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

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Summary

The Navy's proposed FY2010 budget requests $1,084.2 million to complete the cost of a third Zumwalt (DDG-1000) class destroyer that was authorized but only partially funded in FY2009, 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 requests $539 million in research and development funding for the DDG-1000 program.

The Navy's proposed FY2010 budget requests $1,912.3 million to help complete the cost of an Arleigh Burke (DDG-51) class Aegis destroyer to be procured in FY2010. (The Navy also plans to request approval to transfer or reprogram $128.6 million in prior-year funding to help complete the cost of this ship.) The ship received $199.4 million in FY2009 advance procurement funding. The Navy estimates the total cost of this ship at $2,240.3 million.

On April 6, 2009, Secretary of Defense Robert Gates announced a number of Department of Defense (DOD) decisions regarding DOD's proposed FY2010 defense budget. Among these was a decision to end the DDG-1000 program at three ships and restart procurement of DDG-51 destroyers. Gates's announcement appeared endorse, to some degree at least, a proposal announced by the Navy on July 31, 2008, to halt DDG-1000 procurement and restart DDG-51 procurement. Until Gates's April 6 announcement, OSD publicly had reserved judgment on the Navy's July 2008 proposal, stating that further analysis of its merits was needed.

Gates stated on April 6 that DOD's support for building the all three DDG-1000s was contingent on the Navy reaching an agreement with its two surface combatant builders – General Dynamics' bath Iron Works (GD/BIW) of Bath, ME, and Northrop Grumman Shipbuilding (NGSB) – to transfer the second DDG-1000 from NGSB to GD/BIW, so that GD/BIW would be the builder of all three DDG-1000s. On April 8, it was reported that such an agreement had been reached. As a result, GD/BIW is to build all three DDG-1000s, NGSB is to build the first two DDG-51s to be procured under the DDG-51 restart, GD/BIW is to build the DDG-51, and the two firms will then share in the production of subsequent DDG-51s.

Potential issues for Congress include the following: the merits of DOD's decision to halt DDG-1000 procurement and restart DDG-51 procurement; the status of a proposal made by John Young, the then-DOD acquisition executive, in memorandum dated January 26, 2009, to begin procuring in FY2012 a ship called the Future Surface Combatant (FSC) that could be based on either the DDG-51 design or the DDG-1000 design (and whether to provide direction to DOD regarding this proposal); whether to complete the procurement funding for a third DDG-1000 in FY2010; whether to continue with the construction of the second DDG-1000; whether to fund the procurement of one or two DDG-51s in FY2010; whether to direct the Navy to build the second and third DDG-1000s to a modified design featuring additional missile-launch tubes in the place of the DDG-1000's Advanced Gun Systems (AGSs); and whether to provide direction to DOD regarding the design of DDG-51s procured in FY2010 and beyond. This report will be updated as events warrant.

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The Navy's proposed FY2010 budget requests $1,084.2 million to complete the cost of a third Zumwalt (DDG-1000) class destroyer that was authorized but only partially funded in FY2009, 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 requests $539 million in research and development funding for the DDG-1000 program.

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Background

DDG-1000 (Zumwalt) Program

Program Origin and Names

The Navy initiated the DDG-1000 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. The first DDG-1000 is to be named the Zumwalt, so the program is also referred to as the Zumwalt-class program.

Mission Orientation and Design Features

The DDG-1000 is a multimission 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.[1] 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 next-generation cruiser, called the CG(X).[2]

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,[3] a superstructure made partly of large sections of composite materials rather than steel or aluminum, an integrated electric-drive propulsion system,[4] 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."

[1] 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.

[2] 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.

[3] 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.

[4] 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.

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.

Construction Shipyards

Until July 2007, it was expected that Northrop Grumman Shipbuilding (NGSB) would be the final-assembly yard for the first DDG-1000 and that General Dynamic Bath Iron Works (GD/BIW) would be the final-assembly yard for the second. On July 17 and 18, 2007, it was reported that the Navy was considering the option of instead assigning the first ship to GD/BIW and the second to NGSB. 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 proposal.[5]

As mentioned earlier, on April 8, 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 deckhouses (i.e., superstructures), which are to be made of composite (i.e., fiberglass-like) like material at NGSB's composite manufacturing facility at Gulfport, MS.

FY2010 Funding Request and Prior-Year Funding

The first two DDG-1000s were procured together in FY2007 using split funding (i.e., two-year incremental funding) in FY2007 and 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%. 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. (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.)

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 Navy's proposed FY2010 budget also requests $539 million in research and development funding for the DDG-1000 program.

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

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.

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

DDG-51 (Arleigh Burke) Program

Program Origin

The Arleigh Burke (DDG-51) 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 cruisers that could be procured, under projected budgets at the time, at a sustained annual rate of five ships per year.

Mission Orientation and Design Features

The DDG-51, like the CG-47, is a multimission 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-47s.

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, with the most recent DDG-51s being built with a version called Baseline 7.

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.[6]

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.

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

In the earlier years of the DDG-51 program, when as many as four or five DDG-51s per year were being procured, BIW and Ingalls competed on an annual basis for contracts to build DDG-51s. In the 1990s, when the annual procurement rate dropped to about three ships per year, the Navy ended annual competition between the firms and began to allocate DDG-51s between them. Of the 62 DDG-51s procured through FY2005, GD/BIW is the builder of 34, and NGSB is the builder of 28.

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]

The Navy has studied the option of extending the service lives of DDG-51s from 35 years to 40 years, and assumed a 40-year life for DDG-51s as part of the FY2009 version of its 30-year shipbuilding plan for maintaining the Navy's desired 313-ship fleet.[9] As of 2008, however, the Navy had not yet funded a program to perform the additional maintenance work that would be needed to extend the ships' lives to 40 years.

FY2010 Funding Request

The Navy's proposed FY2010 budget requests $1,912.3 million to help complete the cost of a 63rd Arleigh Burke (DDG-51) class Aegis destroyer to be procured in FY2010. (The Navy also plans to request approval to transfer or reprogram $128.6 million in prior-year funding to help complete the cost of this ship.) The ship received $199.4 million in FY2009 advance procurement funding. The Navy estimates the total cost of this ship at $2,240.3 million.

Older CRS reports provide additional historical and background information on the DDG-51 program.[10]

Surface Combatant Construction Industrial Base

Shipyards

All cruisers, destroyers, and frigates procured since FY1985 have been built at two shipyards—General Dynamics' Bath Iron Works (GD/BIW) in Bath, ME, and the Ingalls shipyard in

[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] For a discussion, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[10] 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]

Pascagoula, MS, that forms part of Northrop Grumman Shipbuilding (NGSB).[11] 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).

The Navy informed CRS on March 11, 2008, that a DDG-1000 would require, by Navy estimates, about 2.5 times as much shipyard labor to build as would be required to build a DDG-51.[12] On April 10, 2008, the Navy clarified that this ratio was based on the number of labor hours that the Navy estimates will be needed to build the first two DDG-1000s, and that subsequent DDG-1000s would require smaller amounts of shipyard labor, reducing the ratio for subsequent ships to something less than 2.5 to 1.[13] (The DDG-51 design, in contrast, is already well down its learning curve and would not decline by a substantial additional amount through additional production.) Assuming a rate of learning in the DDG-1000 production process that might be typical for a complex combatant ship, and taking into account the shared production arrangement for the DDG-1000 (see **Appendix B** for a description of this arrangement), a seventh DDG-1000, for example, might require roughly 1.7 to 1.9 times as much shipyard labor to build as a baseline Flight IIA DDG-51. Other calculations based on these factors include the following:

- Procuring roughly 9.3 to 10.3 Flight IIA DDG-51s through FY2013 would provide roughly as many shipyard labor hours as procuring ships 3 through 7 in the 7-ship DDG-1000 program of record.
- Assigning 5.1 to 5.7 of those 9.3 to 10.3 Flight IIA DDG-51s to a shipyard would provide that shipyard with roughly as many shipyard labor hours as it would receive it were the primary yard for building ships 3, 5, and 7 in the 7-ship DDG-1000 program of record.
- Assigning 4.2 to 4.6 of those 9.3 to 10.3 Flight IIA DDG-51s to a shipyard would provide that shipyard with roughly as many shipyard labor hours as it would receive it were the primary yard for building ships 4 and 6 in the 7-ship DDG-1000 program of record.

There are multiple options for supplementing DDG-51 construction work at GD/BIW and NGSB with other forms of work. These options include but are not limited to the following:

- assigning DDG-51 modernizations to the two yards that built the ships—GD/BIW and the Ingalls yard at Pascagoula, MS, that forms part of Northrop Grumman Shipbuilding (NGSB);
- assigning Aegis cruiser (i.e., CG-47 class) modernizations to the two yards that built the ships (again, GD/BIW and the Ingalls yard);[14]

[11] 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.

[12] Source: Navy Office of Legislative Affairs telephone call to CRS on March 11, 2008.

[13] Source: Navy briefing to CRS and CBO on April 10, 2008.

[14] For more on the Navy's program for modernizing its existing Aegis ships (both CG-47s and DDG-51s), see CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

- having GD/BIW participate in the construction of Littoral Combat Ships (LCSs) that are built to the General Dynamics LCS design;[15]
- procuring one or more LPD-17s beyond those in the Navy's shipbuilding plan, and perhaps have GD/BIW build parts of those ships (similar to how GD/BIW is currently building parts of LPD-24 for NGSB);[16]
- procuring additional LHA-type amphibious assault ships, and perhaps have GD/BIW build parts of those ships;[17]
- procuring adjunct non-combat radar ships (an option discussed in **Appendix D**) and assigning the construction of those ships to GD/BIW and/or NGSB;
- procuring AGS-armed versions of the basic LPD-17 class hull—another option that has been suggested for improving the fleet's NSFS capabilities (see **Appendix D**)—and perhaps have GD/BIW builds parts of those ships;
- procuring two new polar icebreakers for the Coast Guard, and assigning construction of those ships to NGSB and/or GD/BIW;[18]
- accelerating the procurement of National Security Cutters (NSCs) for the Coast Guard (NSCs are built at NGSB); and
- having GD/BIW and/or Ingalls participate in the construction of Fast Response Cutters (FRCs) for the Coast Guard, and perhaps accelerating the procurement of these ships.[19]

In addition to total shipyard hours, another factor to consider for maintaining the shipyards is whether the mix of work being pursued preserves critical ship-construction skills, including outfitting skills and combat system integration skills. The options listed above for supplementing DDG-51 construction work would support such skills to varying degrees.

Increasing the scope of work to be performed in the DDG-51 or CG-47 modernization programs to include configuration changes like those discussed in **Appendix D** could increase the amount of work that would be provided by the first two options above.

Procuring additional ships to be built at NGSB could help support GD/BIW, even if GD/BIW does not share in their production, by permitting a greater share of DDG-51 construction work to be assigned to GD/BIW while still adequately supporting NGSB.

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

[16] GD/BIW was originally slated to build 4 of a then-planned class of 12 LPD-17s, and is currently building parts of LPD-24, the eighth ship in the class. NGSB previously subcontracted parts of other LPD-17s to a shipyard in Texas.

[17] For additional discussion of the amphibious lift goal and the numbers of amphibious ships that might be procured to support that goal, see CRS Report RL34476, *Navy LPD-17 Amphibious Ship Procurement: Background, Issues, and Options for Congress*, by Ronald O'Rourke.

[18] For a discussion of the option of procuring new polar icebreakers for the Coast Guard, see CRS Report RL34391, *Coast Guard Polar Icebreaker Modernization: Background, Issues, and Options for Congress*, by Ronald O'Rourke. The procurement of the Coast Guard's newest polar icebreaker, Healy (WAGB-20), was funded in FY1990 through the Navy's shipbuilding budget (the Shipbuilding and Conversion, Navy [SCN] appropriation account).

[19] For more on the NSC and FRC programs, see CRS Report RL33753, *Coast Guard Deepwater Acquisition Programs: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke.

Combat System Manufacturers

Lockheed Martin and Raytheon are generally considered the two leading Navy surface ship radar makers and combat system integrators. 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.

The issue of which kind of destroyer to procure over the next several years has potentially large business implications for Lockheed and Raytheon, because TSCE-I and an open-architecture version of the Aegis system[20] are both potential candidates for the basis of the open architecture combat system that is to be installed on the Navy's planned CG(X) cruiser, and the CG(X)'s combat system in turn might in turn serve as the basis for the open architecture combat systems of other future Navy surface ships.

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.

Secretary of Defense's April 2009 Announcement on Destroyer Procurement

On April 6, 2009, Secretary of Defense Robert Gates announced a number of Department of Defense (DOD) decisions regarding DOD's proposed FY2010 defense budget. Among these was a decision to end the Navy's Zumwalt (DDG-1000) class destroyer procurement program at three ships and restart procurement of Arleigh Burke (DDG-51) class Aegis destroyers. Gates stated that the FY2010 budget request

> will include funds to complete the buy of two navy destroyers in FY10. These plans depend on being able to work out contracts to allow the Navy to efficiently build all three DDG-1000 class ships at Bath Iron Works in Maine and to smoothly restart the DDG-51 Aegis Destroyer program at Northrop Grumman's Ingalls shipyard in Mississippi. Even if these arrangements work out, the DDG-1000 program would end with the third ship and the DDG-51 would continue to be built in both yards.
>
> If our efforts with industry are unsuccessful, the department will likely build only a single prototype DDG-1000 at Bath and then review our options for restarting production of the

[20] In general terms, an open architecture combat system is a combat system that uses non-proprietary computers and software, and can be easily upgraded with new software provided by multiple vendors. The Navy is working with Lockheed, in part through the Aegis ship modernization program, to evolve the Aegis system, which was not originally developed as an open architecture combat system, into an open architecture combat system. For more on the Aegis ship modernization program, see CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

> DDG-51. If the department is left to pursue this alternative, it would unfortunately reduce our overall procurement of ships and cut workload in both shipyards.[21]

Gates's announcement appears to endorse, to some degree at least, a proposal announced by the Navy on July 31, 2008, to halt DDG-1000 procurement and restart DDG-51 procurement (see section below). Until Gates's April 6 announcement, OSD publicly had reserved judgment on the Navy's July 2008 proposal, stating that further analysis of its merits was needed.

As shown in the quoted passage above, Gates stated that DOD's support for building the all three DDG-1000s was contingent on the Navy reaching an agreement with its two surface combatant builders – General Dynamics' bath Iron Works (GD/BIW) of Bath, ME, and Northrop Grumman Shipbuilding (NGSB) – to transfer the second DDG-1000 from NGSB to GD/BIW, so that GD/BIW would be the builder of all three DDG-1000s. On April 8, it was reported that such an agreement had been reached (see next section). As a result, GD/BIW is to build all three DDG-1000s, NGSB is to build the first two DDG-51s to be procured under the DDG-51 restart, GD/BIW is to build the DDG-51, and the two firms will then share in the production of subsequent DDG-51s.

Gates's April 6 announcement left unclear the status of a proposal made by John Young, the then-DOD acquisition executive, in memorandum dated January 26, 2009, to begin procuring in FY2012 a ship called the Future Surface Combatant (FSC) that could be based on either the DDG-51 design or the DDG-1000 design. If the FSC proposal remains in place as a feature of DOD planning, then a decision to base the FSC on the DDG-51 would mean that procurement of DDG-51s in FY2010 and FY2011 would be followed by procurement of modified DDG-51s in FY2012 and subsequent years, while a decision to base the FSC on the DDG-1000 would mean that procurement of DDG-51s would cease after FY2011 and procurement of modified DDG-1000s would begin in FY2012. If the FSC proposal does not remain in place, it would appear that procurement of DDG-51s of either the current design or a modified design would continue in FY2012 and subsequent years.

Navy-Industry April 2009 Agreement Regarding Builder of Three DDG-1000s

An April 8, 2009, press report on the Navy's agreement to have GD/BIW build all three DDG-1000s stated:

> The agreement means all three DDG 1000 Zumwalt-class destroyers will be built at the General Dynamics Bath Iron Works shipyard at Bath, Maine. Northrop Grumman, which at one time was the lead yard on the DDG 1000 program, will instead receive construction contracts for more DDG 51 Arleigh Burke-class destroyers to be built at its Ingalls shipyard in Pascagoula, Miss.
>
> According to one source familiar with the negotiations, Northrop also would become the lead yard for the restart of the DDG 51 program and become the planning yard for future development of the design. The Bath shipyard currently is the lead yard for the DDG 51

[21] Opening remarks of Secretary of Defense Robert Gates at an April 6, 2009, news conference on DOD decisions regarding DOD's proposed FY2010 defense budget.

> program. That element of the agreement, however, couldn't be quickly confirmed by *Defense News*, and the Navy declined to provide details of the agreement.
>
> Northrop also would continue to build the composite-structure deckhouse for all the Zumwalt-class ships at its facility in Gulfport, Miss....
>
> The Navy and its shipbuilders have been in negotiations over the swap since last fall. Northrop, which in addition to destroyers builds Coast Guard cutters and three classes of amphibious ships at the Ingalls shipyard, has had production problems with several of its programs. The Bath yard is building only DDG 51-class destroyers and is eager to build the DDG 1000s. Most observers felt the proposed swap was a reasonable reallocation of resources that would benefit both shipyards and provide the Navy with cost savings.
>
> Northrop, wary of giving up too much, held out for more favorable terms, which apparently have been agreed to.
>
> "No shipyard would accept a deal that was unpalatable," said the source familiar with the negotiations. "It had to work for everybody."[22]

An April 9, 2009, press report on the agreement stated:

> Northrop Grumman, which had expected to build one of the DDG-1000 destroyers at its shipyard in Mississippi, will contribute major components for each of the vessels. It will also receive contracts for two other destroyers as the Navy restarts production of an earlier model....
>
> Military officials said the precise financial arrangements still needed to be worked out....
>
> Under the plan, Northrop Grumman will restart production of the DDG-51, also known as the Arleigh Burke-class destroyer, at its Ingalls shipyard in Pascagoula, Miss., and build the first two ships. General Dynamics will build the third once it completes work on the DDG-1000s at the Bath Iron Works. Officials said it was likely that the companies would split any subsequent orders through some type of competitive bidding.[23]

Navy's July 2008 Proposal on Destroyer Procurement

The following discussion of the Navy's position on destroyer procurement is based primarily on the Navy's prepared statement for, and spoken testimony at, the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee.[24]

[22] Christopher P. Cavas, "All DDG 1000 Construction To Move To Bath," *DefenseNews.com*, April 8, 2009.

[23] Christopher Drew, "Contractors Agree On Deal To Build Stealth Destroyer," *New York Times*, April 9, 2009.

[24] 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., and the spoken remarks of McCullough and Stiller, as reflected in the transcript of the hearing.

Number of New DDG-51s Proposed

How many DDG-51s does the Navy want to procure?

Table 1 shows (in the upper half) the program of record for destroyer procurement from the FY2009 budget submission and (in the lower half) the Navy's July 31, 2008 proposal for destroyer procurement. The table also shows planned procurement of CG(X) cruisers.

Table 1. Destroyer Procurement Plans

(FY2007-FY2017)

	07	08	09	10	11	12	13	14	15	16	17
Program of record from FY2009 budget submission											
DDG-51											
DDG-1000	2[a]		1	1	1	1	1				
CG(X)					1		1	1	2	2	2
Navy's proposed new plan, based on Navy's July 31 testimony											
DDG-51				1	2	1	2	1	1	?	?
DDG-1000	2[a]		1[b]								
CG(X)											1?

Sources: FY2009 budget submission; Navy testimony at July 31, 2008, hearing before Seapower and Expeditionary Forces subcommittee of House Armed Services Committee; August 18, 2008, letters from OSD and the Navy to Congress; and press reports.

a. Two ships procured in FY2007 using split funding (incremental funding) in FY2007 and FY2008.

b. The Navy indicated at the July 31 hearing that for FY2009, it would prefer to procure a DDG-51 rather than a third DDG-1000. On August 18, 2008, however, OSD and the Navy informed Congress that OSD has directed the Navy to support the procurement of a third DDG-1000 in FY2009.

As shown in the table, the Navy on July 31, 2008, proposed procuring a total of eight DDG-51s in the period FY2010-FY2015, in annual quantities of 1-2-1-2-1-1. The Navy testified at the July 31 hearing that this is the profile the service has proposed to OSD for approval as part of the process for preparing the Navy's part of the proposed DOD FY2010-FY2015 Future Years Defense Plan (FYDP) to be submitted to Congress in early 2009.

The Navy indicated at the July 31, 2008, hearing that for FY2009, it would prefer to procure a DDG-51 rather than a third DDG-1000. Procuring a DDG-51 in FY2009 would, under the Navy's proposal, make for a total of nine DDG-51s in the period FY2009-FY2015. On August 18, 2008, however, OSD and the Navy informed Congress that OSD had directed the Navy to support the procurement of a third DDG-1000 in FY2009.[25] The Navy testified on July 31 that it remained

[25] Letters dated August 18, 2008, from Gordon England, Deputy Secretary of Defense, to the Honorable Edward M. Kennedy; and from Donald C. Winter, Secretary of the Navy, to the Honorable Carl Levin, both posted on the Internet at *InsideDefense.com* (subscription required) on August 19, 2008. England's letter to Senator Kennedy states in part:The Navy has been directed to ensure that its proposed plan will complete construction of the [two] DDG 1000 ships currently under contract and conform to the President's FY2009 budget submission by executing the third DDG 1000. This plan will provide stability of the industrial base and continue the development of advanced surface ships technologies such as radar systems, stealth, magnetic and acoustic quieting, and automated damage control. Further, the Navy has proposed to reprogram funds to support additional DDG 51 spare assets in FY2009 and related planning (continued...)

ready to execute construction of a third DDG-1000, should a third DDG-1000 be funded in FY2009.

Design of New DDG-51s

What version of the DDG-51 does the Navy want to procure?

The Navy testified at the July 31, 2008, that the DDG-51s it wants to procure in coming years would be Flight IIA ships equipped with a version of the Aegis combat system that is the same as the version that existing DDG-51s are to receive under the DDG-51 modernization program—a version called the Advanced Capability Build (ACB) 12 (the 12 being a reference to FY2012). As mentioned earlier, in August 2008, it was reported that the Navy has decided to expand the scope of the DDG-51 modernization program to include the installation of a BMD capability, so that every DDG-51 would eventually have a BMD capability.[26] ACB 12 includes the BMD capability. It is apparently on this basis that the Navy testified at the July 31 hearing that the new DDG-51s that would be built under its proposal would be BMD-capable.

In describing the DDG-51's capabilities at the July 31, 2008, hearing, the Navy stated that the ship's ASW equipment included, among other things, a towed array sonar. A towed array sonar was part of the Flight I and Flight II DDG-51 designs, but was removed from the Flight IIA design. The suggestion from the Navy's testimony is that the new Flight IIA ships that the Navy wants to procure would include a towed array sonar.

CRS testimony at the July 31 hearing discussed several options for modifying the design of the DDG-51s that would be procured under the Navy's proposal so as to reduce the ships' O&S costs, or equip each ship with an AGS or additional missile-launch tubes or an improved radar.[27] The Navy's testimony at the July 31 hearing indicated that the Navy at that time was not contemplating procuring DDG-51s with such design modifications.

Procurement Cost of New DDG-51s

What would the new DDG-51s cost to procure?

(...continued)

activities. The Navy proposal, that has been approved, will provide the dual benefits of buying spares at an economical price while also protecting future options for restarting DDG 51 production. Winter's letter to Senator Levin contains similar language. See also Zachary m. Peterson, "In Reversal of Intentions, Navy Now Says It Wants Third DDG-1000," *InsideDefense.com*, August 19, 2008 (also published in the August 25, 2008 issue of *Inside the Navy*); Emelie Rutherford, "Navy Now Wants A Third DDG-1000 Next Year," *Defense Daily*, August 20, 2008; Bettina H. Chavanne, "U.S. Navy to Pursue Funding for a Third DDG-1000," *Aerospace Daily & Defense Report*, August 20, 2008: 4; Philip Ewing, "Lawmaker: Third DDG 1000 Far From Done Deal," *NavyTiomes.com*, August 21, 2008; Rebekah Gordon, "Navy's DDG-1000 Move Pleases Industry Stakeholders, Lawmakers," *Inside the Navy*, August 25, 2008.

[26] 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.

[27] 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, pp. 2-11.

The Navy's proposed FY2010 budget estimates the cost of the DDG-51 requested for procurement in FY2010 at $2,240.3 million.

The Navy's prepared statement for the July 31, 2008, hearing stated:

> 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 [DDG-51] 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.[28]

Admiral Gary Roughead, the Chief of Naval Operations (CNO), in a letter to Senator Edward Kennedy dated May 7, 2008, stated that:

> without firm contracts for future ships of either [the DDG-1000 or DDG-51] 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.[29]

The Congressional Budget Office (CBO) estimated in 2008 that, in constant FY2009 dollars, DDG-51s would cost about $2.3 billion each if procured at a rate of one per year, and about $1.9 billion each if procured at a rate of two per year.[30] CBO's estimates, unlike the Navy's, include outfitting and post-delivery for the ships. Excluding outfitting and post-delivery costs from CBO's estimates to make them more directly comparable to the Navy's estimates would marginally reduce CBO's estimates.

Navy's Reasons for Its Change in Position

Why did the Navy change its position on destroyer procurement?

[28] 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, p. 8.

[29] 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.

[30] Statement of Eric J. Labs, Senior Analyst, [on] The Navy's Surface Combatant Programs before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, July 31, 2008, Table 2 on p. 7.

Change in Threat Assessment

The Navy testified that it has changed its position on destroyer procurement primarily because of a recent change in its assessment of likely future threats to Navy forces. This change in the threat assessment, Navy officials testified, led to a corresponding change in capability requirements for Navy destroyers to be procured over the next few years.

The Navy testified that, over the last two years, its assessment of threats posed by ballistic missiles, anti-ship cruise missiles (ASCMs), and modern non-nuclear-powered submarines operating in blue waters has increased. The Navy's prepared statement and spoken testimony at the July 31, 2008, hearing include multiple references to ballistic missiles, ASCMs (including the proliferation of ASCMs to non-state actors such as the Hezbollah organization)[31], and modern non-nuclear-powered submarines capable of blue-water operations.[32] The Navy also testified that it now believes it has more than enough capacity, as a result aircraft-delivered precision-guided munitions and Tomahawk cruise missiles, to meet requirements for providing fire support for forces ashore.

Navy officials testified that, as a result its changed threat assessment, the Navy now needs to use destroyer procurement over the next several years to improve the fleet's capabilities for BMD, area-defense AAW, [33] and blue-water antisubmarine warfare (ASW). Navy officials testified that while the DDG-1000 is well-suited for NSFS and for operations in littoral waters, it is not capable of area-defense AAW or BMD operations, and its sonar system is not optimized for blue-water ASW operations. The DDG-51 design, they testified, is capable of BMD and area-defense AAW operations, and its sonar is optimized for blue-water ASW operations. Consequently, the Navy testified, the DDG-51 is better suited than the DDG-1000 for meeting the Navy's changed capability requirements for destroyers to be procured over the next several years. Navy officials testified at the July 31, 2008, that modifying the DDG-1000 design to make it capable of BMD, area-defense AAW, and blue-water ASW operations "is unaffordable from the Navy's standpoint."

The Navy's assertion at the July 31, 2008, hearing that the DDG-1000 would not be capable of area-defense AAW operations came as a surprise to some observers, because it appeared to contradict prior Navy descriptions of the DDG-1000's capabilities. The Navy appeared to back away from this assertion in its testimony at an April 2009 hearing on shipbuilding issues.[34]

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[31] The Hezbollah organization fired a Chinese-made C-802 ASCM at an Israeli corvette in July 2006, killing four sailors and damaging the ship.

[32] For a press article discussing what adversary weapons the changed threat environment might include, see Christopher P. Cavas, "Missile Threat Helped Drive DDG Cut," *Defense News*, August 4, 2008: 1.

[33] An area-defense AAW system is capable of defending not only the ship on which it is installed, but other ships in the area as well. An AAW system capable of defending only the ship on which it is installed is referred to as a point-defense AAW system. Area-defense AAW systems generally can intercept aircraft and antis-ship cruise missiles at longer ranges than point-defense AAW systems. U.S. Navy ships need to be able to use the SM-2 interceptor to be considered capable of area-defense AAW operations. Navy ships that can fire only shorter-ranged interceptors, such as the Enhanced Sea Sparrow Missile (ESSM) or the Rolling Airframe Missile (RAM), are considered capable of point-defense AAW operations only. The Navy testified on July 31 that the DDG-1000 as currently design cannot successfully employ the SM-2.

[34] Prepared statement and spoken testimony of Rear Admiral Bernard McCullough, Deputy Chief of Naval Operations for Integration of Capabilities and Resources, at an April 1, 2009 hearing on Navy shipbuilding before the Defense subcommittee of the House Appropriations Committee.

Affordability

Although the Navy at one point in its spoken testimony stated that affordability was not a factor behind its new position—its proposal to build DDG-51s rather than DDG-1000s is intended to be roughly budget-neutral over the period FY2010-FY2015—cost considerations appear to have played some role in the Navy's thinking:

- The Navy testified that "production costs of DDG 51s are known," that "the costs associated with DDG 51 class shipbuilding are well understood," and that the procurement cost of the DDG-51 is "quantifiable." The Navy did not make the same statements about the DDG-1000. This suggests that the Navy believes that the procurement cost of the DDG-51 is known with better confidence than the procurement cost of the DDG-1000, and that procuring DDG-51s would consequently pose less risk of cost growth than procuring DDG-51s.
- The Navy's testimony also makes reference to having enough "capacity" to meet regional combatant commander demands for surface combatants for maintaining day-to-day forward deployments and participating in engagement activities with other countries. "Capacity" is a term usually used to refer to the quantity of something (as opposed to "capability," which usually refers to the kinds of things that something can do). The Navy's use of the term "capacity" suggests that the service has concluded that procuring DDG-51s instead of DDG-1000s will permit the Navy to procure a larger number of destroyers over the next several years.
- As mentioned above, the Navy testified that the option of modifying the DDG-1000 design so as to give it a capability for BMD and area-defense AAW, and to improve its capability for blue-water ASW, "is unaffordable from the Navy's standpoint."

CG(X) Developments

Although the Navy did not say so at the July 31 hearing, developments in the CG(X) program may be an additional factor behind the Navy's decision to change its position on destroyer procurement. The Navy originally wanted to use the DDG-1000 hull design as the basis for the CG(X) design, because doing so would minimize CG(X) hull-design costs and take advantage of the DDG-1000 production learning curve to reduce recurring CG(X) production costs. The potential for reusing the DDG-1000 hull in the CG(X) program was one of the Navy's arguments in previous years for moving ahead with DDG-1000 procurement. It no longer appears, however, that the Navy intends to use the DDG-1000 hull as the best hull design for the CG(X).[35] If the

[35] A July 2, 2008, letter from John Young, the DOD acquisition executive (the Under 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." (Letter dated July 2, 2008 from John Young to Representative Taylor, p. 1.) In addition, the CG(X) may be a nuclear-powered ship, and 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 have judged that designing a new hull for the CG(X) that can accommodate one-half of the Ford-class plant would cost less or pose less technical risk than designing a new reactor plant that can fit into the DDG-1000 hull. (For more on the CVN-78 program, see CRS Report RS20643, *Navy Ford (CVN-78) Class* (continued...)

Navy no longer considers the DDG-1000 hull as the best hull design for the CG(X), that might have removed a reason for the Navy to support continued procurement of the DDG-1000.

In addition, the date for procuring the lead CG(X) reportedly has been deferred from FY2011 (in the FY2009 budget) to about FY2017. The CG(X) is intended to provide the fleet with improved AAW and BMD capabilities. The deferral of the date for procuring the lead CG(X) may have made it more necessary in the minds of Navy leaders to use procurement of destroyers over the next few years to begin achieving that goal. If the scheduled date for procuring the lead CG(X) had remained FY2011, the Navy might have deemed it acceptable to procure two more DDG-1000s in FY2009 and FY2010 before switching to CG(X) procurement the following year, even if the capabilities of those two additional DDG-1000s were not optimized for the Navy's stated new mission priorities. In addition, the Navy might have viewed the up-front cost of restarting the DDG-51 production line as not worth the effort, if only two or three DDG-51s were to be procured in FY2009 and FY2010 before switching over to the CG(X) in FY2011. In the context of a deferral of the lead CG(X) to FY2017, however, the Navy was presented with the prospect of several more years of destroyer production before switching to procurement of the CG(X). This created the prospect of procuring several additional DDG-1000s with capabilities not optimized for the Navy's stated new mission priorities. In addition, it created the prospect that the up-front costs of restarting the DDG-51 production line could be amortized over eight or more DDG-51s, as opposed to two or three.

August 2008 Press Report on CNO's Remarks

An August 31, 2008 press report based on remarks made by Admiral Gary Roughead, the Chief of Naval Operations, states:

> The Navy took the unusual step of abruptly canceling construction of its expensive new class of destroyers last month because the ships lack abilities that top commanders believe are necessary to protect U.S. interests, according to the service's senior officer.
>
> Adm. Gary Roughead, chief of naval operations, said the DDG-1000 Zumwalt class destroyer does not have crucial missile and air defense capabilities and defending it against submarines would be difficult. The last [i.e., third] ship in the class will cost $2.6 billion.
>
> "I started looking at the DDG-1000. It has a lot of technology, but it cannot perform broader, integrated air and missile defense," Roughead said in his first interview since the controversial move to cancel the destroyer program....
>
> The Zumwalt class was designed to operate in coastal waters close to shore, but the Navy is developing a less costly ship[36] for that.
>
> Roughead also noted that design compromises resulted in the removal of some of its torpedoes, making it more vulnerable to submarines.
>
> "Submarines can get very close, and it does not have the ability to take on that threat," Roughead said.

(...continued)

Aircraft Carrier Program: Background and Issues for Congress, by Ronald O'Rourke.)

[36] This is an apparent reference to the Littoral Combat Ship (LCS).

> The destroyer was originally designed as a ship that could move close to shore and fire its guns in support of ground forces. But Roughead said there is little call for the Navy to fire guns on shore.
>
> "If you go back, from the end of Vietnam to our present time, we have only shot about a thousand bullets [from naval guns]," he said. "And I look at the world and I see proliferation of missiles, I see proliferation of submarines. And that is what we have to deal with."
>
> The Zumwalt class is also designed to be difficult for enemy radar to detect. But Roughead said the Navy was evaluating questions about that technology.
>
> Correcting the air defense shortcomings would add billions of dollars to its cost, he said, making it prudent instead to build more of the previous-generation DDG-51 Arleigh Burke class destroyers. Additional models of the Arleigh Burke would cost about $1.8 billion apiece....
>
> Roughead said the first two Zumwalt destroyers would help demonstrate the capabilities and problems of new technology in the ship, including its hull design and innovations designed to reduce the number of sailors needed to operate it.
>
> But he was less enthusiastic about building a third ship. The Navy agreed to the additional vessel because money was already in the current budget proposal, he said.
>
> "It will be another ship with which to demonstrate the technologies," he said. "But it still will lack the capabilities that I think will be in increased demand in the future."...
>
> The Navy, which has 280 ships, is pushing for a 313-ship fleet, but shipbuilding problems are an obstacle.
>
> Roughead said that shifting production from the Zumwalt to the Arleigh Burke class would allow him to build three more vessels.
>
> "I am doing everything I can to increase the capability and capacity of the fleet," Roughead said. "Shipbuilding dominates my thinking."[37]

DOD Reaction Prior to Secretary of Defense's April 2009 Announcement

Prior to Secretary Gates's April 2009 announcement, how did DOD react to the Navy's July 31, 2008, proposal?

Initial Reaction

At a July 22, 2008, meeting between senior OSD and Navy officials, OSD agreed to allow the Navy to brief to Congress the Navy's proposal to stop DDG-1000 procurement and restart DDG-51 procurement, but did not grant its approval for the proposal. John Young, the DOD acquisition executive (the Under Secretary of Defense for Acquisition, Technology and Logistics), reserved judgment on the Navy's proposal at the time, stating on July 24 that "more analysis and

[37] Julian E. Barnes, "Navy Cancels New Destroyers," *Los Angeles Times*, August 31, 2008.

discussion was necessary before there was agreement."[38] Young reiterated this position in remarks to reporters at the end of October 2008.[39]

An August 18, 2008, letters from Gordon England to Senator Kennedy, and from Donald Winter to Senator Levin, both state in part:

> The way ahead for [destroyer procurement in] FY2010 and beyond will of course be determined by the Department's [i.e., DOD's] continuing assessment of existing and evolving threats, ensuring that it delivers those capabilities best suited to meet our national security needs both now and in the foreseeable future. This will include, but not be limited to, defense against missile threats and the challenging requirement to operate in littoral environments. As the Department [of Defense] develops its FY 2010-2015 budget, all of these considerations will be weighed to ensure we build the right Navy for the future.[40]

Reported September 2008 JROC Meeting

An October 6, 2008, press report stated that:

> Another blow was struck last month to the U.S. Navy's embattled DDG 1000 Zumwalt-class advanced destroyer program when a top-level Pentagon review board agreed to eliminate the operational requirements for the ship.
>
> No official decision was reached during the Sept. 18 meeting of the Joint Requirements Oversight Council (JROC), but uniformed sources said a memorandum was drafted to reflect cancellation of the requirements, which justify the need for a particular weapon program....
>
> Marine Gen. James Cartwright, vice chairman of the Joint Chiefs of Staff, chaired the Sept. 18 meeting, which reportedly was attended by about 60 officers and officials. Along with the vice chairman, the four vice chiefs of the military services fill out the JROC membership.[41]

[38] See, for example, Tony Capaccio, "U.S. Navy Confirms Plans to Curtail Construction of Destroyers," *Bloomberg News*, July 24, 2008; Christopher J. Castelli, "Navy Admits Plan to Truncate DDG-1000 At Two Hulls As DOD Hedges," *Inside the Navy*, July 28, 2008; Christopher P. Cavas, "DDG Question Remains Open in Congress, DoD," *Defense News*, July 28, 2008: 4; and Emelie Rutherford, "Pentagon Seeks Info On Navy Destroyer Shift, Senators Suggest Holding Funds," *Defense Daily*, July 28, 2008.Earlier in this decade, Young was the Navy's acquisition executive (the Assistant Secretary of the Navy for Research, Development and Acquisition), during which time he was a principal figure in restructuring the DD-21 program into the DD(X) program and in defending the DD(X) program against various criticisms. Since April 2008, Young has publicly defended the DDG-1000 program and expressed skepticism about the cost effectiveness of stopping DDG-1000 procurement and restarting DDG-51 procurement. (See, for example, Bettina H. Chavanne, "Pentagon Acquisition Chief's memo Points to Value of DDG-1000," *Aerospace Daily & Defense Report*, July 29, 2008.)

[39] See Andrea Shalal-Esa, "More Analysis Needed on Destroyer—Pentagon," *Reuters*, October 30, 2008; Geoff Fein, "More Analysis Needs To Be Done Before Deciding On Path Ahead For DDG-1000, Young Says," *Defense Daily*, October 31, 2008; Zachary M. Peterson, "DOD Acquisition Czar: Future Destroyer Plan Needs More Analysis," *Inside the Navy*, November 3, 2008.

[40] Letters dated August 18, 2008, from Gordon England to the Honorable Edward M. Kennedy, and from Donald C. Winter to the Honorable Carl Levin.

[41] Christopher P. Cavas, "DDG 1000 Takes Another Hit—From JROC," *Defense News*, October 6, 2008: 4.

January 26, 2009, DOD Memo on Destroyer Procurement

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.

Secretary Gates's announcement of April 6, 2009 did not explicitly address the proposal for an FSC discussed in the January 26, 2009, memorandum. Gates's stated on April 6 that "the DDG-1000 program would end with the third ship," but depending on how the term "DDG-1000 program" is defined, that statement may or may not preclude the option of an FSC based on the DDG-1000 design.[42]

Issues and Options for Congress

The situation regarding destroyer procurement following Secretary Gates's April 2009 announcement poses several potential issues and options for Congress, including those discussed below.

Relative Merits of DDG-51s and Modified DDG-1000s

One potential oversight issue for Congress in FY2010 concerns the merits of DOD's decision to stop DDG-1000 procurement and restart DDG-51 procurement, compared to an alternative of continuing DDG-1000 procurement while modifying the DDG-1000 design to align its capabilities more closely with the Navy's revised mission priorities. As stated earlier, the Navy testified at the July 31, 2008, hearing that modifying the DDG-1000 design so as to give it a capability for BMD and area-defense AAW, and to improve its capability for blue-water ASW, "is unaffordable from the Navy's standpoint." Although the Navy stated at the hearing that it had performed an analysis to support its proposal for stopping DDG-1000 procurement and restarting DDG-51 procurement, the Navy has not made public its detailed data on the comparative costs, capabilities, and technical and schedule risks of restarting DDG-51 procurement vs. modifying the DDG-1000 design and procuring modified DDG-1000s. As also stated earlier, the Navy in April 2009 testimony appears to have backed away from its July 2008 argument that the DDG-1000 will not be capable of area-defense AAW, leaving BMD and open-ocean ASW as the two areas for which the DDG-1000 would appear to need design modifications to better align it with the Navy's revised mission priorities. Information on the relative capabilities of the DDG-51 and

[42] 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).

DDG-1000 designs is presented in **Appendix G**. Information on potential modifications to the DDG-1000 design (and also the DDG-51 design) is presented in **Appendix D**.

FSC Proposal

A second potential issue for Congress in FY2010 concerns the status of the proposal in the DOD acquisition executive's memorandum of January 26, 2009, for procuring in FY2012 and subsequent years a ship called the Future Surface Combatant (FSC) that could be based on either the DDG-51 design or the DDG-1000 design.

As mentioned earlier, Secretary Gates's announcement of April 6, 2009 did not explicitly address the FSC proposal. Gates stated on April 6 that "the DDG-1000 program would end with the third ship," but depending on how the term "DDG-1000 program" is defined, that statement may or may not preclude the option of an FSC based on the DDG-1000 design.

If the FSC proposal remains in place as a feature of DOD planning, then a decision to base the FSC on the DDG-51 would mean that procurement of DDG-51s in FY2010 and FY2011 would be followed by procurement of modified DDG-51s in FY2012 and subsequent years, while a decision to base the FSC on the DDG-1000 would mean that procurement of DDG-51s would cease after FY2011 and procurement of modified DDG-1000s would begin in FY2012. Potential features for the FSC could include some of the DDG-51 and DDG-1000 design options presented in **Appendix D**. If the FSC proposal does not remain in place, it would appear that procurement of DDG-51s of either the current design or a modified design would continue in FY2012 and subsequent years.

For Congress, a potential question is when DOD plans to clarify whether the FSC proposal remains in place following Secretary Gates's April 2009 announcement. A related question is whether Congress should, as part of its action on the FY2010 budget, provide direction to the Navy regarding the FSC proposal. Such direction could pertain to whether the proposal should be retained or dropped, to the design of the FSC, or to the acquisition strategy to be followed in procuring the ship.

Third DDG-1000

A third issue for Congress in FY2010 is whether to complete the procurement funding for the third DDG-1000 in FY2010. As mentioned earlier, the proposed FY2010 budget is expected to request the $1 billion or so needed to complete the ship's estimated procurement cost. Potential options for Congress include approving the Navy's funding request; approving part of the request and deferring the rest of the ship's procurement cost to one or more future fiscal years; and rejecting the request, canceling the ship, and rescinding the ship's prior-year procurement funding.

In considering this issue, Congress may consider a number of factors, including the operational value of a third DDG-1000, the potential funding impact on other defense programs of deferring some of the third DDG-1000's procurement cost to one or more future fiscal years, the potential operational benefits of spending the third DDG-1000's procurement funding on other defense programs (or to cover any construction cost overruns on the first DDG-1000s), and the industrial-base impact of not building a third DDG-1000. Congress' consideration of this issue could relate to its consideration of whether to procure two DDG-51s in FY2010 rather than the one that is

expected to be included in the Navy's proposed FY2010 budget (see section below). Congress' consideration of this issue might also be related to its consideration of whether to direct the Navy to build the third DDG-1000 (and also the second) to a modified configuration that replaces the ship's two Advanced Gun Systems (AGSs) with additional missile-launch tubes (see section below).

Second DDG-1000

A fourth potential issue for Congress is whether to continue with the construction of the second DDG-1000, or alternatively cancel the ship and rescind its funding. Canceling the second ship could be related to a decision to cancel the third ship as well. Under such a scenario, only one DDG-1000 would be built, in part as a technology demonstrator, although the ship would be an operational asset as well. In considering this issue, potential factors to consider would include the cost, operational, and industrial-base impact of building one DDG-1000 rather than two or three. Congress' consideration of this issue might also be related to its consideration of whether to direct the Navy to build the second DDG-1000 (and also the third) to a modified configuration that replaces the ship's two Advanced Gun Systems (AGSs) with additional missile-launch tubes (see section below).

One or Two DDG-51s in FY2010

A fifth potential issue for Congress in FY2010 is whether to fund the procurement of two DDG-51s in FY2010, rather than the one that is expected to be included in the Navy's proposed FY2010 budget. In considering this issue, Congress may consider several factors, including the cost, operational value, and industrial-base impact of procuring a second DDG-51 in FY2010 while perhaps also canceling the procurement of a third DDG-1000.

Design of Second and Third DDG-1000s

A sixth potential issue for Congress in FY2010 is whether to direct the Navy to build the second and third DDG-1000s to a design featuring additional missile-launch tubes in the place of the current DDG-1000 design's Advanced Gun Systems (AGSs). In considering this option, potential factors to consider include cost of conducting the necessary ship redesign work, the impact on the ships' procurement cost, the operational impact of the resulting improvement in the ships' area-defense AAW, ASW, and strike capabilities (by being able to store and fire additional SM-2 missiles, anti-submarine rockets [ASROCs], and Tomahawk land-attack cruise missiles), and the operational impact of the resulting reduction in the ships' naval surface fire support (NSFS) capabilities.

Design of DDG-51s Procured in FY2010 and Beyond

A seventh potential issue for Congress is whether to provide direction to the Navy regarding the design of DDG-51s procured in FY2010 and beyond. Some potential modifications to the current DDG-51 design are discussed in **Appendix D**.

FY2010 Legislative Activity

The Navy's proposed FY2010 budget, submitted to Congress in early May. Markup of the FY2010 defense authorization and appropriation bills may occur in June and July.

Appendix A. FY2009 Legislative Activity

Table A-1 summarizes congressional action regarding FY2009 research and development, procurement, and advance procurement funding for the DDG-1000 and DDG-51 programs.

Table A-1. Congressional Action on FY2009 Funding Request

(figures in millions of then-year dollars, rounded to nearest million)

		Authorization			Appropriation		
	Req.	HASC	SASC	Comp.[a]	HAC/D	SAC/D	Comp.[a]
DDG-1000 research and development[b]	449	449	449	449	n/a	n/a	455[g]
Destroyer procurement and advance procurement funding[c]							
Procurement funding for third DDG-1000	2503	0	2503	2503	0[e]	2503?[f]	1509
Advance procurement funding for fourth DDG-1000	51	400[d]	51	51	450 or 501[e]	n/a	0
Advance procurement funding for DDG-51 program	0		0	349	n/a	397[f]	200
Procurement funding for DDG-51 program	0	0	0	0	n/a	n/a	0
Total of procurement and advance procurement	2554	400[d]	2554	2903	n/a	n/a	1709

Sources: FY2009 Navy budget submission, committee reports on FY2009 defense authorization bills, joint explanatory statement and associated funding tables on compromise version of FY2009 defense authorization bill, press releases on the HAC/D and SAC/D markups of the FY2009 defense appropriation bills, and explanatory statement on compromise version of FY2009 defense appropriation bill.

Notes: Req. is administration's request; HASC is House Armed Services Committee; SASC is Senate Armed Services Committee, HAC/D is Defense subcommittee of House Appropriations Committee; SAC/D is Defense subcommittee of Senate Appropriations Committee; Comp. is compromise version of bill. n/a = not available.

a. In lieu of conference reports on the FY20009 defense authorization and appropriation bills, there were compromise versions of the two bills, each accompanied by an explanatory statement intended to serve the same general function as a conference report.

b. DDG-1000 portion of Program Element (PE) 0604300N, DDG-1000 Total Ship System Engineering (previously called SC-21 Total Ship System Engineering), in the Research, Development, Test, and Evaluation, Navy (RDT&EN) account. PE0604300N also includes funding the CG(X) cruiser program.

c. Shipbuilding and Conversion, Navy (SCN) account.

d. To be used "for the construction of DDG 51 class destroyers or DDG 1000 class destroyers."

e. A July 30, 2008, press release from Representative John Murtha, chairman of the Defense subcommittee of the HAC, summarizing the subcommittee's markup of the bill, stated that the markup includes "a reduction of $2.5 billion for the third DDG-1000" and provides $450 million in advance procurement funding for the DDG-1000 program, but is unclear as to whether the $450 million includes or is in addition to the $51 million in advance procurement funding that was requested for the DDG-1000 program. One press report states that the total amount of advance procurement funding recommended by the subcommittee mark was $501 million (i.e., $450 million that was in addition to the requested $51 million). (Zachary M. Peterson, "House Appropriators Promote 'Skip Year' in DDG-1000 Program" *Inside the Navy*, September 8, 2008.)

f. A September 10, 2008, press release from the SAC summarizing the markup of the bill by the Defense subcommittee of the SAC stated that the markup "Supports the budget request for oneDDG-1000 Zumwalt class destroyer" and "Adds $397 million in advance procurement of oneDDG-51 class ship."

g. The explanatory statement for the compromise version of the bill increases the request forDDG-1000 research and development work by $6.3 million, with the increase going to "Floating Area Network Littoral Sensor Grid" ($4.8 million) and "Bio/Nano-MEMS [micro electro-mechanical systems] for Defense Applications" ($1.5 million).

FY2009 Defense Authorization Bill (H.R. 5658/S. 3001)

House

The House Armed Services Committee, in its report (H.Rept. 110-652 of May 16, 2008) on H.R. 5658, recommended reducing the Navy's request for FY2009 DDG-1000 procurement funding from $2,503 million to zero, and increasing the Navy's FY2009 request for DDG-1000 advance procurement funding from $51 million to $400 million. (Page 79, lines 010 and 011.) The $400 million in advance procurement funding would be used "for the construction of DDG 51 class destroyers or DDG 1000 class destroyers." (Page 83) The report recommended approval of the DDG-1000 portion of the Navy's request for FY2009 research and funding request for the DDG-1000 and CG(X) programs. (Page 186, line 97.) With regard to procurement and advance procurement funding, the report states that:

> The committee authorizes a reallocation of funding in the Shipbuilding and Conversion, Navy account and the National Defense Sealift Fund. The committee recommends: full funding for the 10th ship of the LPD 17 class; an increase in advance procurement funding for the Virginia class submarine program, necessary for the procurement of 2 ships in fiscal year 2010; advance procurement for the final 2 ships of the T-AKE class; and advance procurement for the construction of DDG 51 class destroyers or DDG 1000 class destroyers. The committee notes that due to the overall delay in the DDG 1000 destroyer program, the Navy would be unable to execute the full funding request in fiscal year 2009 for the third ship of the planned seven ship class. Additionally, the committee is concerned with potential significant cost overruns in the DDG 1000 program and considers it prudent to pause the program until technological challenges are completely understood.
>
> The committee authorizes these programs without prejudice to any specific program. The committee also understands the Navy is strongly considering re-starting the DDG 51 class destroyer upgraded with an improved radar system to fill an urgent need in ballistic missile defense. The committee would only support that decision if the industrial base for surface combatant construction is not affected. The committee expects the Secretary of Defense, subject to the availability of appropriations, to enter into advance procurement and advance construction contracts for the construction of surface combatants balanced between the two current surface combatant shipyards, taking into account workforce challenges still in effect on the Gulf Coast due to the lingering economic effects of Hurricane Katrina. (Page 83)

See also the additional views of Representative Niki Tsongas on pages 654-655 of the report.

Senate

The Senate Armed Services Committee, in its report (S.Rept. 110-335 of May 12, 2008) on S. 3001, recommended approval of the Navy's requests for FY2009 procurement and advance procurement funding for the DDG-1000 program. (Page 58, lines 010 and 011.) The report

recommended approval of the DDG-1000 portion of the Navy's request for FY2009 research and funding request for the DDG-1000 and CG(X) programs. (Page 181, line 97.)

Compromise

In lieu of a conference report, there was compromise version of S. 3001 that was accompanied by a joint explanatory statement. Section 4 of S. 3001 states that the joint explanatory statement "shall have the same effect with respect to the implementation of this Act as if it were a joint explanatory statement of a committee of conference." The joint explanatory statement states:

> The agreement would authorize full funding for the third DDG-1000 class destroyer without prejudice to any potential future Department of Defense decision to truncate the DDG-1000 class acquisition program in favor of a return to DDG-51 class destroyers.
>
> However, the agreement would authorize $349.0 million for surface ship advance procurement which would permit the Navy to acquire major spares for DDG-51 destroyers or buy advance procurement should the Secretary of Defense determine that there is a validated requirement to produce more of these ships.[43]

FY2009 Defense Appropriations Bill (H.R. 2638/P.L. 110-329)

House

The House Appropriations Committee did not file a report on the FY2009 defense appropriations bill. On July 30, 2008, Representative John Murtha, the chairman of the Defense subcommittee of the House Appropriations Committee, issued a press release summarizing the subcommittee's markup of the bill that day. The press release states that the subcommittee mark includes "a reduction of $2.5 billion for the third DDG-1000" and provides $450 million in advance procurement funding for the DDG-1000 program, but is unclear as to whether the $450 million includes or is in addition to the $51 million in advance procurement funding that was requested for the DDG-1000 program.[44] A September 8, 2008 press report states that the total amount of advance procurement funding recommended was $501 million (i.e., that the $450 million was in addition to the $51 million). The press report states:

> House appropriators this summer cut the Navy's request to fund the third DDG-1000 destroyer in its fiscal year 2009 budget—a move made by the committee to allow the program to mature and control future costs, according to details provided in the closely held report accompanying the July mark-up.
>
> "The committee notes that the third DDG-1000 is being requested in the third year of the program and believes that the program would benefit from inserting the traditional 'skip' year into the program prior to appropriating funding for the third ship," the report states.

[43] Joint Explanatory Statement to accompany S. 3001, the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, pp. 1-2.

[44] July 30, 2008, press release from the office of the Honorable John P. Murtha, entitled "Murtha Summary of the FY09 Defense Appropriations Bill," p. 2.

> A copy of the House Appropriations defense subcommittee FY-09 defense appropriations mark-up report was obtained last week by *InsideDefense.com*.
>
> Noting that the Virginia-class submarine program has been cited by Navy officials as the model for the DDG-1000 program—both ships are being built by two separate shipyards teamed together by the government—House appropriators write that the third ship of the Virginia-class program was appropriated in the fourth year of the program.
>
> "This should result in less rework and help reduce the overall cost of the third ship," lawmakers write of the decision to not fund the third DDG-1000 in FY-09.
>
> The subcommittee does provide nearly $501 million in advance procurement funds to "help maintain the industrial base," according to the report.[45]

Senate

The Senate Appropriations Committee did not file a report on the FY2009 defense appropriations bill. On September 10, 2008, the committee issued a press release summarizing the markup of the bill that day by its Defense subcommittee. The press release stated that the subcommittee "supports the budget request for one DDG-1000 Zumwalt class destroyer" and "adds $397 million for advance procurement of one DDG-51 class ship."[46]

Compromise

In lieu of a conference report, there was compromise version of the FY2009 defense appropriations bill that was incorporated as Division C of H.R. 2638/P.L. 110-329 of September 30, 2008. (H.R. 2638, originally the FY2008 Department of Homeland Security appropriations bill, was amended to become an FY2009 consolidated appropriations bill that included, among other things, the FY2009 defense appropriations bill.) The compromise version of H.R. 2638 was accompanied by an explanatory statement. Section 4 of H.R. 2638 states that the explanatory statement "shall have the same effect with respect to the allocation of funds and implementation of this Act as if it were a joint explanatory statement of a committee of conference."

The explanatory statement provides $1,508.8 million in FY2009 DDG-1000 procurement funding, consisting of a reduction of exactly $1 billion from the requested figure of $2,502.8 million, plus an increase of $6 million for "AGS Pallets." The explanatory statement notes that the $1-billion reduction reflects a decision to procure a third DDG-1000 in FY2009 using use split funding (i.e., two-year incremental funding) in FY2009 and FY2010. The explanatory statement also rejects the Navy's request for $51 million in FY2009 DDG-1000 advance procurement funding to support the procurement of a fourth DDG-1000 in FY2010, and provides $200 million in DDG-51 advance procurement funding "to preserve the option to restart the DDG-51 class destroyer program." The explanatory statement states:

> Surface Combatant Funding

[45] Zachary M. Peterson, "House Appropriators Promote 'Skip Year' in DDG-1000 Program," *Inside the Navy*, September 8, 2008.

[46] Source: September 10, 2008, press release from Senate Appropriations Committee entitled "Senate Defense Appropriations Subcommittee Approves Fiscal Year 2009 Defense Appropriations Bill," p. 2.

> The bill includes $1,507,603,000 [sic] for the first year of split funding for the DDG-1000 program. The Navy is directed to budget for the remaining funding requirement in fiscal year 2010 and to award a construction contract consistent with the ship's current acquisition schedule and the Joint Requirements Oversight Council (JROC) review described in the next section. The bill also includes $200,000,000 in advance procurement funding to preserve the option to restart the DDG-51 class destroyer program.
>
> Surface Combatant Funding
>
> The Navy's recent decision to truncate production of the DDG-1000 Zumwalt Class destroyers and restart production of the DDG-51 Arleigh Burke Class destroyers will require a program review by the [Department of Defense] Joint Requirements Oversight Council (JROC). Therefore, the Department [of Defense] is directed to complete a JROC program review, as expeditiously as possible, that examines the Navy's proposal and addresses the warfighting requirements implications of this decision and revalidates future surface combatant warfighting requirements prior to the obligation of any fiscal year 2009 procurement funds for either destroyer program.

The explanatory statement increases the request for FY2009 DDG-1000 research and development work by $6.3 million, with the increase going to "Floating Area Network Littoral Sensor Grid" ($4.8 million) and Bio/Nano-MEMS [micro electro-mechanical systems] for Defense Applications" ($1.5 million).

With regard to the JROC review mentioned in the language above from the explanatory statement, an October 6, 2008, press report stated that:

> Another blow was struck last month to the U.S. Navy's embattled DDG 1000 Zumwalt-class advanced destroyer program when a top-level Pentagon review board agreed to eliminate the operational requirements for the ship.
>
> No official decision was reached during the Sept. 18 meeting of the Joint Requirements Oversight Council (JROC), but uniformed sources said a memorandum was drafted to reflect cancellation of the requirements, which justify the need for a particular weapon program....
>
> Marine Gen. James Cartwright, vice chairman of the Joint Chiefs of Staff, chaired the Sept. 18 meeting, which reportedly was attended by about 60 officers and officials. Along with the vice chairman, the four vice chiefs of the military services fill out the JROC membership.[47]

[47] Christopher P. Cavas, "DDG 1000 Takes Another Hit—From JROC," *Defense News*, October 6, 2008: 4.

Appendix B. 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 late-July 2008 change in position on future destroyer procurement.*

Origin of Program

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:[48]

- **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,[49] 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.[50]

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.[51]

[48] 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).

[49] 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.

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

[51] 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).

Construction Sequence for Two Lead Ships

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 July 17 and 18, 2007, it was reported that the Navy was considering the option of instead assigning the first ship to GD/BIW and the second to NGSB. The potential switch in construction sequence reportedly was being considered by the Navy in part because the Navy believed it could provide some additional help in maintaining GD/BIW's work force as its DDG-51-related construction work winds down, and because it could also provide some additional time for NGSB to recover from Katrina-related damage.[52]

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.[53] The difference in the two ships' construction schedules (about one year) is driven in large part by the production capacities of vendors making certain components for the ships—some of these vendors can make only one ship-set worth of components at a time.

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 proposal.[54]

Contract Modification Awards 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.

Acquisition Strategy for Third and Subsequent Ships[55]

Under an acquisition strategy approved by the Department of Defense (DOD) acquisition executive and documented in an updated Acquisition Strategy Report (ASR) of February 13, 2008, the Navy intended to conduct a single competition between GD/BIW and NGSB for the contracts to build the five remaining ships in the previously planned seven-ship program (i.e., ships three through seven). The winner of the competition was to have built three ships (the third, fifth, and seventh ships in the program, which were to have been procured in FY2009, FY2011, and FY2013, respectively), while the other firm was to have built two ships (the fourth and sixth ships in the program, which were to have been procured in FY2010 and FY2012, respectively).

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[52] Christopher P. Cavas, "First DDG 1000 Could Shift To Bath," *Defense News*, July 17, 2007; Geoff Fein, "Navy Exploring Workload Options For DDG-1000," *Defense Daily*, July 18, 2007.

[53] Geoff Fein, "Bath Iron Works To Take Delivery of First Set of DDG-1000 Equipment," *Defense Daily*, September 26, 2007; Christopher P. Cavas, "Bath To Build First DDG 1000," *DefenseNews.com*, October 1, 2007; and Chris Johnson, "Navy Changes Equipment Delivery For First Two DDG-1000 Destroyers," *Inside the Navy*, October 1, 2007.

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

[55] The information presented in this section is based on an April 10, 2008, Navy briefing to CRS and CBO on the DDG-1000 program.

Under this strategy, each firm would have built a minimum of two ships, and the two firms would in effect have competed for the right to build the remaining fifth ship. In light of the shared production arrangement for the DDG-1000 program (see discussion below), the two firms more specifically would have been competing for the right to build certain portions of that fifth ship, and to perform the final-assembly work on that ship—work that would amount to about 50% of the total shipyard labor hours needed to build that fifth ship. The two firms could also be viewed as having been competing for the timing of their respective second ships, as the winner's second ship would have been the ship to be procured in FY2009, while the other firm's second ship would have been the ship to be procured in FY2010.

The Navy intended to structure the contract with the winning firm as a fixed-price incentive fee (FPIF) contract to build the ship that was to have been procured in FY2009, with priced options for building the ships that were to have been procured in FY2011 and FY2013. The Navy intended to structure the contract with the other firm as an FPIF contract to build the ship that was to have been procured in FY2010, with a priced option to build the ship was to have been procured in FY2012. If one or more of the third and subsequent ships were not procured in the years in which the Navy currently planned procure them, the options would not have been exercised and the Navy might have conducted a new competition to determine who would have built the follow-on ships in the program.

Shared Production Arrangement

NGSB and GD/BIW have agreed on a shared-production arrangement for building DDG-1000s. Under this arrangement, certain parts of each ship will be built by NGSB, certain other parts of each ship will be built by GD/BIW, and the remaining parts of each ship would be built by the yard that does final-assembly work on that ship. Each firm's repeating portion of the ship would amount to about 25% of the labor hours for the ship; the yard that does the final-assembly work on the ship would also perform the remaining 50% or so of the labor hours needed to build the ship. The arrangement can be viewed as somewhat analogous to the joint-production arrangement for Virginia-class submarines that was proposed by industry and the Navy, and then approved by Congress in Section 121 of the FY1998 defense authorization act (H.R. 1119/P.L. 105-85 of November 18, 1997).[56]

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.

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

Appendix C. 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.[57] 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

[57] 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 D. Ship Design Options

This appendix presents some ship design options that policymakers may consider for reducing DDG-51 O&S costs, or for improving fleet capabilities through procurement of modified DDG-51s, modified DDG-1000s, or other ships. Parts of this appendix are adapted from CRS testimony at the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee,[58] which in turn was 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.

DDG-51 Design Options

Although the Navy's proposal for restarting DDG-51 procurement calls for procuring essentially repeat copies of the current Flight IIA DDG-51 design, policymakers may consider the alternative of procuring a modified version of the DDG-51 design. A modified version could have lower O&S costs, and could be better aligned with a potential policy goal of using DDG-51 procurement to improve the fleet's capabilities for NSFS or for BMD and area-defense AAW (the latter two referred to in this appendix as Integrated Air and Missile Defense, or IAMD).

In deciding whether destroyer procurement over the next several years should focus on providing improved NSFS capabilities or improved IAMD capabilities, policymakers could consider several factors, including current and potential U.S. Navy operations, the operational requirements for conducting these operations, current and projected threats or challenges associated with these operations, and current or projected Navy or DOD programs (other than destroyer procurement) for countering these threats or overcoming these challenges.

A key system for providing improved NSFS capability is the 155mm Advanced Gun System (AGS) and the associated 155mm Long Range Land Attack Projectile (LRLAP). Key systems for providing improved IAMD capabilities include higher-capability radars and vertical-launch tubes for IAMD interceptors.

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.

Compared to the option of procuring repeat 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

[58] 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.

changing the ship's design and (for some of the options discussed below) the enlargement of the ship. Depending on the exact option pursued, the nonrecurring design and engineering costs could total in the hundreds of millions of dollars. Given the number of DDG-51s that may be procured between now and the procurement of a lead CG(X) in FY2015, FY2016, or FY2017, these additional costs might be deemed cost effective in terms of making it possible to procure DDG-51s that have lower O&S costs and are better aligned with a possible policy goal of using DDG-51 procurement to provide the fleet with improved NSFS or IAMD capabilities.

DDG-51 configuration options that may be procured in coming years include but are not limited to the following:

- the current Flight IIA design;
- a modified version with additional features for reducing O&S costs;
- a modified version with additional features for reducing O&S costs and an AGS;
- 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. The first of these options might be ready for implementation sooner than the others. If so, and if procurement of a modified DDG-51 design were desired, procurement of DDG-51s over the next several years could begin with procurement of the current Flight IIA design and then shift to the modified design when the modified design was ready for procurement.

Although the option of procuring the current Flight IIA DDG-51 design might be ready for implementation sooner than the other options, the Navy and other observers have cautioned that the time line for restarting procurement of the current Flight IIA design could be extended by the need to restart or reestablish vendors for certain key DDG-51 components, such as the reduction gear.

Current Flight IIA Design

This option, which might be considered the baseline option, has the lowest nonrecurring design and engineering costs and the lowest recurring production costs of all the options presented here. It would maximize the number of DDG-51s that could be procured for a given amount of procurement funding. It would also pose the lowest amount of technical, schedule, and cost risk. It would have higher life-cycle O&S costs then the next option discussed below, and perhaps higher O&S costs than some of the other options discussed below as well. Procuring the current Flight IIA design would provide more of the same capabilities that DDG-51s currently provide for the fleet, but the ships might not be considered particularly well-aligned if a possible policy goal was to use DDG-51 procurement to provide improved (as opposed to additional) capabilities for NSFS or IAMD. As mentioned above, the current Flight IIA design could be procured as a bridge to procurement of one of the modified designs discussed below.

Version with Features for Reducing O&S Costs

This option would procure Flight IIA ships 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.[59]

(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.

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.[60]

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.[61] 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:

[59] 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.

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

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

> 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.[62]

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,[63] 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 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.[64]

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.[65] If fuel in coming years costs more than $112.14 per barrel, the dollar savings associated with a 3.9% reduction in fuel use

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

[63]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.

[64] 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").

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

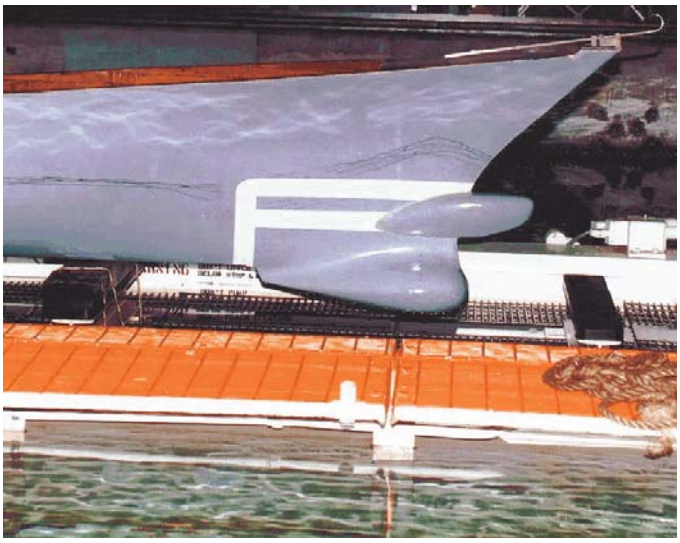
would be greater than $2.5 million per year. The obverse would be true if fuel in coming years costs less than $112.14 per barrel.

Adding a Near-Surface Bow Bulb

As discussed in a CRS report,[66] 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%.[67]

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:

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

[67] 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.)

> 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.[68]

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.

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 an AGS

This version of the DDG-51 design would include an AGS as well as features for reducing O&S costs. The purpose in procuring this version would be to provide the fleet with improved NSFS capabilities. Under this option, the Flight IIA design would be modified by removing the 5-inch gun and perhaps also the forward 32-cell vertical launch system (VLS) battery, lengthening the ship forward of the deckhouse through the insertion of a hull plug, and installing an AGS with a magazine capable of storing as many LRLAP rounds as can be fitted, with a goal of 300.

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

Some of the sources that CRS consulted expressed doubts or concerns about the technical feasibility or engineering difficulty of this option. Other sources expressed fewer concerns along these lines. A redesign of the AGS's ammunition storage and handling space would be needed to accommodate the AGS in the DDG-51 hull.

The Navy informed CRS in 2005 that it might be possible to fit the existing DDG-51 hull with one AGS, that doing so would likely require the removal of 5-inch gun and the forward 32-cell VLS battery, and that in this configuration, the DDG-51 might carry about 120 LRLAPs.[69]

At a March 14, 2008, hearing on shipbuilding issues before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee, Vice Admiral Barry McCullough was asked what platforms other than the DDG-1000 might be equipped with an AGS. He replied:

> Well, sir, I will tell you we looked at [whether] could you put the Advanced Gun System in an Arleigh Burke [DDG-51] hull. And without doing a detailed shock analysis on it, I will tell you physically it fits. We'd have to do some arrangement changes in it. But you can put the gun in there. And my concern is the magazine capacity. Outside of that, we haven't looked at putting it in any other hull form. So I'll get back to you on that.[70]

This comment, like the information that the Navy provided to CRS in 2005, appears to relate to an installation that does not involve lengthening the DDG-51 hull. Lengthening the DDG-51 hull forward of the deckhouse could provide additional space and weight-carrying capacity for additional LRLAP rounds, and perhaps also permit the retention of the forward 32-cell VLS battery. The Navy and industry in the past have studied options for lengthening the DDG-51 hull by various lengths to accommodate various capability upgrades, such as additional VLS cells;[71] the maximum possible hull extension might be 55 or 56 feet.[72] An extension of 55 or 56 feet might permit a magazine of more than 300 rounds, or alternatively might permit the retention of at least some of the ship's forward VLS cells.

Because the AGS requires much more electrical power to operate than the DDG-51's current 5-inch gun, equipping the DDG-51 with an AGS might require the installation of an additional

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[69] Source: Navy briefing to CRS on DDG-1000 and DDG-51 capabilities, June 10, 2005.

[70] Source: Transcript of hearing. The idea of backfitting an AGS onto an existing Spruance (DD-963) class destroyer, so that the ship could be used as a risk-reduction platform for the DDG-1000, was explored by a group of three Navy lieutenants in a 2003 study done while at the Massachusetts Institute of Technology. The study's preferred installation option, which involved the removal of the ship's aft 5-inch gun but no hull extension, resulted in a magazine with an estimated capacity of 304 LRLAP rounds. (Julie Higgins, Jason Rhoads, and Michael Roach, *Advanced Gun System (AGS) Backfit, DD-988 Naval Gunfire Support Ship Conversion*, Massachusetts Institute of Technology, 13.413, Project in Naval Ship Construction, Spring 2003, 30 pp.)

[71] 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.

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

electrical generator. The best location for such a 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.

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.[73] In 1997, to support research that CRS was conducting into possible alternatives to the Navy's proposed Arsenal Ship,[74] 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 detail 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.

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

[73] 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.

[74] 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.

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.[75] Supporting equipment to be installed would include an additional electrical generator and additional cooling equipment.[76] 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

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

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

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.[77] 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-51 Modernization Program

Policymakers may consider the option of altering the current program for modernizing existing DDG-51s[78] so as to produce modernized ships with configurations similar to the modified configurations discussed above for new-construction DDG-51s. Each of the modified configurations discussed above might be achievable through modernizations of existing DDG-51s.

Altering the DDG-51 modernization program to include such changes to the ship configuration would

- increase the cost of the modernization program;
- increase the amount of shipyard work associated with each modernization, which could have implications for supporting the shipbuilding industrial base (see discussion below);
- produce ships with lower O&S costs than currently planned;
- produce ships that are aligned more closely with a possible policy goal of providing the fleet with improved NSFS or IAMD capabilities; and
- permit the modernization effort to produce ships with improved NSFS capabilities while the new-construction effort produces ships with improved IAMD capabilities, or vice versa, thus pursuing both of these potential policy goals.

DDG-1000 Design Options

DDG-1000 design options that policymakers may consider include but are not necessarily limited to those discussed below. As with the DDG-1000 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.

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[77] 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.

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

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 the ship's two AGSs and their magazines and using the freed-up space for additional vertical launch tubes.

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.

Procuring a modified DDG-1000 design equipped with a sonar optimized for blue-water ASW

This option would more closely align the DDG-1000 design with a goal of providing the fleet with improved blue-water ASW capabilities by replacing the DDG-1000's current bow-mounted sonar, which is optimized for littoral (i.e., near-shore) ASW operations, with a bow-mounted sonar optimized for blue-water ASW operations. The new sonar could be the same as, or similar to, the DDG-51's bow-mounted sonar. This option might be combined with either of the two previous options to provide the fleet with improved IAMD and blue-water ASW capabilities.

Press Report

A September 12, 2008, press report relating to options such as those outlined above 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.[79]

[79] 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.

Non-Combat Adjunct Ship With Powerful Radar

Another option that policymakers may consider for improving the fleet's IAMD capabilities in the near term (i.e., prior to the start of CG(X) procurement) 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 modified DDG-51. 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.[80] 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.

Modified CG-47s With Improved Radar

Another option that policymakers may consider to improve the fleet's IAMD capabilities in the near term would be to alter the current program for modernizing Aegis cruisers (CG-47s)[81] so as to include the installation of an improved radar. This option would involve replacing the SPY-1 radar on existing CG-47s with an improved radar using active-array technology similar to the technology used in the current DDG-1000 radar. This option would require the removal of one of the CG-47's two 5-inch guns, as well as the removal of some other mission equipment. It would also require replacing the ship's electrical generators and cooling equipment with more capable models, and replacing the ship's electrical distribution system.

LPD-17 Hull Equipped With AGSs

Another option that policymakers may consider for improving the fleet's NSFS capabilities would be to procure a modified LPD-17 hull equipped with two AGSs has been suggested by both the Congressional Budget Office (CBO) and the Center for Strategic and Budgetary Assessments (CSBA) as a potential alternative to procuring DDG-1000s. The two guns and their magazines would be installed in the aft part of the ship, which would degrade or eliminate the LPD-17 design's well deck and aviation capabilities. CBO estimated in 2006 that an initial AGS-armed LPD-17 might cost about $1.9 billion, including $400 million detailed design and nonrecurring engineering costs, and that subsequent ships might cost about $1.5 billion each.[82]

[80] 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

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

[82] See Congressional Budget Office, *Options for the Navy's Future Fleet*, May 2006, pp. 56-57 (Box 3-1).

Modified LHA-6 Equipped With AGSs

Another option that policymakers may consider for improving the fleet's NSFS capabilities would be to procure LHA-6 amphibious assault ships (earlier known as LHA Replacement, or LHA(R) class ships) to a modified design featuring a lengthened hull and up to four AGSs. One option for such a modified design would lengthen the LHA-6 hull by 56 to 77 feet forward of the ship's deckhouse (i.e., it's "island" superstructure) and place four AGSs forward of the deckhouse, along the starboard (i.e., right) edge of the ship. Supporters of this option might argue that building new LHA-6 class ships to this modified configuration rather than to the current design (which is equipped with no major-caliber guns) would increase LHA-6 procurement costs by a relatively small percentage and thus permit the Navy to introduce AGSs into the fleet at a relatively low additional cost. Supporters might argue that the ship could continue to fire its AGSs while taking on additional LRLAP shells for the AGSs through the ship's well deck, creating an "infinite magazine" similar to that in the DDG-1000 design. Supporters might argue that the location of the AGSs could permit them to be installed and used with potentially little reduction to the ship's other capabilities.

Appendix E. FY2009 Oversight Issues Relating to Navy's July 2008 Proposal

Timing of Announcement of Navy's New Position

One potential oversight issue for Congress in FY2009 concerned the timing of the Navy's announcement its change in position on destroyer procurement. The announcement came well after the submission of the Navy's proposed FY2009 budget and the spring budget-review hearings held by the House and Senate Armed Services committees and the Defense subcommittees of the House and Senate Appropriations Committees. A potential oversight question for Congress was, Why did the Navy not announce its changed position prior to the budget submission, or at least prior to the spring budget-review hearings?

An October 9, 2008, news report quoting Vice Admiral Barry McCullough, the Deputy Chief of Naval Operations for Integration of Capabilities and Resources, stated:

> McCullough added that the process the Navy undertook to make its decision was done right.
>
> "First we conducted an in-depth evaluation [within] the Navy. Once we came to the conclusion that rendered the decision that the Navy made then we socialized this with OSD, because we want to have a solidified Navy position and then we wanted a solidified 'big' department-wide position. Once we received approval from OSD to go forward, that's when we took it to Congress," he explained. "That's the right way to do it."
>
> It wasn't approval of the plan, McCullough added, it was the approval to go to Congress with the Navy's proposal. "That's what we did. We think that's the right way to do business."

"From the outside, it looks like the timing was bad. The timing was hard and we realized that, but we wanted to make sure we had the decision right and then we wanted to make sure we briefed OSD on where we wanted to take the Navy and then go to Congress," McCullough said. "As I look back on it, I really think we did it right, and it's required some intense socialization with industry, with members of Congress that have an interest in it from an industrial base concern.[83]

Availability of Navy's Analytical Basis for Its New Position

A second potential oversight issue in FY2009 concerned the availability of the Navy's analytical basis for its new position on destroyer procurement. The Navy testified at the July 31, 2008, hearing that the service's new position is based on an analysis performed in the Assessment division (N81) of the Navy's Resources, Requirements and Assessments office (N8). As of the July 31 hearing, the Navy had not shared the analysis with at least some of the Members present at the hearing, who asked to see the analysis. Potential oversight questions for Congress included the following:

[83] Geoff Fein, "Navy Needs Ships It Can Evolve To Meet Growing Ballistic, Cruise Missile Threats, Official Says," *Defense Daily*, October 9, 2008.

- When does the Navy intend to share its analysis with Members of Congress and congressional staff who have not yet seen it?
- When was the analysis performed, and what DOD offices, parts of the Navy other than N81, or industry firms participated in the analysis?

Navy's Changed Threat Assessment

A third potential oversight issue for Congress in FY2009 concerned the Navy's changed threat assessment. Potential oversight questions for Congress included the following:

- What are the specific developments over the last two years concerning ballistic missiles, ASCMs, and submarines that caused the Navy to alter its threat assessment? (The Navy indicated at the July 31 hearing that it could discuss this matter in detail only in a classified setting.)[84]
- Is the Navy correct in its judgment that these developments require reorienting destroyer procurement over the next several years toward a goal of improving the fleet's BMD, area-defense AAW, and blue-water ASW capabilities?
- Why, after arguing for years that the Navy needs the improved NSFS capabilities of the DDG-1000, does the Navy now believe that it has more than enough capability in this area? What recent changes in warfighting scenarios, concepts of operations, or acquisition programs have occurred to support this conclusion? Does the Marine Corps agree with the Navy that there is more than enough NSFS capability?

Naval Surface Fire Support

The discussion below provides additional information bearing on the issue of the Navy's changed assessment regarding the adequacy of Navy NSFS capabilities.

March 2006 Navy Report On NSFS

A March 2006 Navy report to Congress on the Navy's NSFS programs stated:

> In the 1970's, the Navy adopted the 5-inch/54-caliber gun as the standard gun system aboard surface combatants [i.e., cruisers and destroyers] with [the gun having] a range of 13 nautical miles (nm). It was intended for general purpose use against surface craft, slow moving aircraft, and near shore targets. Additionally, four IOWA Class BBs [battleships] were brought back into service to provide longer-range shore fire support.
>
> With the retirement of the [Iowa-class] battleships in 1992, the surface Navy was left with only the short-range 5-inch/54 caliber guns to conduct Naval gunfire support missions. New and improved coastal defense systems meant the Navy must develop platforms capable of

[84] A October 9, 2008, news report quoted Vice Admiral Barry McCullough, the Deputy Chief of Naval Operations for Integration of Capabilities and Resources, as stating: "I have had several classified briefings with staffers and members [of Congress] to explain how rapidly the threat has changed over the last three years. It's hard to talk about that in an open hearing." (Geoff Fein, "Navy Needs Ships It Can Evolve To Meet Growing Ballistic, Cruise Missile Threats, Official Says," *Defense Daily*, October 9, 2008.)

delivering fires ashore from greater distances than were achievable with the MK45 Mod 2, 5"/54 caliber gun.

In the National Defense Authorization Act for FY1992 and FY1993, Congress directed the Navy to "establish a Naval surface fire support R&D [research and development] program" and investigate "potential technologies and weapons systems for improving ship-to-shore fire support," as well as to formally "report on ship-to-shore fire support requirements." The Navy was also tasked to conduct a cost and operational effectiveness analysis (COEA) based on their findings. The Secretary of Defense, through the Institute for Defense Analysis (IDA), was required to provide an additional study of requirements and cost effective alternatives. The Navy and Marine Corps signed a Naval Surface Fire Support (NSFS) Mission Needs Statement in July 1992, emphasizing the importance of NSFS in support of amphibious operations.

Results from the Navy's NSFS study, the IDA study, and the NSFS COEA shared a common theme: a combination of systems are required and precision guided munitions are needed to maintain accuracy across longer ranges for NSFS. The Navy's NSFS COEA, issued in March 1994, found that a new 155-mm, 60-caliber gun with an advanced propellant and precision-guided munitions, coupled with the Tomahawk missile, is the most cost effective NSFS solution. The Navy proposed a research and development program to develop the 155-mm gun and accompanying precision guided munition, as well as upgrade the current MK45, Mod 2, 5"/54 gun, resident on guided missile cruisers and destroyers, to achieve greater ranges until the new 155-mm gun became operational. Based on affordability and timeliness, the Chief o f Naval Operations (CNO) approved a new NSFS plan in December 1994, to focus on a "near term" NSFS solution by upgrading the existing 5"/54 gun to allow for increased range and to develop an accompanying 5-inch precision guided munition. Plans to develop the near-term 155-mm gun and munitions were cancelled, but were kept in consideration as a long term NSFS solution. The 155 mm solution is currently supported by the Advanced Gun System (AGS), which will be installed on DD(X) [i.e., DDG-1000].

Today the Navy continues to invest in NSFS requirements. The MK45 Mod 2, 5"/54 gun has been upgraded to a MK45 Mod 4, 5"/62 gun, and the Naval Fires Control System has achieved Initial Operating Capability (IOC). The extended range 5" munition [or ERM—also known as the Extended Range Guided Munition, or ERGM] suffered setbacks due to technical and financial constraints, but is scheduled for a FY 2011 IOC. DD(X) will be delivered with AGS and the Long [R]ange Land Attack Projectile (LRLAP) in FY 2013 to satisfy mid term requirements. In addition, the Navy continues research on potential technologies that will answer far term requirements.

NSFS requirements have recently been validated and documented in accordance with the Joint Capability Integration and Development System [JCIDS} through the Joint Fires in Support of Expeditionary Operations in the Littoral Initial Capabilities Document (ICD), known as the Joint Fires ICD. This Joint Fires ICD defines the NSFS measures of effectiveness for various ranges of military operations from major combat operations to the Global War on Terrorism (GWOT) and identified four capability gaps not covered by the existing systems and programs of record....

From 1996 to 2002, in various letters to the Chief of Naval Operations, the Marine Corps established NSFS requirements that mirrored the range, volume of fire, and lethality of current ground based artillery systems. Specifically, the capability of the 155-mm towed artillery with rocket-assisted projected was noted. NSFS requirements were expressed in specific detail in terms of "near," "mid," and "far" term requirements.

> 1. Near term requirements were defined as 41 to 63nm. (Standoff distance (25nm) plus maximum range of Marine Corps 155-mm artillery (16nm) plus range for threat artillery (22nm)
>
> 2. Mid term requirements were defined as 63 to 97nm. (Operational radius of CH-46E (75nm) plus range for threat artillery (22nm)
>
> 3. Far term requirements were described as 97 to 262nm. (Range of the MV-22 (240nm) plus range for threat artillery (22nm)....
>
> The Joint Fires ICD incorporates the requirements of the U.S. Army, Special Operations Command, and other applicable organizations. The Joint Fires ICD defined four requirement gaps that are currently not filled:
>
> (1) Ability to transmit/receive required targeting information from Intelligence, Surveillance, and Reconnaissance sources to command and control systems.
>
> (2) Ability to engage moving point and moving area targets under adverse weather conditions.
>
> (3) Ability to engage known/identified targets when friendly forces are in close contact or when collateral damage is a concern.
>
> (4) Ability to provide volume fires to suppress targets.
>
> The Navy continues to work to close these joint gaps. SACC(A) [the Supporting Arms Coordination Center (Automated)] significantly closes gap (1). The use of ERM and LRLAP projectiles frees up tactical air assets in order to engage moving targets, thus minimizing gap (2). ERM and LRLAP will significantly close gap (3). The use of MRSI [Multiple Round Simultaneous Impact] capability of ERM and LRLAP has demonstrated the ability to play a role in minimizing the volume fires requirement of gap (4)....
>
> The Navy's NSFS Program was initiated as part of a larger strategy to meet USMC [U.S. Marine Corps] stated requirements for Expeditionary Maneuver Warfare. However, NSFS will support all Joint maneuver forces ashore at extended ranges and will provide responsive and persistent fire support for all other operations. The NSFS program will represent economy over time as fewer rounds will be required to achieve the desired effects on most targets due to greatly enhanced accuracy, precision and lethality. Ships will no longer need to fire 300 rounds to cover one target during a fire support mission for units ashore. An individual target may potentially be engaged with as few as two rounds more accurately, more quickly, and at a greater range than is currently possible. Programs such as ERM and LRLAP represent transformation capabilities first conceived in 1992, and continue today to provide balance to the fire support triad [consisting of NSFS, close air support from tactical air, and organic fires from artillery and mortars].[85]

The report includes views and recommendations of the Chief of Naval Operations (CNO) and the Commandant of the Marine Corps. The CNO's views and recommendations state in part:

[85] *Report to Congress On Naval Surface Fire Support*, Prepared by: Director of Surface Warfare, Office of the Chief of Naval Operations, March 2006, pp. 1-2, 4, 7, 10. Although the report is dated March 2006 on its cover, the accompanying transmission letters to Congress are dated April 4, 2006.

> The Extended Range Munition (ERM) and Long Range Land Attack Projectile (LRLAP) are the first sea fired NSFS weapons designed specifically to support the land battle and the challenging "call for fire" environment at extended ranges....
>
> Finally, I am most encouraged by the efforts of the Navy-Marine Corps team to get our NSFS requirements approved by the Joint Staff. We have received JROC [Joint Requirements Oversight Council] approval of the Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document (ICD) and the ERM Capability Development Document (CDD). 2006 also marks the kick off of a far-reaching NSFS Analysis of Alternatives that will set the course for future acquisition programs. It is important that the Navy ensures the Joint Force Commander has a robust capability to support ground forces at all times and in all conditions.[86]

The Commandant's views and recommendations state in part:

> Firepower, including responsive, lethal, and persistent fires from U.S. Navy surface ships, is essential in expeditionary operations against irregular and conventional forces. A robust set of round-the-clock (24/7), all-weather, sea-based fire support capabilities is fundamental to the success of naval or special operations forces engaged in littoral combat operations. As we look at operating across an extended battlefield, Naval Surface Fire Support (NSFS) capability will require greater range, volume, and accuracy....
>
> In December 2005, the Joint Requirements Oversight Council validated the Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document (ICD), and recognized NSFS as a potential solution for mitigating several of the identified fire support gaps to include—the ability to engage targets in close support of maneuver forces or with collateral damage concerns, and the ability to provide volume fires over a large area or for sustained periods of time (e.g., suppression)....
>
> Our existing liabilities in conventional ammunition are range and availability. Current NSFS systems remain our only available all-weather fires capability for ship to shore operations; however, at 13 nautical miles (nm), conventional 5" ammunition does not meet our requirements for Expeditionary Maneuver Warfare....
>
> The use of Tactical Tomahawk [TACTOM—the newest version of the Tomahawk land attack missile] for tactical-level fire support is not feasible. While designed to be more flexible and responsive, relative to conventional [i.e., earlier-design] Tomahawk missiles, the release authority and cost of the TACTOM drive it to remaining a strike weapon suited for operational and strategic employment....
>
> As the planned second phase of the NSFS roadmap, the DD(X) [i.e., DDG-1000], in conjunction with the DDGs' ERGM fires, is a program of record that is planned to satisfy the Marine Corps' NSFS requirements. With two 155 Advanced Gun Systems (AGS) and 600 Long Range Land Attack Projectiles (LRLAP) per ship capable of engaging targets with precision accuracy in excess of 63nm (threshold [objective]), the DD(X) provides the range, lethality, and volume to address a larger piece of the target set, complementing the DDG's NSFS capabilities. DD(X) provides our first integrated, sea-based counter-fire capability....
>
> We have a requirement for counter-fire detection capability. DD(X) will have the first integrated counter-fire system that will address this capability gap. An interim capability is required. The Marine Corps would like to see this capability proliferated to all AEGIS

[86] *Report to Congress On Naval Surface Fire Support*, Chief of Naval Operations' views and recommendations.

> equipped surface combatants. Integration of a CBR [counter-battery radar] functionality into AEGIS may represent a relatively low cost solution to meet this capability requirement.[87]

November 2006 GAO Report On NSFS

A November 2006 Government Accountability Office (GAO) report on NSFS stated:

> In December 2005, more than a decade after the Navy and Marine Corps began to formulate requirements, agreement was reached on the capabilities needed for naval surface fire support. However, quantifiable measures are still lacking for volume of fire—the delivery of a large quantity of munitions simultaneously or over a period of time to suppress or destroy a target. Until further quantifiable requirements are set for volume of fire, it is difficult to assess whether additional investment is necessary or the form it should take.
>
> The Navy's Extended Range Munition and Zumwalt class destroyer have cost more, taken longer to develop and field than anticipated, and will deliver fewer capabilities than originally promised. Largely due to technical challenges, the Extended Range Munition is expected to exceed the original cost estimate for development by 550 percent, and the Navy has delayed delivery of initial capability by 11 years. The munition's path for development and fielding remains uncertain as key technologies and munition design have not been adequately demonstrated. The Office of the Secretary of Defense recently assumed oversight of the program, and while a comprehensive review has not yet been held, there are ongoing studies that could assist such a review. The Navy has reduced Zumwalt class land attack munitions by 50 percent and cut ship quantities from 32 to 7. The primary reason for reduced capabilities are cost pressures created by the Navy's original concept of revolutionary performance at an unrealistically low cost. The Navy plans to begin construction of the first two ships in the Zumwalt class in fiscal year 2008.
>
> The recent study of future fire support needs approved by the Joint Requirements Oversight Council identifies four capability gaps: command and control of fire support; engaging moving targets in poor weather; engaging targets when collateral damage is a concern; and engaging targets that require a large volume of fire. The analysis that forms the basis of the joint study contends that while the Extended Range Munition and Zumwalt class destroyer offer significant capabilities in some scenarios, they do not provide enough capability to meet all fire support needs. The Navy, through its surface warfare directorate, has begun analyzing the three engagement gaps, but the Navy has not chosen an organization to analyze the gap in command and control, which is essential for target assignment and information. Any attempts to accept the risks or invest in programs to fill remaining gaps should also involve the expeditionary warfare directorate as the Marine Corps representative. The expeditionary warfare directorate does not have a formal role in developing requirements, determining capabilities, and managing resources for systems that provide naval surface fire support.[88]

March 2008 Termination of ERGM Funding

In late March 2008, the Navy announced that it would cease funding the development of the ERGM due to dissatisfaction with the development program's progress.[89] The ERGM was

[87] *Report to Congress On Naval Surface Fire Support*, Commandant of the Marine Corps' views and recommendations.

[88] Government Accountability Office, *Defense Acquisitions[:] Challenges Remain in Developing Capabilities for Naval Surface Fire Support*, GAO-07-115, November 2006, summary page.

[89] See, for example, Dan Taylor, "Navy To Examine Its Options After Pulling Plug on Munition Program," *Inside the* (continued...)

intended to extend the firing range of the Aegis ships' 5-inch guns to 50 nautical miles, or almost four times their current range of 13 nautical miles. The Navy reportedly is considering possible alternatives to ERGM for an extended-range 5-inch shell.[90] Skeptics might argue that, until a replacement for the ERGM program is identified and funded, the Navy's termination of the ERGM program would, other things held equal, increase the apparent need for procuring a ship equipped with the AGS and the LRLAP.

September 2008 Press Report on New NSFS AOA

A September 22, 2008, press report states:

> Under the direction of senior Pentagon leadership, the Navy and Marine Corps will study gaps in naval surface fires support for Marines ashore, a capability once advertised as the reason the Navy needed to build the new DDG-1000 destroyer.
>
> A Sept. 8 joint memorandum for the record signed by Lt. Gen. George Flynn, commander of Marine Corps Combat Development Command, and Vice Adm. Barry McCullough, deputy chief of naval operations for integration of resources and capabilities, states that the Office of the Secretary of Defense has directed the two services to conduct a joint expeditionary fires analysis of alternatives in time for a Defense Acquisition Executive Review slated for June 2009.
>
> "We believe this [analysis] is the appropriate process to determine the best solution for current gaps in 24/7 expeditionary fire support with an eye to refining the role of [naval surface fires support] in meeting Marine Corps and joint needs across the range of military operations," the three-star officers write in the memo.
>
> "We expect the [study] to underpin the Department of the Navy strategy for [naval surface fires support] out to the 2020 time frame, synchronizing our weapons, shipbuilding and supporting capabilities efforts and investments," Flynn and McCullough add.
>
> In a speech last week, McCullough said the Navy is not "walking away" from providing naval surface fires despite the planned truncation of the DDG-1000 program to three hulls, down from seven, in favor of building more DDG-51 vessels, which lack the littoral capabilities long cited as the reason the service needed the newer ship.
>
> "I've been asked [in light of the DDG-1000 decision] if we were walking away from the fires," McCullough said Sept. 16 at a luncheon sponsored by the Surface Navy Association. "Nothing could be further from the truth."
>
> However, retired Marine Lt. Gen. Paul Van Riper, who led Marine Corps Combat Development Command in the mid-1990s, expressed doubt that the latest study will produce any concrete result.

(...continued)

Navy, March 31, 2008. See also William Matthews, "Guided Munition May Be Canceled," *NavyTimes.com*, March 21, 2008; Geoff Fein, "Navy Likely To Terminate ERGM Program In Coming Days," *Defense Daily*, March 24, 2008; William Matthews, "End of ERGM Spotlights Other Future Guns," *NavyTimes.com*, April 1, 2008.

[90] See, for example, Dan Taylor, "Navy To Examine Its Options After Pulling Plug on Munition Program," *Inside the Navy*, March 31, 2008; Tom Kington, "U.S. navy Eyes Italian Guided Munition," *Defense News*, May 12, 2008: 10; "Starting Over," *Defense Daily*, June 9, 2008; Geoff Fein, "BAE-Lockheed Martin Partner To Develop ERM For Navy," *Defense Daily*, July 3, 2008.

"For 12 years the Navy has repeatedly sought letters or requested studies detailing the Marine Corps' naval surface fire-support requirements," Van Riper wrote in an e-mail to Inside the Navy. "When provided such specific requirements Navy leaders have acted irresolutely. In several cases they touted new technologies that never lived up to their promises. I am not convinced that the Navy has been or is serious today about naval surface fire support."...

In March, the Navy pulled the plug on Raytheon's Extended Range Guided Munition (ERGM) program due to myriad developmental issues. ERGM was meant to fill the Navy's extended range munition (ERM) requirement for a five-inch precision projectile with an enhanced range and greater accuracy than current munitions.

The Navy canceled the ERGM program entirely in July.

"We are still very interested in firing an extended range projectile," McCullough said last week when asked about the subject.

Yet, retired Marine officers such as Van Riper remain doubtful of the Navy's sincerity in such efforts.

"Based on my own experiences and having observed since 1995 the Navy's failure to adequately support improvements to naval surface fire support, I am skeptical that this latest effort will be any different than those of the past," Van Riper said.

Robert Work, a naval analyst at the Center for Strategic and Budgetary Assessments, explained that the Marine Corps wants fire support in a range of 41 to 63 nautical miles with the ultimate goal of 200-plus nautical miles in order to support an MV-22 Osprey insertion. However, challenges remain to reaching this goal.

"Are you going to be able to have a five-inch round that goes 41 to 63 nautical miles?" Work said. "What type of rounds would allow you to fire at a greater range? Also, are there other platforms that you can put the Advanced Gun System on? How would loitering [unmanned aerial vehicles] with small-diameter bombs help you?"

Work suggested that arming UAVs with bombs could be considerably cheaper than firing the AGS.

Naval surface fires are important to Marines to allow naval maneuver.

"When you have naval maneuver and when you are doing naval maneuver close to a coast, being able to be covered by fire is an extreme advantage," Work said. "It's a capability that is useful, but the question you have to ask is, how much do you need and how much are you willing to pay for it? And what is the most cost-effective way to do it?"[91]

September 2008 Press Report on Mix of NSFS Solutions

A September 29, 2008, press report states:

[91] Zachary M. Peterson, "Navy, Marine Corps To Study Naval Surface Fires Requirement Gaps," *Inside the Navy*, September 22, 2008. Words in brackets as in original.

A variety of platforms could end up providing naval surface fires for Marine Corps forces ashore, Vice Adm. Barry McCullough, the Navy's top programmer, told *Inside the Navy* last week....

"I don't think there's going to be one material solution to this mission set, I think it's going to end up being multiple material solutions," McCullough said in a Sept. 24 interview. "I think that's what we need to go after so that we have a variety of platforms that can service those requirements."...

"We remain fully committed to naval surface fires requirements both for the Marine Corps and for the joint force," McCullough said....

"We have looked at putting AGS on the DDG-51 hull and believe that's viable," he said. "Now whether we choose to do that or not, we'll see, but that is a viable alternative."

The LPD-17 amphibious ship has been considered by naval analysts as a possible candidate for AGS as well.

"LPD-17 is a huge ship; we haven't looked at it specifically, but it would seem to me we could probably put it on there," McCullough said when asked about the possibility.

Further, the sea service will continue to pursue an extended range five-inch projectile despite the cancellation of Raytheon's Extended Range Guided Munition (ERGM) program earlier this year due to myriad developmental issues. ERGM was meant to fill the Navy's extended range munition (ERM) requirement for a five-inch precision projectile with an enhanced range and greater accuracy than current munitions.

"We're going to recommence efforts to get at a five-inch extended range projectile," McCullough said last week.

Another option for the surface fires mix the admiral predicts is to use the Non-Line of Sight missile system being developed for the Littoral Combat Ship.

"If you look at the Non-Line of Sight (NLOS) missile system that we put on LCS, that's got a GPS guidance capability and could be used for fires," the three-star admiral suggested. "It currently has a range in excess of 20 miles and while that doesn't meet the current threshold of 41 miles, it's well in excess of our current capability with five-inch projectiles and the net-explosive weight of the projectile and NLOS missile is about the same."

However, despite McCullough's statements defending the Navy's commitment to providing Marines with naval surface fires, some retired Marine officers remain doubtful.

"When provided such specific requirements Navy leaders have acted irresolutely," retired Marine Lt. Gen. Paul Van Riper wrote in a recent e-mail. "In several cases they touted new technologies that never lived up to their promises. I am not convinced that the Navy has been or is serious today about naval surface fire support."

Naval analyst Robert Work, a vice president at the Center for Strategic and Budgetary Assessments, told *ITN* [*Inside the Navy*] recently that surface fires are important to provide for naval maneuver, but questions linger about how much is needed and at what cost.

> "When you have naval maneuver and when you are doing naval maneuver close to a coast, being able to be covered by fire is an extreme advantage," Work said. "It's a capability that is useful, but the question you have to ask is, how much do you need and how much are you willing to pay for it? And what is the most cost-effective way to do it?"[92]

Navy's Selection of DDG-51 to Meet New Requirements

A fourth potential oversight issue for Congress for FY2009 concerned the Navy's selection of the Flight IIA DDG-51 as its preferred ship to procure over the next several years for responding to the changed threat assessment. Potential questions for Congress included the following:

- What options did the Navy examine for modifying the DDG-1000 design so as to improve its capabilities for area-defense AAW, BMD, and blue-water ASW? As discussed in **Appendix D**, such options might include giving the ship an ability to employ the SM-2 missile so as to provide area-defense AAW; removing one or both of the DDG-1000's two AGSs and installing additional missile-launch tubes in their place; equipping the ship with a more powerful radar; and replacing the ship's sonar with one better optimized for blue-water ASW operations. Are such modifications technically feasible, what would they cost, and how would they change DDG-1000 program risks?
- What options did the Navy examine for modifying the Flight IIA DDG-51 design so as to reduce its O&S costs or improve its capabilities for BMD and area-defense AAW? (For a discussion of potential such options, see **Appendix D**.) Are such modifications technically feasible, what would they cost, and how would they change DDG-51 program risks?
- How does the Navy's preferred option of procuring Flight IIA DDG-51s compare with the options of procuring modified DDG-1000s or modified DDG-51s in terms of factors such as overall acquisition cost; life-cycle O&S cost; capabilities provided; technical, cost, and schedule risk; implications (if any) for the CG(X) program; and industrial-base implications? Did the Navy accurately measure and assess all these factors in deciding in favor of procuring Flight IIA DDG-51s?

DDG-1000's Current and Potential Capabilities

Regarding the DDG-1000's ability to fire the SM-2 missile and conduct area-defense AAW operations, to eventually accept the successor SM-6 AAW interceptor, and to be modified to conduct BMD operations using the SM-3 BMD interceptor, a September 2, 2008, press report states:

> The DDG-1000 2004 JROC [Joint Requirements Oversight Council]-approved Operational Requirements Document [ORD] clearly states, "DDX [i.e., DDG-1000] will establish local air superiority using the SM-2 family of Surface to Air Missiles." This capability is included in the requirements and design of the DDG-1000 today, a Raytheon spokesperson tells *Defense Daily*. Overall, at baseline configuration, the Zumwalt [DDG-1000] Dual Band Radar (DBR) has 37 percent better performance than a SPY-1 D [radar on a DDG-51] in a

[92] Zachary M. Peterson, "McCullough: Mix of Solutions For Naval Surface Fires Is Likely," *Inside the Navy*, September 29, 2008.

> blue water AAW environment and 50 percent better performance in a littoral environment, the spokesperson says. "Further, the Zumwalt radar suite is specifically designed for capability growth for the emerging BMD mission. This is achieved by simply 'fully populating' the [DBR] array faces with additional electronics," the spokesperson adds. "The most affordable and quickest path to upgrade to even more superior AAW and BMD is via the completion of the DDG-1000 TSCE-based[93] mission equipment. Our estimate is that it would be about one-quarter the cost of upgrading the DDG-51 system and would result in 200+ percent more capability for BMD."...
>
> "As previously stated, Zumwalt mission equipment was designed to accommodate the SM-2 family of missiles and is therefore easily scalable to accommodate the SM-3 and SM-6," the spokesperson notes. "Traditionally, [the Navy] funds the ships-side of a weapon for the ship-side of the interface and missile-side of the weapon for the missile-side of the interface. Confusion arises when interface changes to the S[M]-2 family of missiles are attributed to the ship-side." The missile interface changes required are known and "costed," the spokesperson adds. "The cost to modify the [SM-2] missile for Zumwalt is approximately four times less than redesigning the DDG-51 radar, C2 and significant HM&E[94] modifications which are represented in the [DDG-51] modernization budgets."...
>
> "The U.S. Navy-initiated technology study, [called] TI-37, concluded in 2003/04 that the SM-6 could be integrated into the TSCE-based mission system at relatively low cost to either the ship system or the missile, due to the flexibility of the DDG-1000 open architecture," the spokesperson says. "In February 2008, a detailed technical paper was presented showing a clear path to the integration of the SM-3 missile into DDG-1000 with only minor changes due to the open architecture flexibility built into the DDG-1000. All of this data was delivered to the [Navy] in a non-proprietary form per the requirements of the DDG-1000 program."[95]

A September 12, 2008, press report relating to potential modified versions of the current DDG-1000 design 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....

[93] This is a reference to the Total Ship Computing Environment (TSCE), the computer system and software for moving information around the DDG-1000.

[94] This is a reference to the ship's basic hull, mechanical, and electrical (HM&E) systems.

[95] Consecutive short items entitled "To Build Or Not To Build," "Standard Missiles," and "Missile Integration," in "Defense Watch," *Defense Daily*, September 2, 2008. The bracketed phrase, "[the Navy]," appears in the original; other bracketed phrases added by CRS.

"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.[96]

[96] 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.

CBO Estimates of Comparative DDG-1000 and DDG-51 Costs

Regarding the question of comparative costs for procuring DDG-1000s or DDG-51s, CBO believes that DDG-1000s will cost about 55% more to build than the Navy estimates. (The substantial difference of opinion between the Navy and CBO on estimated DDG-1000 construction costs has been a major DDG-1000 program oversight issue; for further discussion of the issue, see the section entitled "Accuracy of Navy Cost Estimate" in **Appendix F**.) Using a hypothetical annual procurement rate for DDG-51s that differs from the Navy's proposed profile as shown earlier in **Table 1**, CBO testified at the July 31 hearing that:

> Building the newest generation of destroyers and cruisers—the DDG-1000 Zumwalt class guided-missile destroyer and the CG(X) future cruiser (the intended replacement for the Ticonderoga class guided-missile cruiser)—would probably cost significantly more than the Navy estimates.
>
> Building two DDG-51 Arleigh Burke class destroyers—the class of destroyer currently in use—per year would cost less than building one DDG-1000 per year. Procuring three DDG-51s per year would cost about 35 percent more than buying a single DDG-1000. Counting projected operating costs over a period of 35 years, the total ownership cost of five DDG-1000s would almost equal that of eight DDG-51s.[97]

Table E-1, below, reproduces a table from CBO's July 31 testimony showing CBO's estimates of the comparative costs of procuring DDG-1000s and DDG-51s at certain annual rates. The annual rates shown in the table for procuring DDG-51s differ from the Navy's proposed profile shown earlier in **Table 1**.

Table E-1. CBO Estimates of Costs for Procuring DDG-1000s or DDG-51s

(FY2009-FY2013, in billions of constant FY2009 dollars)

	09	10	11	12	13	Total
DDG-1000 (one per year)[a]	3.7	3.8	3.6	3.7	3.6	18.5
DDG-51 (annual procurement rate starting in FY2010)						
One per year	0.4[b]	2.2	2.3	2.3	2.4	9.6
Two per year	0.4[b]	3.7	3.8	3.9	3.9	15.7
Three per year	0.4[b]	5.1	5.2	5.3	5.4	21.4
Memorandum:						
DDG-1000 (Navy's estimate)	2.5	2.5	2.2	2.3	2.0	11.4

Source: Table reproduced from Statement of Eric J. Labs, Senior Analyst, [on] The Navy's Surface Combatant Programs before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, July 31, 2008, Table 2 on p. 7. The notes below are reproduced from the original table.

Notes: All figures include outfitting and post-delivery costs. The Navy has announced that it will recommend ending the DDG-1000 program at two ships and resume building DDG-51s in 2010.

[97] Statement of Eric J. Labs, Senior Analyst, [on] The Navy's Surface Combatant Programs before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, July 31, 2008, p. 1.

a. Figures exclude amounts needed to pay for potential cost overruns on the first two DDG-1000s.

b. Figure represents an assumption about the costs of restarting the production of DDG-51s.

Navy's Description of DDG-1000 AAW Capabilities

A fifth potential oversight issue for FY2009 concerned Navy information on the question of whether the DDG-1000 can employ the SM-2 (i.e., Standard Missile, version 2) air-defense interceptor missile, and consequently perform area-defense AAW.[98] The Navy testified at the July 31, 2008, hearing that the DDG-1000 cannot successfully employ the SM-2, and consequently cannot perform area-defense AAW. This came as a surprise to observers who have believed for years that the DDG-1000 could employ the SM-2 and perform area-defense AAW. This belief was based in part on the following:

- Navy briefing slides on the DD(X)/DDG-1000 program from 2002 to 2008 have consistently listed the Standard Missile as among the weapons to be carried by the DDG-1000.
- The Navy's designation of the ship in 2006 as DDG-1000 (meaning a guided missile destroyer with hull number 1000) rather than DD-1000 (meaning destroyer with hull number 1000) implied that the ship would have an area-defense AAW capability. For U.S. Navy surface combatants, the use of a "G" (meaning a guided missile ship) in the ship's designation traditionally has meant that the ship was equipped with an area-defense AAW system.

The Navy's FY2009 budget submission contains, in the service's research and development account, a project that appears aimed at making changes to SM-2 Block IIIB missile (the currently used version of the SM-2) so as to integrate the SM-2 Block IIIB with the DDG-1000 combat system. The description of the project states in part that:

> Production representative missiles will be built between FY10 & FY12 for the 21 missiles that the DDG 1000 require for Developmental Test & Operational Test (DT&OT) in FY12 and FY13. SM2 IIIB will have dual use on AEGIS Cruisers/Destroyers & DDG 1000.[99]

As mentioned in the previous section, a September 2, 2008, press report states that:

> The DDG-1000 2004 JROC [Joint Requirements Oversight Council]-approved Operational Requirements Document [ORD] clearly states, "DDX [i.e., DDG-1000] will establish local air superiority using the SM-2 family of Surface to Air Missiles." This capability is included in the requirements and design of the DDG-1000 today, a Raytheon spokesperson tells *Defense Daily*

[98] An area-defense AAW system is capable of defending not only the ship on which it is installed, but other ships in the area as well. An AAW system capable of defending only the ship on which it is installed is referred to as a point-defense AAW system. Area-defense AAW systems generally can intercept aircraft and antis-ship cruise missiles at longer ranges than point-defense AAW systems. U.S. Navy ships need to be able to use the SM-2 interceptor to be considered capable of area-defense AAW operations. Navy ships that can fire only shorter-ranged interceptors, such as the Enhanced Sea Sparrow Missile (ESSM) or the Rolling Airframe Missile (RAM), are considered capable of point-defense AAW operations only.

[99] Source: Description of Project 0439, Standard Missile Improvement, within Program Element (PE) 0604366N, Standard Missile Improvements, in *Department of the Navy Fiscal Year (FY) 2009 Budget Estimates, Justification of Estimates, February 2008, Research, Development, Test & Evaluation, Navy, Budget Activity 5*, R-1 Line Item No 101, Exhibit R-2a, page 5 of 16 (pdf page 417 of 974). See also page 4 of 16 (pdf page 416 of 974).

> "As previously stated, Zumwalt mission equipment was designed to accommodate the SM-2 family of missiles and is therefore easily scalable to accommodate the SM-3 and SM-6," the spokesperson notes. "Traditionally, [the Navy] funds the ships-side of a weapon for the ship-side of the interface and missile-side of the weapon for the missile-side of the interface. Confusion arises when interface changes to the S[M]-2 family of missiles are attributed to the ship-side." The missile interface changes required are known and "costed," the spokesperson adds. "The cost to modify the [SM-2] missile for Zumwalt is approximately four times less than redesigning the DDG-51 radar, C2 and significant HM&E modifications which are represented in the [DDG-51] modernization budgets."... [100]

A September 17, 2008, press report states:

> While DDG-1000 can carry and shoot off the Standard Missile-2 (SM), it can't, as currently configured, communicate with the SM once it is fired, according to a top Navy official.
>
> The inability of DDG-1000 to "talk" with SM-2 is one of several reasons that the ship can't perform area air defense or ballistic missile defense, Vice Adm. Barry McCullough, deputy chief of naval operations for integration of capabilities and resources (N8), told attendees yesterday during a speech to the Surface Navy Association.
>
> The Navy has invested $80 million to develop an X-band communications link so the ship and missile can talk, and the service is evaluating further funding for this effort in Program Objective Memorandum (POM) 10, McCullough said....
>
> One shortcoming of DDG-1000, McCullough mentioned in response to a question, was that while DDG-1000 can carry and launch the SM-2, it can't communicate with the missile once it is in flight.
>
> According to the Navy, DDG-1000 cannot employ SM-2, SM-3 or SM-6, and BMD capability is not included in the ship's Total Ship Computing Environment (TSCE). "Additional Research and Development investment through 2013 would be required for DDG-1000 to have these capabilities."[101]

Potential oversight questions for Congress include the following:

- Was a capability to employ the SM-2 missile, and thus to provide area-defense AAW, ever included in the DDG-1000 design?
- If so, when was this capability removed from the DDG-1000 design, and why? If the capability was removed for cost reasons, what were the savings associated with the decision?
- If a capability to employ the SM-2 missile, and thus to provide area-defense AAW, was never included in the DDG-1000 design, why did Navy briefing slides on the DD(X)/DDG-1000 program from 2002 to 2008 consistently list the Standard Missile as among the weapons to be carried by the DDG-1000, and why was the ship designated in 2006 as DDG-1000 rather than DD-1000? During the

[100] Consecutive short items entitled "To Build Or Not To Build" and "Standard Missiles" in "Defense Watch," *Defense Daily*, September 2, 2008. The bracketed phrase, "[the Navy]," appears in the original; other bracketed phrases added by CRS.

[101] Geoff Fein, "DDG-1000 Lacks Ability To 'Talk' With SM-2, Can't Do Air Defense Mission, Official Says," *Defense Daily*, September 17, 2008: 1-2.

years that the Navy supported continued DDG-1000 procurement and defended the DDG-1000 against various criticisms, did the Navy believe it was advantageous to have others believe, incorrectly, that the ship could fire the SM-2 and provide area-defense AAW?

- If the Navy's intention was to integrate an area-defense AAW missile (either the SM-2 or the planned successor missile, the SM-6) into the DDG-1000 combat system at a later date, should the Navy have noted this in its July 31 testimony?
- What does the DDG-1000 Operational Requirements Document [ORD] state with regard to the ship's ability to use the SM-2 missile?
- What is the status of Project 0439 within PE 0604366N of the Navy's research and development account, which appears aimed at integrating the SM-2 Block IIIB missile into the DDG-1000 combat system? Has the Navy altered the project since the submission of the FY2009 budget in February 2008?

If the Navy at some point mis-described the DDG-1000's AAW capability with regard to employ the SM-2, what implications might that have, if any, regarding the dependability of Navy descriptions of other ship capabilities for the DDG-1000, the DDG-51, or other ships?

As mentioned earlier, in April 2009 testimony, the Navy appeared to back away from its assertion that the DDG-1000 would not have an area-defense AAW capability.

Appendix F. Earlier DDG-1000 Oversight Issues for Congress

This appendix presents some oversight issues for Congress specifically regarding the DDG-1000 program. Prior to the Navy's announcement in late July 2008 that it wanted to stop DDG-1000 procurement at two ships and restart DDG-51 procurement, these and other DDG-1000 program oversight issues were presented in the main body of this CRS report.

Accuracy of Navy Cost Estimate

One potential oversight issue for Congress specific to the DDG-1000 program concerns the accuracy of the Navy's cost estimate for the program.

CBO July 2008 Testimony

The Congressional Budget Office (CBO) believes that the Navy is significantly underestimating DDG-1000 procurement costs. Consistent with previous CBO testimony and reports, CBO testified at the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee that it believes DDG-1000s will each cost about 55% more than the Navy estimates. CBO testified that:

> The Navy had planned to buy one DDG-1000 Zumwalt class destroyer each year between 2009 and 2013, in addition to the two authorized in 2007. The service's 2009 budget suggests that the Navy expected the first two ships to cost $3.2 billion each [in constant FY2009 dollars] and the next five to cost an average of $2.3 billion each [in constant FY2009 dollars]—reflecting an increase of about $200 million per ship for the last five ships compared with the costs projected in the Navy's 2008 budget. CBO, by contrast, estimates that the first two DDG-1000s would cost about $5.0 billion apiece [in constant FY2009 dollars] and that the next five would have cost an average of $3.6 billion each [in constant FY2009 dollars].
>
> The Navy's cost goals and estimates for the DDG-1000 program and its predecessors, the DD(X) and DD-21, have increased several times since 1996 ... ; further growth in the ship's cost is likely. The Navy's current estimate for the two lead-ship DDG-1000s prices the ship at about $250 million [in constant FY2009 dollars] per thousand tons of lightship displacement (the weight of the ship minus its crew, materiel, weapons, or fuel). By contrast, the lead ship of the DDG-51 Arleigh Burke class destroyer cost about $390 million [in constant FY 2009 dollars] per thousand tons, and the lead ship of the Ticonderoga class cruiser cost more than $400 million [in constant FY2009 dollars] per thousand tons.... CBO used the DDG-51 lead-ship cost as its basis for estimating the cost of the lead ship of the DDG-1000 class, adjusting for the size of the ship.
>
> The Navy has asserted that the basis for CBO's estimate may not be valid because the DDG-51 had a number of problems in the early stages of its construction that should not be expected to occur during the construction of the first DDG-1000s. Specifically, the design of the lead DDG-51 was disrupted and delayed because a new design tool being used at the time was incomplete and not well understood. It had to be abandoned and the design restarted using more traditional methods. The design of the lead DDG-51 was thus about 20 percent complete when construction began. By contrast, according to the Navy, the design of the DDG-1000 progressed far more smoothly; the Navy expects to have the design 85

percent complete when construction begins this summer. In addition, because the DDG-51 is a smaller, more compact ship, the Navy believes that, on a ton-for-ton basis, it has been more difficult to build than the DDG-1000 class is designed to be. (The more open internal spaces of the DDG-1000 mean that it would not be as difficult to install piping, wiring, and other components, and, thus, on a ton-for-ton basis, it should be less time-consuming, and therefore less expensive, to build than a DDG-51.)

Although the Navy may not encounter the same problems constructing the lead DDG-1000s that it did when constructing the lead DDG-51, CBO expects that the service will encounter other problems that will increase the costs of the DDG-1000 and delay its construction. As Navy officials have stated, lead ships are often very difficult to build, and many problems typically occur during construction. Problems with the first littoral combat ships (for which costs doubled) and with the lead ship of the LPD-17 class amphibious transport dock (for which costs increased by 80 percent and construction time more than doubled) illustrate the difficulties the Navy has encountered recently in constructing lead ships. Both the LCS and the LPD-17 are much less complex technologically than the DDG-1000 will be. In addition, while the designs of the littoral combat ships and DDG-51 were 20 percent to 30 percent complete at the start of fabrication, the design of the LPD-17 was about 80 percent complete at the start of fabrication—and it was arguably the Navy's most troubled lead-ship program over the past 20 years. Experience with the Virginia class submarine program raises similar concerns. Recently, Navy officials stated in testimony before the Congress that, when construction of those new submarines began, the Virginia class program was at about the same point in its design that the DDG-1000 will be. The cost of the first two ships of the Virginia class exceeded their budget by an average of 17 percent.

Moreover, the DDG-1000 program is incorporating 10 major new technologies in the lead ship of the class that are intended to improve on technologies used in the previous-generation DDG-51 destroyer. Those technologies include electric drive and a distributed power system, a tumblehome hull (one in which the sides of the ship slope outward to increase stealthiness), an advanced gun system, new radars, and composite materials and stealth-enhancing coatings for the deckhouse. In the past, the Navy typically introduced three or four major new technologies into a new class of surface combatant.

A comparison of the Navy's estimate for two additional DDG-51s and its estimate for the seventh DDG-1000, which was slated to be purchased in 2013, illustrates the risk for cost growth in the latter program. In information recently provided to the Chairman of the Subcommittee on Seapower of the Senate Armed Services Committee, the Navy stated that if the Congress authorized the purchase of two new DDG-51s in 2009—ships that would benefit from lessons learned during the construction of 62 similar ships—the cost would be about $3.3 billion, or slightly less than $1.7 billion each. At the same time, in its fiscal year 2009 budget submission to the Congress, the Navy stated that the cost to build the seventh DDG-1000 in 2013 would be about $2.4 billion in 2013 dollars. Deflating the cost of the seventh DDG-1000 using the inflation index for shipbuilding that the Navy provided to CBO brings the Navy's estimate for that ship to about $1.9 billion [in constant FY2009 dollars] (excluding outfitting and postdelivery costs). The lightship displacement of the DDG-1000 is about 5,000 tons (or more than 50 percent) greater than that of the DDG-51s being constructed today. In effect, the Navy's estimates imply that those 5,000 extra tons, as well as the 10 new technologies being incorporated in the DDG-1000 class, will increase the ship's cost by only $200 million, or about 10 percent.

If CBO's cost estimates for the lead DDG-1000s are realized—CBO's estimate is about 55 percent higher than the Navy's for the cost of procuring the first two DDG-1000s—the lead ships of the DDG-1000 program would still experience lower cost growth than the Navy's other lead-ship programs did over the past 20 years. According to an analysis conducted in 2006 by the Department of Defense's Cost Analysis Improvement Group, commonly known

> as the CAIG, five of eight lead-ship programs experienced cost growth of over 60 percent. The CAIG's analysis at the time did not include the Virginia class submarine program, the first two ships of which experienced cost growth of 11 percent and 25 percent. (Those ships were built under a teaming arrangement and assembled in two different shipyards). The analysis also did not include the first two littoral combat ships, which have experienced cost growth of about 100 percent.[102]

GAO July 2008 Testimony and Report

The Government Accountability office (GAO) similarly believes that cost growth in the DDG-1000 program is likely. GAO testified at the July 31, 2008, hearing that:

> Costs of the DDG 1000 ships are likely to exceed current budgets. If costs grow during lead ship construction due to technology, design, and construction risks, as experience shows is likely, remaining funds may not be sufficient to buy key components and pay for other work not yet under contract.
>
> Despite a significant investment in the lead ships, the remaining budget is likely insufficient to pay for all the effort necessary to make the ships operational. The Navy estimates a total shipbuilding budget of $6.3 billion for the lead ships. Of this amount, the Navy has approximately $363 million remaining in unobligated funds to cover its outstanding costs and to manage any cost growth for the two lead ships, but known obligations for the lead ships, assuming no cost growth during construction, range from $349 million to $852 million....
>
> The main discrepancy is the current estimated cost of the combat systems. In order to create a cash reserve to pay for any cost increases that may occur during construction of the lead ships, the Navy has deferred contracting and funding work associated with conducting shipboard testing of the combat systems—and in some cases has also delayed purchasing and installing essential ship systems until later in the construction sequence. The Navy has estimated the cost of these combat systems to be around $200 million, while the contractor's estimate is over $760 million. If the agreed-on cost approaches the contractor's estimate, the Navy will not have enough in its remaining funds to cover the cost.
>
> There is little margin in the budget to pay for any unknown cost. To ensure that there was enough funding available in the budget to cover the costs of building the lead ships, the Navy negotiated contracts with the shipbuilders that shifted costs or removed planned work from the scope of lead ship construction and reduced the risk contingency in the shipbuilders' initial proposals. For example, the Navy stated that it shifted in excess of $100 million associated with fabrication of the peripheral vertical launch system from the scope of ship construction and funded this work separately using research and development funding. As a result, this work is no longer included in the $6.3 billion end cost to construct DDG 1000.
>
> To the extent that the lead ships experience cost growth beyond what is already known, more funding will be needed to produce operational ships. However, these problems will not surface until well after the shipyards have begun construction of the lead ships. Cost growth during construction for lead ships has historically been about 27 percent, and an independent estimate by the Department of Defense already projects the cost of the two lead ships to be

[102] Statement of Eric J. Labs, Senior Analyst, [on] The Navy's Surface Combatant Programs, before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, July 31, 2008, pp. 3-6. For an example of an earlier CBO report with a similar passage, see Congressional Budget Office, *Resource Implications of the Navy's Fiscal Year 2009 Shipbuilding Plan June 9, 2008*, pp. 20-23.

> $878 million higher than the Navy's budget. With ships as expensive as DDG 1000, even a small percentage of cost growth could lead to the need for hundreds of millions of dollars in additional funding.[103]

GAO's testimony at the July 31, 2008, hearing was based on a longer GAO report on the DDG-1000 program that was released on the day of the hearing.[104]

GAO July 2007 Testimony

Although the Navy publicly stands by its DDG-1000 cost estimates, the Government Accountability Office (GAO) testified in July 2007 that the Navy had assigned a confidence level of about 45% to its own estimates, meaning that the Navy itself believed there was about a 55% chance that DDG-1000s will exceed the Navy's estimates. GAO testified that:

> One way to improve the cost-estimating process is to present a confidence level for each estimate, based on risk and uncertainty analyses. By conducting an uncertainty analysis that measures the probability of cost growth, the Navy can identify a level of confidence for its estimates and determine whether program costs are realistically achievable. Navy cost analysts told us that they used quantitative risk analyses to test the validity of cost estimates of CVN 78 and DDG 1000. We believe that the Navy and the Department of Defense (DOD) should take this a step further—requiring a high confidence level threshold when making program commitments and budget requests. The Defense Acquisition Performance Assessment Panel recommended an 80 percent confidence level, meaning that a program has an 80 percent chance of achieving its estimated costs. Whether this is the right level warrants thoughtful discussion, but it is worth noting that analyses for CVN 78 and DDG 1000 were well below an 80 percent confidence level (in the case of DDG 1000 at around 45 percent)—increasing the likelihood that costs will grow above budget.[105]

GAO's July 2007 testimony was presented while Congress was considering the Navy's proposed FY2008 budget. In its proposed FY2009 budget, the Navy has increased its estimate of DDG-1000 procurement costs by about 6.9%.[106] In light of this increase, it is possible that the Navy's confidence level has increased from 45% to some higher figure.

October 2007 Press Report on CAIG Estimate

On October 1, 2007, it was reported that the Cost Analysis Improvement Group (CAIG), a cost-estimating office within the Office of the Secretary of Defense, had estimated that the first two

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[103] Government Accountability Office, *Defense Acquisitions[:] Zumwalt-Class Destroyer Program Emblematic of Challenges Facing Navy Shipbuilding*, Statement of Paul L. Francis, Director Acquisition and Sourcing Management, Testimony Before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives, July 31, 2008 (GAO-08-1061T), pp. 6-8.

[104] Government Accountability Office, *Defense Acquisitions[:] Cost to Deliver Zumwalt-Class Destroyers Likely to Exceed Budget*, GAO-08-804, July 2008. 56 pp.

[105] Government Accountability Office, *Defense Acquisitions[:] Realistic Business Cases Needed to Execute Navy Shipbuilding Programs, Statement of Paul L. Francis, Director, Acquisition and Sourcing Management Team, Testimony Before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives*, July 24, 2007 (GAO-07-943T), pp. 17-18.

[106] Under the FY2008 shipbuilding plan, the Navy estimated the combined end cost of the seven DDG-1000s at $18,185 million in then-year dollars; under the FY2009 shipbuilding plan, the Navy estimates their combined end cost at $19,136 million in then-year dollars. There is no change in the years in which the ships are to be procured.

DDG-1000s would together cost about $7.2 billion to procure, or about 14% more than the Navy's combined estimate for the two ships in 2007.[107]

Program Affordability and Cost Effectiveness

A second potential oversight issue for Congress specific to the DDG-1000 program concerns the affordability and cost effectiveness of the DDG-1000 program.

Prior to the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee, the affordability and cost-effectiveness of the DDG-1000 program was explored extensively at a two-part hearing on the DDG-1000 program held on July 19 and 20, 2005, before the Projection Forces subcommittee of the House Armed Services Committee. At the end of the July 19 portion of the hearing, DOD and Navy witnesses were asked by the subcommittee chairman, Representative Roscoe Bartlett, to provide the subcommittee with their own individual views on the procurement cost figures at which the lead DDG-1000 and a follow-on DDG-1000 (defined as the fifth ship) would become unaffordable. At the beginning of the July 20 portion of the hearing, Representative Bartlett stated that the figures provided by the witnesses ranged from $4 billion to $4.5 billion for the lead ship and $2.5 billion to $2.9 billion for the fifth ship. The Navy's current cost estimates for the first and fifth DDG-1000s are below these figures; CBO's current cost estimates for the first and fifth DDG-1000s are substantially above these figures.

Technical Risk

A third potential oversight issue for Congress specific to the DDG-1000 program concerns technical risk in the program, which can affect the Navy's ability to build DDG-1000s on schedule and within budgeted costs. Over the past several years, GAO has reported on the technical risks involved in developing the several significant new technologies that are to be incorporated into the DDG-1000. The Navy over the years has worked to retire these risks. GAO testified at the July 31, 2008, hearing on destroyer procurement before the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee that:

> The DDG 1000 program has from the onset faced a steep challenge framed by demanding mission requirements, stealth characteristics, and a desire to reduce manning levels by more than half that of predecessor destroyers. These requirements translated into significant technical and design challenges. Rather than introducing three or four new technologies (as is the case on previous surface combatants), DDG 1000 plans to use a revolutionary hull form and employ 11 cutting-edge technologies, including an array of weapons, highly capable sensors integrated into the sides of a deckhouse made primarily of composite material—not steel, and a power system designed for advanced propulsion as well as high-powered combat systems and ship service loads. This level of sophistication has necessitated a large software development effort—14 million to 16 million lines of code. All of this is to be accomplished while splitting construction between two shipyards. The Navy believes this approach and schedule is important to managing shipyard workloads, as starting later would have caused shipyard workload to drop too low. In a sense, then, the construction approach

[107] "Sticker Price," *Defense Daily*, October 1, 2007. See also Christopher P. Cavas, "DDG 1000 Contract Talks Hit Rough Seas," *DefenseNews.com*, October 15, 2007, which refers to "a recent non-Navy estimate" of $7.2 billion for the two ships.

and schedule became an additional challenge as they became constraints on the pace of technology and design development. To meet these multiple and somewhat conflicting demands, the Navy structured its acquisition strategy to develop key systems and mature the design before starting to build the ship. While the Navy has made good decisions along the way to address risk, it is already likely, shortly before the Navy embarks on ship construction, that additional funding will be necessary or trade-offs will need to be made to develop and deliver DDG 1000 ships.

Despite multiple and somewhat competing demands, the Navy conceived a thoughtful approach and achieved developmental successes on DDG 1000. Developing 10 prototypes of the ship's critical systems helped to create confidence that a number of technologies would operate as intended, and the Navy's plan to mature the ship's design before starting construction aims to reduce the risk of costly design changes after steel has been cut and bulkheads built. For example, the Navy successfully demonstrated the advanced gun system through initial guided flight and testing on land. In other cases, such as for the integrated power system, tests brought to light technical problems, which the Navy was able to address by going to an alternate technology. However, notwithstanding these efforts, significant challenges remain in developing the ship's design and a number of key components—in particular, the deckhouse, volume search radar, and the integrated power system. Moreover, the ship's capability is contingent on an unprecedented software development effort. Recently, the Navy restructured the schedule to buy more time for development—a good decision. However, as construction of the first ship has not yet begun, the Navy may have exhausted its options for solving future problems without adding money and time.

Although the initial phases of the design are complete, the shipbuilders will be pressed to complete a large amount of design work by October 2008 when lead ship construction begins. From August 2007 through May 2008, the shipbuilders finished work on 16 of the 100 design zones (individual units that make up the ship's design) leaving 5 months to finish the final design phases in 84 zones leading up to the start of construction. While the shipbuilders believe they can finish the design by the start of ship construction, delays in the development of the ship's key systems could impede completion of the design and eventually interfere with DDG 1000 construction. If the shipbuilders cannot finish planned design work prior to the start of lead-ship construction, the program is at greater risk for costly rework and out-of-sequence work during construction.

To maintain the start of ship construction in 2008 while continuing to develop the ship's technologies, the Navy recently realigned the program's schedule. Rather than delivering a fully mission-capable ship, the Navy will take ownership of just the vessel and its mechanical and electrical systems—including the ship's power system—in April 2013. At that point, the Navy plans to have completed "light-off" of the power, mechanical, and electrical systems. Light-off refers to activating and testing these systems aboard ship. The Navy deferred light-off of the combat systems—which include the radars, guns, and the missile launch systems—by over 2 years until May 2013. According to the Navy, conducting light-off in phases allows the program to test and verify the ship's major systems, in particular the integrated power system, in isolation and creates additional time to mature the combat systems, as well as the software that supports these systems, before ship installation and shipboard testing. However, since the Navy will only test and inspect the hull prior to taking ownership of the vessel, it will not have a full understanding of how the ship operates as a complete and integrated system until after final shipboard testing of the combat systems in 2014.

While the restructure maintains the construction schedule, it does delay verifying the performance of the integrated power system before producing and installing it on the ship. Tests of a complete integrated power system with the control system will not occur until 2011—nearly 3 years later than planned. To meet the shipyard's schedule, the Navy will buy

a power system intended for the third ship and use it in land-based tests. As a result, the integrated power system will not be demonstrated until a year after the power systems have been produced and installed on the two lead ships—an approach that increases exposure to cost and schedule risk in production.

Finalizing deckhouse manufacturing and assembly processes are essential to constructing and delivering the deckhouse as planned. Changes to the manufacturing processes for deckhouse production are ongoing. The shipbuilder is validating process changes through production and inspection of a series of test units, culminating with a large-scale prototype manufactured to the same thickness and other specifications of the deckhouse. Final validation of the manufacturing processes for deckhouse construction will not occur until after construction, inspection, and shock testing of the large-scale prototype. However, test and inspection activities are not scheduled for completion until after the deckhouse production readiness review in September 2008. Problems discovered during testing and inspection may require additional changes to manufacturing methods. Moreover, facility and machinery upgrades necessary to construct and assemble the deckhouse are not all scheduled to be complete until March 2010—over a year after the start of construction of the first deckhouse. While the shipbuilder expects to complete efforts to meet the construction schedule, if difficulties occur, the deckhouses may not be delivered to the shipyards on time, disrupting the construction sequence of the ships.

Further, the volume search radar (one of two radars in the dual band radar system) will not be installed during deckhouse construction as initially planned. Instead, installation will occur at the shipyard when the first ship is already afloat, a more costly approach. The change was partly due to delays in developing the volume search radar. Land-based demonstrations of the volume search radar prototype originally planned to be done before starting ship construction will not be completed until 2009—almost 2 years later. Development difficulties center on the radar's radome and transmit-receive units. The contractor has been unable to successfully manufacture the radome (a composite shield of exceptional size and complexity), and the transmit-receive units (the radar's individual radiating elements) have experienced failures operating at the voltage needed to meet range requirements. While the Navy believes that the voltage problem has been resolved, upcoming land-based tests will be conducted at a lower voltage—and without the radome. The Navy will not demonstrate a fully capable radar at its required power output until after testing of the first production unit sometime before combat systems light-off in 2013.

Crucial to realizing DDG 1000's required manning reductions is the ability to achieve a high degree of computer automation. If the ship's software does not work as intended, crew size would need to be increased to make up for any lack of automation. Given the risks associated with the ship's software system, referred to as the total ship computing environment, the Navy initially planned to develop and demonstrate all software functionality (phased over six releases and one spiral) over 1 year before ship light-off. As a result of changes in the software development schedule, the Navy eliminated this margin. Until recently, the Navy was able to keep pace with its development schedule, successfully completing the first three software releases. However, the Navy is now entering the complex phases of software development when ship functionality is introduced. The Navy certified release 4 without the release meeting about half of the software system requirements, mainly because of issues coding the ship's command and control component—the heart of the ship's decision-making suite. Problems discovered in this release, coupled with the deferred work, may signify larger software issues that could disrupt the development of releases 5 and 6 and prevent the timely delivery of software to meet the ship's schedule.[108]

[108] Government Accountability Office, *Defense Acquisitions[:] Zumwalt-Class Destroyer Program Emblematic of* (continued...)

GAO's testimony at the July 31, 2008, hearing was based on a longer GAO report on the DDG-1000 program that was released on the day of the hearing.[109]

As individual DDG-1000 technologies mature, technical risk in the DDG-1000 program will shift more to the follow-on task of system integration—of getting all ship's technologies to work together smoothly in a single platform. In past defense acquisition programs, system integration has often proven to be at least as challenging as the task of developing individual new technologies.

As mentioned in the "Background" Section, the Navy since September 30, 2005, has been acting as the system integrator for the DDG-1000 program. Problems in the execution of the Coast Guard Deepwater program[110] and the Littoral Combat Ship (LCS) program led to a reexamination in Congress in 2007 of the concept of the private-sector lead system integrator (LSI), and to a desire among some Members to shift certain acquisition functions, including system design and integration, from the private sector, to where they had migrated starting in the 1990s, back to the federal government. The Navy's decision in 2005 to begin acting as the system integrator for the DDG-1000 program will make the program an early test of DOD's ability to once again perform the system-integration function following the downsizing of DOD's technical and acquisition workforce that occurred when acquisition functions were earlier transferred to the private sector. The DDG-1000 program, in addition to being an early test of DOD's abilities in this area, may represent a fairly challenging test, given the number of significant new technologies that are to be integrated into the ship.

In discussing the system-integration task, Navy officials argue that the DDG-1000 program office has the authority and resources to access technical capacity throughout the Navy, including expertise at Navy research, development, and testing centers in various parts of the country. Navy officials also argue that the engineering development models (EDMs) that it has used to develop key technologies for the DDG-1000 have been designed not only to develop the ability of each technology to work as a stand-alone item, but also to integrate well with other systems when installed on the ship. Navy officials also argue that since its beginning in the 1980s, the Navy has been responsible for managing a large number of contractors who make various components of the DDG-51 (including the Aegis combat system) that are then provided by the Navy to the shipbuilders as government-furnished equipment (GFE). By comparison, Navy officials argue, the task of overseeing the integration of the DDG-100 combat system will require the Navy to work with only two contractors (Raytheon and BAE).[111]

(...continued)

Challenges Facing Navy Shipbuilding, Statement of Paul L. Francis, Director Acquisition and Sourcing Management, Testimony Before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives, July 31, 2008 (GAO-08-1061T), pp. 3-6.

[109] Government Accountability Office, *Defense Acquisitions[:] Cost to Deliver Zumwalt-Class Destroyers Likely to Exceed Budget*, GAO-08-804, July 2008. 56 pp.

[110] For additional discussion of the Deepwater program, see CRS Report RL33753, *Coast Guard Deepwater Acquisition Programs: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke.

[111] Source: Navy briefing to CRS and CBO on April 10, 2008.

DDG-1000 Mission Requirements

A fourth potential oversight issue for Congress specific to the DDG-1000 program concerns the ship's mission requirements, and whether they were appropriately determined, particularly in the context of potential ship affordability.

The DDG-1000's capabilities reflect an Operational Requirements Document (ORD) for the DDG-1000 that was approved by the Joint Staff of DOD in February 2004. Key performance parameters included in this document include having two AGSs that can each fire 10 rounds per minute, for a total of 20 rounds per minute.[112] DOD stated in 2005 that

> During the restructuring of the DD-21 program into the DD(X) program, the Navy re-evaluated each DD-21 Key Performance Parameter (KPP) to determine the potential for minimizing the size of the ship and ultimately the cost. The Navy made many adjustments and the resulting DD(X) KPPs represent the Navy's minimum requirements. No other known alternative meets all of the DD(X) KPPs and provide the sustained, precision, long-range naval surface fire support that the United States Marine Corps requires.[113]

Some observers speculate that the Navy and DOD established requirements for the DDG-1000 without a full appreciation of how large and expensive a ship design the requirements would generate. Naval analyst Norman Friedman, the author of numerous books on U.S. warship designs, stated in a 2004 book on U.S. destroyer designs that

> In past [Navy ship design] practice, the naval policymakers in OpNav [the Office of the Chief of Naval Operations] would write a draft set of [ship] characteristics.... The Preliminary Design branch of BuShips [the Bureau of Ships] or NAVSEA [the Naval Sea Systems Command] would develop sketch designs to meet the requirements. Often the OpNav policymakers would find the results outrageous—for example, exorbitantly expensive. Such results would force them to decide just how important their various requests had been. Eventually Preliminary Design would produce something OpNav found acceptable, but that might not actually be built....
>
> In contrast to past practice, no preliminary design [for the DDG-1000] was drawn up to test the cost of various requirements. Each requirement was justified in operational terms, (e.g., a level of stealth that would reduce detectability by some percentage); but those sponsoring the ship had no way of knowing the impact that a particular combination of such requirements would have. Normally NAVSEA would have created a series of sketch designs for exactly that purpose.[114]

An August 2005 trade press article suggested that growth in DD-21/DDG-1000 requirements (and cost) over time may have been related to the disestablishment of a Navy ship-design board called the Ship Characteristics Improvement Board (SCIB)—an entity that Admiral Michael Mullen, who became the Chief of Naval Operations on July 22, 2005, reestablished under a new name:

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[112] Statement by The Honorable Kenneth J. Krieg, Under Secretary of Defense (Acquisition, Technology and Logistics), Before the Subcommittee on Projection Forces, House Armed Services Committee, United States House of Representatives, July, 19, 2005, p. 2.

[113] Ibid, pp. 6-7.

[114] Norman Friedman, *U.S. Destroyers, An Illustrated Design History, Revised Edition.* Annapolis, Naval Institute Press, 2004, pp. 437 and 447-448. Punctuation as in the original.

> Adm. Michael Mullen, the chief of naval operations, has directed the Navy to re-establish a high-level panel to closely monitor and control the requirements and configurations of new ships in a bid to rein in the skyrocketing cost of new vessel procurement.
>
> Adm. Robert Willard, vice chief of naval operations, is leading the effort as part of a larger undertaking to draw up alternative options for the Navy's current shipbuilding program....
>
> In essence, sources said, Mullen is looking to reconstitute the Ship Characteristics Improvement Board, which eventually became inactive in 2002. For more than 100 years, the Navy has maintained a high-level group of officials to advise service leaders on ship design and configuration. This group, established in 1900 as the General Board has gone through many name changes, including the Ship Characteristics and Improvement Board in the early 1980s and, until 2002, the Ship Characteristics and Improvement Panel.
>
> Navy officials say that the panel's oversight began to wane in the late 1990s, just as the DD-21 program—originally envisioned as a $750 million replacement for Spruance-class destroyers—took off, before becoming officially inactive in 2002. Requirements during this time were added to the new destroyer program, some of which raised eyebrows in the Navy, such as the need for a flag officer quarters. No other ship in that class has accommodations for an admiral. Still, the DDG-1000 has come to be regarded as a technology carrier for future surface ships and the price tag has ballooned to $3 billion a copy.
>
> Mullen's goal, spelled out in a July 25 memo to Willard and provided to *InsideDefense.com*, is to put in place a "process that adequately defines warship requirements and manages changes to those requirements (e.g. Ship Characteristics Improvement Board) in a disciplined manner, with cost and configuration control as the paramount considerations."...
>
> A recent RAND study conducted at the request of Mullen's predecessor, retired Adm. Vern Clark, concluded that a key cause for climbing ship costs is the number of requirements tacked on to a program, according to a consultant familiar with the findings of the study, which has not been made public.
>
> "So, what I think Mullen has in the back of his head is, 'I've got to get the requirements process for ships back under control or we're always going to end up, every time we talk about a new destroyer, with a $3 billion ship,'" said a former senior Navy official.
>
> This senior official, who was in a key Pentagon position as the DD-21 program commenced, said that without a panel overseeing the ship's configuration and true requirements the new destroyer program became weighed down with capabilities that carried a high price tag.
>
> "In hindsight, we realized that we had put requirements on the ship that no one had really vetted for its cost impact on the ship. For example, it was to operate acoustically silent and risk free in minefields," said the official. "If the SCIB had existed, this probably would not have happened."[115]

A March 2007 report from the Center for Strategic and Budgetary Assessments (CSBA) made a similar point:

> For nearly a century, the Navy's SCIB—a group of high-ranking DoN [Department of the Navy] officials—worked to balance desired warship warfighting requirements against their

[115] Jason Sherman, "Mullen To Bring Back Panel To Control Ship Configuration, Cost," *Inside the Navy*, August 8, 2005.

> impact on a ship's final design and production costs. The primary reason why the Navy lost cost control over the DD-21/DD(X)/DDG-1000 was that just as the ship entered its design definition phase, the power of the Navy's SCIB was waning, replaced by a Joint requirements definition process with no fiscal checks and balances.[116]

Some observers, such as Norman Friedman, have raised questions about the Navy's decision to use a tumblehome (i.e., inward-sloping) hull for the DDG-1000. A 2006 magazine article by Friedman, for example,

- raised questions about the implications of a tumblehome hull for the ship's ability to deal with underwater damage;[117]
- asked whether the Navy knew at the outset of the DDG-1000 design process how much a decision to incorporate a tumblehome hull (and other survivability features) would increase the size of the ship; and
- questioned whether the reduced visibility of the tumblehome hull to certain types of radars—the central reason for using a tumblehome hull—will be negated by its visibility to high-frequency (HF) surface wave radars that are now for sale on the international market.

The article, which refers to the DDG-1000 by the previous designation DD(X), stated:

> In the case of the DD(X), the overriding requirement [in determining the hull design] was to minimise radar cross section—stealth. Much of the hull design was dictated by the attempt to reflect radar pulses away from the radar emitting them, so that radar returns would be minimised. By now the main technique is well known: slope all flat surfaces and eliminate the corner reflector created by the juncture of the hull and water....
>
> If the ship could be stabilized sufficiently [against rolling from side to side], then she would never (or almost never) present any vertical surfaces [to a radar]. In the case of DD(X), stabilization is apparently achieved using ballast tanks. Such tanks in turn demand internal volume deep in the ship. Overall, stealth demands that as much as possible of the overall volume of the ship be buried in her hull, where the shape of the ship can minimise radar returns. That is why, paradoxically, a carefully-designed stealthy ship will be considerably larger—for more internal volume—than a less stealthy and more conventional equivalent. In the case of DD(X), there were also demands for improved survivability. The demand for stealth implied that anti-ship missiles were the most important envisaged threat. They hit above water, so an important survivability feature would be to put as much of the ship's vitals as possible below water—which meant greater demands for underwater volume....
>
> Once the tumblehome hull had been chosen, [the ship's designers] were apparently also constrained to slope the bow back [creating a surface-piercing or ram bow] instead of, as is usual, forward....

[116] Robert Work, *Know When To Hold 'Em, Know When To Fold 'Em: Thinking About Navy Plans For The Future Surface Battle Line*, Washington, Center For Strategic and Budgetary Assessments, 2007. p. 6. (CSBA Backgrounder, March 7, 2007.)

[117] Other observers have also expressed concerns about the stability of the DDG-1000's tumblehome hull in certain see conditions. For a discussion, see Christopher P. Cavas, "Is New U.S. Destroyer Unstable?," *DefenseNews.com*, April 2, 2007.

There were numerous reasons why [past] naval architects abandoned tumblehome hulls and ram bows. Tumblehome reduces a ship's ability to deal with underwater damage. When a conventional flared (outward-sloping) hull sinks deeper in the water, its waterplane area [the cross-section of the ship where it intersects the plane of the water] increases. It becomes somewhat more stable, and it takes more water to sink it deeper into the water. Because the waterplane area of a tumblehome ship *decreases* as it draws more water, such a ship is easier to sink deeper. Tumblehome also apparently makes a ship less stable, and hence less capable of resisting extreme weather conditions. The larger the ship, the more extreme the weather has to be to make that critical. Critics of DD(X) have concentrated on the danger; defenders have concentrated on how extreme the critical weather condition would be.

In the end, whether the DD(X) hull form is attractive depends on an evaluation of anti-radar stealth as a design driver. About a decade ago, the DD(X) design concept was sold on the basis of a lengthy (and, incidentally, unclassified) analysis, the gist of which was that a heavily-armed surface combatant could play a decisive role in a Korean scenario...

The key analytic point... was that it would be very important for the ship to come reasonably close to enemy shores unobserved. That in turn meant anti-radar stealth. However, it soon came to mean a particular kind of anti-radar performance, against centimetric-wave radars [radars with wavelengths on the order of centimeters] of the sort used by patrol aircraft (the ship would fire [its weapons] from beyond the usual horizons of shore-based radars). As it happens, anti-ship missiles use much the same kinds of radars as patrolling aircraft, so it could be argued that the same anti-radar techniques would be effective in the end-game in which missiles would approach the ship....

Without access to files of the time, it is impossible to say whether those approving the [DDG-1000] project realised that its stealth and survivability characteristics would produce a 14,000 to 17,000 ton destroyer. About the same time that DD(X) characteristics (requirements) were being approved, the decision was taken at [the] Defense Department (not Navy) level that there would be no internal feasibility design. In the past, the feasibility stage had the very useful role of showing those setting requirements what their implications would be. At the very least, the Navy's senior leadership would have been given warning that they would have to justify a drastic jump in destroyer size when they wanted to build DD(X). That jump might well have been considered justified, but on the other hand the leadership might also have asked whether a somewhat less dramatic approach would have been acceptable.

About a decade after the requirements were chosen, with DD(X) well advanced, the situation with regard to stealth may be changing. Shaping is relevant only at relatively short [radar] wavelengths. For about a quarter-century, there has been talk of HF surface wave radars, which operate at wavelengths of about 10 to 200 meters—i.e. at wavelengths the size of a ship. Canada currently operates this type of radar, made by Raytheon, for surveillance of the Grand Banks; another is being tested in the Caribbean. Australia has bought this kind of radar to fill gaps in over-the-horizon radar coverage. Turkey is buying such radars for sale for some years. In 2005 it was reported unofficially that China had bought [a] Russian HF surface wave radar the previous year.

It seems almost certain that HF surface wave radar can defeat any kind of stealth shaping designed primarily to deal with shorter-wave[length] radars. Moreover, [HF surface wave] radars have an inherent maximum range (due to the way they operate) of about 180nm.... At long range [the radar's beam] is not nearly accurate enough to aim a missile. However, we can easily imagine a netted system which would use the long-range [HF surface wave] radar to define a small box within which the target ship would be. A missile with GPS [Global Positioning System] guidance could be flown to that box, ordered to search it....

> If the argument given here is realistic, then the considerable sacrifices inherent in the DD(X) design no longer seem nearly as attractive. It can still be argued that a design like the DD(X) is attractive well out to sea, beyond the reach of coastal radars. In that case, however, there may be other signatures which can be exploited. For example, ships proceeding at any speed create massive wakes.... it is clear that the wake produces a radar return very visible from an airplane or, probably, from a space-based radar....
>
> In the end, then, how much is stealth worth? As a way of avoiding detection altogether, probably less than imagined. That leaves the rather important end-game, the hope being that decoys of some sort greatly exceed actual ship radar cross-section. That is probably not a foolish hope, but it does not require the sort of treatment reflected in [the] DD(X).
>
> Now, it may be that the Untied States typically faces countries which have not had the sense to buy anti-stealth radars (though we would hate to bet on that). In that case, DD(X) may well be effectively invisible to them. So will a lot of less thoroughly stealthy ships.[118]

An October 6, 2008, press report stated that:

> Another blow was struck last month to the U.S. Navy's embattled DDG 1000 Zumwalt-class advanced destroyer program when a top-level Pentagon review board agreed to eliminate the operational requirements for the ship.
>
> No official decision was reached during the Sept. 18 meeting of the Joint Requirements Oversight Council (JROC), but uniformed sources said a memorandum was drafted to reflect cancellation of the requirements, which justify the need for a particular weapon program....
>
> Marine Gen. James Cartwright, vice chairman of the Joint Chiefs of Staff, chaired the Sept. 18 meeting, which reportedly was attended by about 60 officers and officials. Along with the vice chairman, the four vice chiefs of the military services fill out the JROC membership.[119]

Potential oversight questions for Congress include the following:

- **SCIB and DDG-1000 requirements.** Are the DDG-1000's requirements partly a result of inadequate discipline, following the disestablishment of the SCIB, in the Navy's process for setting requirements for new ships? If the SCIB had remained in existence during the DD-21/DDG-1000 design process, which of the DDG-1000's current requirements would have been reduced or eliminated?
- **Tumblehome hull.** How much did the decision to use a tumblehome hull (and other survivability features) increase the size and cost of the DDG-1000? In the mid-1990s, when design work began on the ship now known as DDG-1000, how well did the Navy understand the relationship between using a tumblehome hull and ship size and cost? What effect does the tumblehome hull have on the DDG-1000's ability to deal with underwater damage? To what degree will HF surface wave radars negate the stealth characteristics of the DDG-1000 design?
- **AGSs.** Since the DDG-1000 is the only ship planned to carry AGSs, and since AGSs are viewed by the Marine Corps as necessary to meet Marine Corps

[118] Norman Friedman, "The New Shape of Ships," Naval Forces, No. II, 2006: 56-58, 60, 62-63. Italics as in the original. Friedman makes somewhat similar comments in chapter 17 (pages 431-450) of *U.S. Destroyers, An Illustrated Design History, Revised Edition*, op cit.

[119] Christopher P. Cavas, "DDG 1000 Takes Another Hit—From JROC," *Defense News*, October 6, 2008: 4.

requirements for naval surface fire support capability, should the AGSs be considered the most-critical payload element on the DDG-1000, and certain other payload elements, though desirable, be considered as possibly less critical by comparison?

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

This appendix provides information on the capabilities and costs of the DDG-1000 and DDG-51 designs, as 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:

- in July 19, 2005, Navy testimony before the Projection Forces subcommittee of the House Armed Services Committee;
- at a June 10, 2005, Navy briefing to CRS;
- 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.

The appendix concludes with a section on comparing the costs of DDG-51s and modified DDG-1000s.

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.

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.[120]

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.

[120] 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.

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[121] 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

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

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.[122] 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 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-

[122] 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.

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.

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 G-1**.

Table G-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

Item	DDG-1000 compared to DDG-51
Electrical power	Sufficient capacity for rail gun, laser weapons, and future radar upgrades

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 G-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.[123] 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.[124]

In elaborating on the point in **Table G-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:

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

[124] 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.[125]

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

[125] 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.[126]

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.

[126] 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.[127]

[127] 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.

Cost Tables for Comparing DDG-51s and Modified DDG-1000s

If the blank cells in **Table G-2** and **Table G-3** were filled in with figures from a source such as the Navy or CBO, the tables would provide acquisition and operating and support (O&S) cost data for comparing the options of procuring either Flight IIA DDG-51s (the Navy's proposal) or modified DDG-1000s as a means of improving the fleet's BMD, area-defense AAW, and open-ocean ASW capabilities. Such cost information could provide additional perspective for assessing the Navy's statement at the July 31, 2008, hearing that modifying the DDG-1000 design to make it capable of BMD, area-defense AAW, and blue-water ASW operations "is unaffordable from the Navy's standpoint." **Table G-2** assumes that procurement of surface combatants would shift to CG(X)s beginning in FY2017, and that procurement of modified DDG-1000s would continue at a rate of one per year through FY2016.

The cost and ship-quantity data in the two tables, if provided by a source such as the Navy or CBO, could be combined with a comparison of the relative capabilities of the two resulting groups of DDG-51s and modified DDG-1000s to arrive at an overall comparison of the cost-effectiveness of the two options.

Table G-2. Acquisition Costs for DDG-51s and Modified DDG-1000s

(costs in millions constant FY2010 dollars)

	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	To complete[a]	Total[a]
Navy proposal: DDG-51s									
Quantity	*1*	*2*	*1*	*2*	*1*	*1*		*0*	
RDT&E[b]									
SCN[c]									
WPN[d]									
Total									
Alternative option: Modified DDG-1000s[e]									
Quantity	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*	*7*
RDT&E[b]									
SCN[c]									
WPN[d]									
Total									

Source: Table prepared by CRS. Blank cells to be filled in with figures from sources such as the Navy or CBO. On October 22, 2008, CRS asked the Navy to fill in the blank cells; as of the date shown on the cover of this CRS report, the Navy had not provided to CRS a version of the table with the blanks filled in.

a. "To complete" column includes any costs beyond FY2016 needed to complete costs for the ships procured in FY2010-FY2016. "Total" column includes both FY2010-FY2016 and "To complete" column.

b. Research, development, test and evaluation (RDT&E) costs for the ships procured in FY2010-FY2016. Excludes costs that the Navy plans to incur for DDG-51s procured in FY2005 and prior years (such as costs for the DDG-51 modernization program) and costs that the Navy plans to incur to support the construction of the three DDG-1000s procured in FY2007-FY2009. Includes all ship and weapon RDT&E costs needed to achieve the modified DDG-1000 described in note e below.

c. Shipbuilding and Conversion, Navy (SCN) costs for the ships procured in FY2010-FY2016, including outfitting and post-delivery costs. Excludes FY2010 cost for the DDG-1000 procured in FY2009 using split funding in FY2009 and DY1010 (and any other SCN costs for the three DDG-1000s procured in FY2007-FY2009).

d. Weapon Procurement, Navy (WPN) costs for the weapons needed to arm the ships procured in FY2010-FY2016.

e. Current DDG-1000 design modified as follows:

—AGSs 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 BMD and area-defense AAW capability not less than that of Flight IIA DDG-51 with ACB 12.

—Ship's bow sonar and other ASW combat system elements changed as needed to give the ship an open-ocean ASW capability not less than that of Flight IIA DDG-51.

Table G-3. Annual O&S Costs for a DDG-51 and a Modified DDG-1000

(costs in millions of constant FY2010 dollars)

Cost element[a]	DDG-51	Modified DDG 1000[b]
Operating (steaming), assuming crude oil cost of:		
$ 50 per barrel:		
$100 per barrel:		
$150 per barrel:		
Maintenance		
Manpower		
Total, assuming crude oil cost of:		
$ 50 per barrel:		
$100 per barrel:		
$150 per barrel:		
Total crew size		

Source: Table prepared by CRS. Blank cells to be filled in with figures from sources such as the Navy or CBO. On October 22, 2008, CRS asked the Navy to fill in the blank cells; as of the date shown on the cover of this CRS report, the Navy had not provided to CRS a version of the table with the blanks filled in.

a. Average annual cost, calculated on 35-year life-cycle basis so as to capture periodic costs, such as costs for periodic depot maintenance.

b. Current DDG-1000 design modified as described in previous table.

Press Report of Letter Requesting Cost and Other Information

On October 31, 2008, it was reported that:

> Sen. Edward Kennedy (D-Mass.) has asked the Navy to provide him data comparing costs between the DDG-51 and DDG-1000 as well as documentation supporting the Navy's assertion that the plan to restart the Arleigh Burke class of destroyers would be budget neutral.

Because of the questions surrounding the Navy's decision to go back to DDG-51, which, according to service officials, were based on rapid changes in the global security environment that outstripped the capability set that DDG-1000 was designed to combat, Kennedy is asking for an "apples-to-apples" comparison of the two destroyers.

"I believe this would entail providing complete cost data on a DDG-51, as envisioned by the Navy after restart of the production line, and on a DDG-1000 that has modifications the Navy believes are critical to perform the ballistic missile defense (BMD), area-defense anti-air warfare and blue-water anti-submarine warfare missions driving the Navy's desire to shift between platforms," Kennedy said in an Oct. 24 letter to Chief of Naval Operations Adm. Gary Roughead.

The Navy should provide cost estimates that assume: improvements are made to the dual band radar only as necessary to give the ship capabilities comparable to the radar envisioned for restarted DDG-51s; and improvements are made that would reflect a growth path to greater capability while the Navy is waiting on the CG(X) program, Kennedy added.

Additionally, Kennedy questions the Navy's assertion that the plan to restart DDG-51 production would be budget neutral.

"Even if that were the case, it is not clear to me that the 'budget neutral' plan is neutral when it comes to funding the workload necessary to support the surface combatant industrial base," he said. "Therefore, I would like to see how many DDG-51s you plan to procure, budget quality estimates for that plan, what effect that plan would have on the surface combatant industrial base, and any associated termination costs while the Navy waits to begin building the CG(X) in 2017," Kennedy said.

The Massachusetts senator also noted that a number of questions have yet to be answered in regard to the Navy's decision to cap production of DDG-1000 and restart the DDG-51 line.

According to Kennedy, Congress has yet to see:

• intelligence analysis reflecting the coordinated assessment of the Defense Intelligence Agency supporting these changes to the mix of platforms;

• validation of this shift that is supported by reviews by the Joint Requirements Oversight Council for an Acquisition Category I program;

• an approved acquisition strategy for cruisers and destroyers that supports the approved requirements baseline and is consistent with the previous Navy studies on what investment is required to support the surface combatant industrial base;

• evidence that potential changes in the shipbuilding program reflect: modeling and simulation, including war gaming conclusions regarding combat effectiveness; assessments of platform operational availability; and cost savings or penalties from changed vessel manning levels to accomplish missions;

• verification by the commanders of the combatant commands that the Navy's currently preferred program would be better than the Navy's previously preferred shipbuilding program in meeting their future mission requirements.

Additionally, Kennedy noted that Congress has also yet to see any analysis to support the Navy's contention that DDG-51 will offer greater ballistic missile defense, advanced anti-ship cruise missile defense, and blue-water anti-submarine warfare capabilities, and that the service couldn't afford to make DDG-1000 capable of supporting the same missions.

Kennedy pointed to testimony Vice Adm. Barry McCullough, deputy chief of naval operations for integration of capabilities and resources, gave to the House Armed Services Subcommittee on Seapower in July.

"Modifying the DDG-1000s to support these missions is unaffordable from the Navy's standpoint," McCullough said at the hearing.

McCullough made a similar statement in September at a Surface Navy Association luncheon ....

"The Congress still has not seen the analysis to support this statement," Kennedy said in his letter to Roughead.

"Even if we are to believe that there is an excess of capacity relative to the fire support requirement, it is not clear to me that the Navy's path forward makes the most sense," Kennedy added.

Kennedy said it's his understanding that:

• the Standard Missile-2 (SM-2) is included in the baseline and relatively modest research and development would allow the ship to also employ SM-3 and SM-6 missiles in a ballistic missile defense (BMD) mission;

• the DDG-1000 could be further optimized for the ballistic missile defense mission through combat systems modifications and by perhaps deleting the Advanced Gun System and replacing it with additional missile tubes;

• the DDG-1000 radar has more potential for improvement to achieve capability required to support more a robust BMD mission, as compared to the radar on DDG-51;

• the DDG-1000 Operational Requirements Document already articulates a recruitment to provide area air defense capability and that the advances in capability provided by the dual band radar are well suited to counter the Hezebollah threat often cited;

• the DDG-1000 has an integrated undersea warfare suite that is not only capable of blue water and littoral anti-submarine warfare, but is also capable of in-stride mine avoidance; and

• the DDG-1000 platform has more growth potential for carrying bigger, more capable radars and other new sensors and weapons.[128]

Press Report of Raytheon Estimate for Modified DDG-1000

On November 4, 2008, it was reported that:

> Earlier this year, the Navy tasked Raytheon with looking at how quickly the company could implement a ballistic missile defense (BMD) capability onto DDG-1000. Of interest to the Navy was the time frame for adding BMD, which hull would get the capability, what exactly is the capability the ship would get, as well as what were the risks and challenges in pursuing

[128] Geoff Fein, "Kennedy Seeks Cost Comparison Data Between DDG-51 and [DDG-]1000," *Defense Daily*, October 31, 2008: 3-5.

this concept, Mike Moe, director of seapower capability systems for Raytheon integrated defense systems, told Defense Daily in a recent interview.

"Their time frame they were looking at in this tasking was 2015. We did our analysis, and came back in 30 days. We found we could do it one year later ... 2016 ... [that] was the earliest we could provide credible capability," he said.

As it stand[s] now, in the current operational requirements document (ORD) for Zumwalt, there is no call for BMD, Moe noted.

Raytheon came up with three options for bringing BMD capability to Zumwalt. The options looked at radar, software and missiles, Moe said.

The ship would need to have enough capability to radiate enough energy to be able to discern a target when it was in space and then to put weapons on that target, he added. "So the radar had to change."

In Zumwalt's case, the Dual Band Radar (DBR) would have to be modified, Moe said.

DBR is designed to go across a wide spectrum of the family of ships in the Navy, Moe said, including the CVN-78 Ford-class of aircraft carriers. DBR has two pieces—the SPY-3 which is X-band and the Volume Search Radar (VSR) which is S-band, Moe explained.

Raytheon is the prime for the back end for both radars, and Lockheed Martin [LMT] provides the VSR base on the S-band side, Moe said.

"The VSR was the radar that needed to be adjusted. In the development of VSR, from day one on Zumwalt, there was space allocated for growth…for other missions or more pressing threats that might require more volume search even in the air defense spectrum," he said. "We had room in there to add additional modules, additional TR (transmitter receiver) pieces."

VSR is partially populated, Moe said. It has about 2,600 modules in the current radar, the one in development right now.

To make it BMD capable, Moe said the radar would have to be fully populated.... fill in the rest of the blanks that were left for growth in the original design.

One idea was to leave the VLS [sic: VSR] the way it is and see what that could provide in the way of BMD if the BMD software were added and the missile changed.

A second idea was to fully populate the VLS [sic: VSR] to its fullest extent. A third idea was to fully populate the VLS [sic: VSR] but also change the duty cycle…that would change the frequency of how much energy would be put a target, he added.

"Each one of those…the baseline ... the term we use is sensitivity ... so the sensitivity of the baseline radar is a zero dB sensitivity. So when we did the fully populated we got to a 11 dB of sensitivity which means more power on target," Moe explained. "And then with the change in the duty cycle, we got to 15 dB. So 15 dB of sensitivity was the maximum we could get out of fully populating [the radar], putting all the modules in all the holes that weren't used initially and bring that kind of capability to bear for this capability we are looking for."

The Navy, Moe noted, went right away for the 15 dB. "So that's where our focus was at, but we also [priced] the 11 dB capability. So there were really two options off the baseline, which was zero dB as a reference point."

So Raytheon grew the radar to be all it could be, against the BMD threat, and they did the corresponding analysis with their radar folks to see if the solution would give them a credible capability. "The answer was yes," Moe said.

In Zumwalt's combat system, there is no software for a BMD mission, Moe said, although there was software to integrate the Stand[ard] Missile for area air defense.

"The actual missile defense algorithms for discrimination and those kind of things to work with a threat in the exo-atmosphere required different algorithms and different software," he said. "Because we build that software for all of our radars, the BMD system radars, that was something we felt would be easy to bring in and leverage into our command and control system on Zumwalt."

Moe said Raytheon also looked, from purely a cost point of view, at the Aegis BMD capability and what could be leveraged from that to save money. But to do that, Moe added, would require some provisions within the government and some kind of national team approach because of the proprietary nature of Aegis BMD effort underneath Lockheed Martin and with the Missile Defense Agency.

"But we saw that as something that certainly should be considered. So we put that into our assessment of other ways you could go at this requirement to leverage some additional capability that's already in play [in] Aegis BMD," he said.

For the software, Raytheon is going to take that from existing software they use in various radars for missile defense. Moe said the company would leverage that software into the additional code they had to change, and bring in the discrimination algorithms to be able to discriminate the object of interest particularly in the exo-atmospheric threat.

The third option looked at the missiles.

Allowances had to be made for using the SM-3 missile because it is an exo-atmospheric platform, Moe said. "That was probably the easiest of the pieces."

Moe added that the Raytheon team looked at a marinized PAC-3 for use on a shipboard environment or a SM-6 variant that would be competed somewhere downstream.

The missile people were concerned whether or not the missile would fit in the MK 57 launcher, Moe said. And when the Navy moves in 2015 to a 21-inch full up more robust SM-3, would that missile fit?

"First off, the missile does fit. Every missile that fits in the MK 41 launcher on the current Aegis fleet will fit in the 57," Moe said. "In fact we have about 15 to 20 more inches of vertical room and we have about three more inches of diameter relative to the size of the modules."

So everything that can be shot out of an Aegis [Mk] 41 launcher can be shot out of a [Mk] 57 launcher with a lot of margin left, Moe noted.

"The difference is, for SM-3, because it goes exo-atmospheric, it needed a second cable that references the missile to its ship platform upon launch," he said. "So it has a zero reference from where it is launching from as it goes out into space, and that cable provides GPS,

> inertial [navigation] uplink ... [a] reference point upon launch. So [there is] a little difference for that missile because of how it works."
>
> After all the analysis, Raytheon told the Navy the company could provide a very credible capability in the short term…2016, Moe said.
>
> [On] the cost side, non-recurring cost came out to be $389 million for the 11 dB and approximately $400 million for the 15 dB radar. For recurring costs is was $117 million for the 11dB solution and $110 million for the 15 dB solution, Moe said.

"So all in all we could provide capability [in] 2016. We would meet the third hull realizing Zumwalt's first hull comes out in 2014 and is on schedule right now in the May-June time frame. A year later, hull two comes out in 2015, and hull three became our ship of choice to meet the requirement the Navy had given us."[129]

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[129] Geoff Fein, "Raytheon Says It Can Convert Zumwalt Into A Missile Cruiser By 2016," *Defense Daily*, November 4, 2008: 5-7.