the figure of $15.7 million shown in the table to about $12.7 million—a reduction of $3.0 million. This savings figure is again based on a fuel cost of $112.14 per barrel.

Summary of Potential O&S Cost Reductions

Table D-1, below, summarizes the potential reductions in annual DDG-51 O&S costs from the three options discussed above. The total figure of $34.8 million shown in the final column of the table is about 15% less than the figure of $41.2 million from the table in Admiral Roughead's May 7 letter. These figures would need to be adjusted for the options discussed later in this statement to take into account the configuration changes of those options.

[65] Document entitled "Recent Design Programs, DDG 51," available online at http://www.nswccd.navy.mil/hyd/mul-gal/doc-gal-1/documents/DDG51.pdf.

Table D-1. DDG-1000 and DDG-51 Annual O&S Costs

(FY$M)	DDG 1000	DDG 51	DDG 51 with potential O&S cost reductions
Operating (steaming)	$18.5	$15.7	$12.7
Maintenance	$10.3	$5.6	$5.6
Manpower	$8.5	$19.9	$16.5
Total	$37.3	$41.2	$34.8
Crew Size	120 Total: (14 officers, 106 enlisted)	296 Total: (24 Officers, 272 Enlisted)	246 Total

Source: Letter dated May 7, 2008, from Admiral G. Roughead to the Honorable Edward M. Kennedy, p. 2 (first two data columns) and CRS review of Navy and industry data (third data column).

Version with Reduced O&S Costs and Additional Vertical-Launch Tubes

This version of the DDG-51 design would include additional vertical-launch tubes as well as features for reducing O&S costs. The purpose in procuring this version would be to provide the fleet with improved IAMD capabilities.

Additional vertical-launch tubes could be installed by lengthening the ship's hull forward of the deckhouse. A 1994 CRS report discussed, on the basis of Navy information, how a 12-foot extension could permit the installation of 32 additional VLS cells.[66] In 1997, to support research that CRS was conducting into possible alternatives to the Navy's proposed Arsenal Ship,[67] the Navy provided CRS with information on how lengthening the DDG-51 hull so as to install additional VLS tubes might change the ship's procurement cost. The information is summarized in **Table D-2**, below. The estimated changes in procurement cost were parametric, rough order of magnitude (ROM) estimates only, subject to further engineering evaluation, and did not include detailed design or nonrecurring engineering costs. Although the table shows variants equipped with Mk 41 VLS tubes (the kind currently used on Navy surface ships), adding vertical launch tubes of a newer design may also be possible.

[66] 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]), pp. CRS-27 to CRS-28.

[67] The Arsenal Ship program was aimed at acquiring a small number of relatively simple and inexpensive surface ships, each armed with about 512 VLS tubes. The program was cancelled in 1997. For more on the program, see CRS Report 97-455, *Navy/DARPA Arsenal Ship Program: Issues and Options for Congress*, by Ronald O'Rourke, and CRS Report 97-1004, *Navy/DARPA Maritime Fire Support Demonstrator (Arsenal Ship) Program: Issues Arising From Its Termination*, by Ronald O'Rourke.

Table D-2. 1997 Navy Information on DDG-51 Variants

Variant	Number of Mk 41 VLS tubes (% change relative to Flight IIA)	Number of 5-inch guns	Hull extension (in feet)	Rough recurring procurement cost (relative to Flight IIA)
Current Flight IIA design	96	1	0	1.00
Option 1	128 (+ 33%)	1	12	<1.05
Option 2	160 (+ 67%)	1	30	<1.10
Option 3	192 (+100%)	1	<56	<1.15
Option 4	256 (+167%)	1	56	<1.20

Source: U.S. Navy data provided to CRS on April 9, 1997, except for the figure of 12 feet shown for the variant with 32 additional VLS cells, which is U.S. Navy data provided for 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]). The cost figures in the table are rough order of magnitude (ROM) estimates and do not reflect any detailed design or engineering costs typically reflected in a lead-ship cost. The cost estimates provided by the Navy to CRS, though ROM estimates, were more precise than shown here, and were labeled business sensitive. They have been rendered more approximate by CRS for presentation in this table. The costs of the options as estimated by the Navy did not differ from one another in exact increments of 5%. See also Figure 6 on page 131 from Dean A. Rains, "Methods For Ship Military Effectiveness Analysis," *Naval Engineers Journal*, March 1994: 126-135; and Table 3 on page 26 from Dean A. Rains, "Naval Ship Affordability," *Naval Engineers Journal*, July 1996: 19-30.

As shown in the table, all these options retain the DDG-51's 5-inch gun. If the gun is considered not critical for the ship's intended concept of operations, it could be eliminated from the design, which would reduce the design's procurement cost. Supporters of eliminating the 5-inch gun might argue that the gun is not critical because it does not contribute to a goal of providing improved IAMD capabilities, and because the Navy already has 106 5-inch guns on 22 existing Aegis cruisers (two guns each) and 62 DDG-51s already in service or under construction (one gun each). Opponents of eliminating the 5-inch gun could argue that the absence of a gun would reduce the mission flexibility of the ship.

Version with Reduced O&S Costs and an Improved Radar

This version of the DDG-51 design would include an improved radar in the place of the DDG-51's current SPY-1 radar, as well as features for reducing O&S costs. The purpose in procuring this version would be to provide the fleet with improved IAMD capabilities.

The improved radar would use active-array radar technology, as opposed to the older passive-array technology used in the SPY-1. The active-array technology would be similar to that used, for example, in the DDG-1000 dual band radar. Multiple industry sources have briefed CRS on their proposals for modifying the DDG-51 design to include an active-array radar with greater capability than the SPY-1.

If the DDG-51 hull is not lengthened, then modifying the DDG-51 design to include an improved radar would require removing the 5-inch gun to make space and weight available for additional equipment needed to support operations with the improved radar. Lengthening the hull might

provide enough additional space and weight capacity to permit the 5-inch gun to be retained.[68] Supporting equipment to be installed would include an additional electrical generator and additional cooling equipment.[69] The best location for the generator might be in one of the ship's two helicopter hangar spots, which would reduce the ship's helicopter hangar capacity from two helicopters to one.

Due to the higher cost of the improved radar compared with the SPY-1 and the cost for the additional generator and cooling equipment, modifying the DDG-51 design to this configuration would increase the recurring procurement cost of the ship. Information provided to CRS by industry suggests that if the hull is not lengthened, the increase might be in the general range of $100 million, or perhaps or more. If the hull were lengthened, the cost increase would be greater.

Version with Reduced O&S, Additional Tubes, and an Improved Radar

This version of the DDG-51 design would include both additional vertical-launch tubes and an improved radar, as well as features for reducing O&S costs. The purpose in procuring this version would be to provide the fleet with improved IAMD capabilities. This option would require the hull to be lengthened. The resulting ship would be more expensive in all respects (nonrecurring design and engineering costs, procurement costs, and annual O&S costs) and more capable than the other options discussed here.[70] If the ship's hull were lengthened by 55 or 56 feet, the resulting ship might be roughly 25% more expensive to procure than the current Flight IIA design, or perhaps more than that.

DDG-1000 Design Variants

As with the DDG-51 design options discussed above, modifying the DDG-1000 design could incur additional nonrecurring design and engineering costs, and could affect the estimated procurement cost of the ship.

Procuring a modified DDG-1000 design that includes additional vertical launch tubes rather than AGSs

This option would more closely align the DDG-1000 design with a goal of providing the fleet with improved IAMD capabilities by removing one or both of the ship's two AGSs and their magazines and using the freed-up space for additional vertical launch tubes.

[68] Some sources consulted by CRS believe that the 5-inch gun could be retained, even if the hull is not lengthened.

[69] Some sources consulted by CRS believe that an additional electrical generator might not be needed.

[70] Depending on the amount of reduction in annual O&S costs, it is possible that this ship might be comparable to, or less expensive than, a baseline DDG-51 Flight IIA in terms of annual O&S costs.

Procuring a modified DDG-1000 design that includes additional vertical launch tubes rather than AGSs, and also a higher-capability radar

This option, which would also more closely align the DDG-1000 design with a goal of providing the fleet with improved IAMD capabilities, is similar to the previous option, except that the DDG-1000 would also be equipped with a radar with more capability than the radar in the current DDG-1000 design. (The higher-capability radar would use active-array technology, like the current DDG-1000 radar, but would use that technology in a radar with more fully populated arrays.) A radar with a certain amount of additional capability could be accommodated without redesigning the DDG-1000 deck house; a radar with a greater amount of additional capability could be accommodated through a partial redesign of the deckhouse (i.e., a redesign that would affect the deckhouse but not require a change to the ship's basic hull design). Due to the space needed for the additional cooling units that would be needed to support a higher-capability radar, this option might result in a smaller number of additional vertical launch tubes than the previous option.

September 2008 Press Report

A September 12, 2008, press report stated:

> Raytheon [RTN] has a proposal on the table with the Navy to make the emergent Zumwalt-class DDG-1000 destroyers missile defense platforms, according to a company official.
>
> In an interview yesterday with sister publication *Space and Missile Defense Report*, Taylor Lawrence, president of Raytheon Missile Systems, noted that the Zumwalt-class destroyers have stealth capabilities, able to move in close to enemy shores without being detected by enemy radar.
>
> "The good thing about Zumwalt is, it's really the advanced ship, with the advanced combat system, and the advanced components of missiles and everything that brings it together to give it ... the best capability that the Navy could have for the next few years," Lawrence said....
>
> "The thing we're talking about right now is even more over and above some of the capabilities that is in its [the Zumwalt] current requirements ... specifically about missile defense," Lawrence said.
>
> "Is it a missile-defense-capable ship? And our answer—and we put proposals on the table—is, it could be."
>
> A Zumwalt missile defense system would be equipped with the same family of missiles that Raytheon built for the Aegis system, Lawrence added.
>
> But, he added, the Zumwalt "would be a far more capable missile defense ship."
>
> Additionally, he said, "our proposal says let's do some things that basically enhance the missiles so that they're compatible across, say, the Aegis system and the Zumwalt class and then even our coalition partners."
>
> That would be accomplished, he said, by putting a data link on board the ships that "could talk to either one ... can talk to Aegis, talk to Zumwalt, talk to our coalition partners. We think that that's really the future. You make the missile interoperable across all those

configurations. If you do that, then if the Navy chooses to make Zumwalt a missile-defense-capable ship, it becomes very easy to do—and we think very affordable."

The Zumwalt combat system could track an enemy missile, and "the Zumwalt could be, then, a missile-defense-capable ship, with an SM-3 [interceptor], or SM-6, by itself," with a dual data link on the missile.

Thus far, the Navy hasn't accepted the Raytheon offer, deciding that the Zumwalt "is not a missile-defense-capable ship because they've decided, so far, not to buy that capability," Lawrence said.

But the same could be said of Arleigh Burke-class destroyers until they are upgraded with the Aegis/SM-3 ballistic missile defense capability, he said. "These are ... enhancements to the baseline destroyers, and you can do the enhancement to either one."

Where all that comes down is a decision as to how many of each type of ship the Navy wishes to procure. "The big debate is, how much of either one do you want to do," Lawrence said. "We believe that we have a proposal on the table that would make the Zumwalt the most capable missile defense destroyer in the fleet. But [first] you need to do a few things to the [interceptor] missiles, you need to do a few things to the combat system, you need to buy that incremental capability."

As well, Zumwalts could function well in area air warfare, taking out incoming enemy air threats, Lawrence added.

"You put the SM-2s on board, eventually SM-6s, you got a very, very capable area air warfare defense destroyer," he said.[71]

November 2009 Press Report

A November 9, 2009, press report stated:

Faced with a U.S. Navy that has moved away from the Zumwalt DDG 1000-class destroyer's original land-attack mission, Raytheon, prime contractor for the big destroyer's combat system and missiles, has presented the service with a detailed but unsolicited proposal to upgrade the ship to perform the ballistic missile defense (BMD) mission the Navy says is key to its future warships.

And in an attempt to sweeten the pot, the company is willing to guarantee the price of most of the work. Raytheon says it can do the job for an additional $580 million under a fixed-price contract. The total price, including specialized radar components, will be a bit higher, industry sources said, but those items are dependent upon customer preferences and would be furnished as government-supplied equipment.

"The work would involve fully populating the [SPY-4 S-band] volume-search radar with transmit/receive modules," the industry source said, along with "a minor tweak to the launcher electronics to upgrade from SM-2 [Standard missiles] to handle SM-3 [BMD missiles]." The BMD software to upgrade the ship's computers could come from the Army's Theater High Altitude Area Defense (THAAD) system or the U.S. Missile Defense Agency's

[71] Dave Ahearn, "Raytheon Pitching Missile Defense Variant of DDG-1000," *Defense Daily*, September 12, 2008: 2-3. Bracketed words and stock-symbol identifiers, as well as ellipses in the interiors of paragraphs, as in the original.

Sea-Based X-band radar (SBX), the industry source added, "and voilà, you have a BMD version of the Zumwalt at sea six years ahead" of the CG(X) cruiser, the next-generation ship planned to handle cruise and ballistic missile defense.

Raytheon submitted its proposal in September. And the Navy response? "Zero. Nothing from anybody," an informed source said Nov. 5. "Kind of surprising, but that's the answer." Navy officials said they were aware of the Raytheon proposal, but said there wasn't much interest.

"There has been no change to the DDG 1000 program of record." said Cmdr. Victor Chen, a Navy spokesman.

"We don't have a requirement for a BMD DDG 1000," one Navy source said.

A top Raytheon official explained the idea.

"Given the current world situation, we believe it is important for decision-makers to know that a credible BMD capability for the Zumwalt is doable and affordable, with potential schedule advantages," said Dan Smith, president of Raytheon's Integrated Defense Systems, Tewksbury, Mass. "We have not yet received a response." The idea of converting the land-attack destroyer to handle the increasingly important BMD mission isn't new—particularly after the Navy announced in summer 2008 it was "truncating" the planned seven-ship Zumwalt class to three ships. That move, service officials said, was in response to new threats that included ballistic missiles able to hit ships at sea and to the increasing threat from cruise missiles. Defeating those threats, the Navy said, was not part of the DDG 1000 design.

Additionally, the Navy said the requirement to support Marines ashore with persistent, precision fire support from the Zumwalt's new 155mm Advanced Gun System also could be met by other means.

What the Navy really needs, service officials say, are ships able to meet the BMD threat now. That's a blow for Raytheon, since the ships the Navy is buying in increasing numbers are Arleigh Burke DDG 51-class destroyers with Lockheed Martin's Aegis combat system, modified to take on the BMD role.

Industry sources said the Navy asked Raytheon early in 2008 to analyze upgrading the Zumwalts to the BMD mission. The company said few significant enhancements were needed to the SPY-3 X-band radar—half of the ship's dual-band radar system—but the S-band SPY-4 volume search radar needed significant modifications. Each radar array, the informed source said, has about 2,688 transmit/receive modules. A "fully populated" array would have about 4,544.

Fully upgraded, the radar system would show an improvement in baseline performance of about 16 dB, the informed source said.

The September proposal upgraded the early 2008 work and added further enhancements to bring the system fully up to a BMD capability, the informed source said. Key modifications would be necessary to the radar, the Mk 57 peripheral vertical launch system, and the software. Each of the ship's three fixed, phased radar arrays would gain about 8 metric tons from the improvements, and the ship's composite-structure deckhouse would need "minor strengthening" to support the additional 24 metric tons.

But the Zumwalt design provides for future upgrades, industry sources said, and the ship has power, cooling and stability margins available in the design specifications.

> The modification plan "stayed within the margins," the informed source said, and the upgraded ship would still meet its speed requirements of better than 30 knots.
>
> The informed source noted that underlying the proposal is a desire by Raytheon "to counter some of the skepticism" of the DDG 1000 decision "and try to solicitate some more engagement" in getting more use out of the design.
>
> Raytheon's proposal concerns only the as-yet-unnamed third ship, DDG 1002, which isn't scheduled to begin construction until 2011.
>
> Construction of the first ship, DDG 1000, is about 16 percent com-plete at General Dynamics' Bath Iron Works shipyard in Maine, and fabrication of the second ship, the Michael Monsoor (DDG 1001), is expected to begin next year.
>
> Much of the BMD upgrade cost involves nonrecurring development costs, industry sources said. Raytheon estimates the first two DDG 1000s could be upgraded for $62 million to $65 million per ship.
>
> While the Navy has yet to respond to Raytheon's proposal, company officials have been briefing the idea to Navy and Pentagon parties and to key congressional committees.
>
> Left out of those briefings, though, are the shipbuilders. General Dynamics is building the ships, while Northrop Grumman—the original prime contractor on the DDG 1000 program—builds the composite deckhouse and other components.
>
> Industry sources stressed that the BMD upgrade proposal was strictly a Raytheon initiative.
>
> "There has been no external teaming or involvement with General Dynamics," the informed source said. "No industry partners or peers."[72]

Non-combat Adjunct Ship with Powerful Radar

Another option that policymakers may consider for improving the fleet's IAMD would be to procure a non-combat ship equipped with a powerful radar to act as an adjunct platform for missile defense operations and perhaps also air defense operations. The radar on the ship would be a large, active-array radar that would be considerably more powerful, for example, than the improved radar that could be installed on a DDG-51 or DDG-1000. The presence in the fleet of such a radar could significantly improve the fleet's IAMD capabilities. The ship might be similar to the Cobra Judy Replacement ship currently under construction.[73] A few or several such adjunct 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.

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[72] Christopher P. Cavas, "Raytheon Pitches BMD Upgrades For Zumwalts," *Defense News*, November 9, 2009: 27. Material in brackets as in original.

[73] The Cobra Judy Replacement (CJR) ship is intended to replace the missile range instrumentation ship Observation Island (TAGM-23). Observation Island is a converted merchant ship operated by the Navy for the U.S. Air Force. The ship is equipped with a powerful radar, called Cobra Judy, that is used for collecting technical information on foreign-country ballistic missiles in flight. For more on the CJR program, see http://acquisition.navy.mil/programs/information_communications/cjr.

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