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

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Summary

At a July 31, 2008, hearing, Navy officials announced a major change in the service's position on what kind of destroyers it wants to procure over the next several years: The Navy testified that it no longer wants to procure additional Zumwalt (DDG-1000) class destroyers, and instead now wants to restart procurement of Arleigh Burke (DDG-51) destroyers. The Navy has proposed this new path as part of internal Department of Defense (DOD) planning for the FY2010 defense budget to be submitted to Congress in early 2009. The Office of the Secretary of Defense (OSD) has reserved judgment on the Navy's proposal, pending further analysis, but gave the Navy permission in late July to brief the proposal to Congress.

Prior to changing its position, the Navy had wanted to continue procuring DDG-1000s, and did not want to procure any more DDG-51s. Navy plans had called for procuring a total of seven DDG-1000s. The first two were procured in FY2007, and the Navy's proposed FY2009 budget, submitted to Congress in February 2008, requests funding for a third. The three DDG-51s procured in FY2005 were to have been the final ships in the DDG-51 program, and Navy budgets since FY2006 have included funding for closing out the DDG-51 program. Until the July 31 hearing, the Navy for several years had stressed the need for procuring additional DDG-1000s, defended the DDG-1000 program against various criticisms, and rejected proposals for stopping DDG-1000 procurement and for resuming procurement of DDG-51s.

Although the Navy's proposed FY2009 budget requests funding for procuring a third DDG-1000, Navy officials suggested at the July 31 hearing that they would prefer Congress to instead fund the procurement of a DDG-51 in FY2009. 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.

The issue for Congress is how to take the Navy's new position on destroyer procurement into account in marking up the Navy's proposed FY2009 budget. Potential oversight issues for Congress include the timing of the Navy's announcement of its new position, the availability of the Navy's analytical basis for its new position, the changed threat assessment that the Navy says underlies its new position, the Navy's selection of the DDG-51 as the ship best suited for responding to the changed threat assessment, the Navy's description of the DDG-1000's anti-air warfare (AAW) capabilities, and the industrial-base implications of stopping DDG-1000 procurement and restarting DDG-51 procurement.

Congress has several options regarding destroyer procurement in FY2009 and subsequent years. This report will be updated as events warrant.

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Introduction

At a July 31, 2008, hearing before the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee, Navy officials announced a major change in the service's position on what kind of destroyers it wants to procure over the next several years: The Navy testified that it no longer wants to procure additional Zumwalt (DDG-1000) class destroyers, and instead now wants to restart procurement of Arleigh Burke (DDG-51) destroyers. The Navy's testimony confirmed press articles that began appearing in mid-July that had reported the Navy's change in position.[1]

The Navy testified at the hearing that it has proposed its preferred new path for destroyer acquisition as part of internal Department of Defense (DOD) planning for the FY2010 defense budget to be submitted to Congress in early 2009. The Office of the Secretary of Defense (OSD) has reserved judgment on the Navy's proposal, pending further analysis, but gave the Navy permission in late July to brief the proposal to Congress.

Prior to changing its position, the Navy had wanted to continue procuring DDG-1000s, and did not want to procure any more DDG-51s. Navy plans had called for procuring a total of seven DDG-1000s. The first two were procured in FY2007, and

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[1] See for example, Christopher J. Castelli, "In Major Reversal, Navy Aims To Curtail DDG-1000 Destroyer Program," *Inside the Navy*, July 14, 2008; Christopher P. Cavas, "DDG 1000 Destroyer Program Facing Major Cuts," *DefenseNews.com*, July 14, 2008; Dale Eisman, "Cost and Design Bugs Could Sink New Destroyer Program," *Norfolk Virginian-Pilot*, July 20, 2008; Christopher P. Cavas, "DDG 1000 Faces More Uncertainty," *Defense News*, July 21, 2008; Christopher J. Castelli, "Plan To Curtail DDG-1000 Program Advances," *InsideDefense.com*, July 22, 2008; Christopher P. Cavas, "DDG 1000 Program Will End At Two Ships," *DefenseNews.com*, July 22, 2008; Geoff Fein, "Navy Ready To Propose Limiting DDG-1000 But At Two," *Defense Daily*, July 23, 2008; Bettina H. Chavanne, "U.S. Navy Cancels DDG-1000 Destroyer," *Aerospace Daily & Defense Report*, July 24, 2008; Megan Scully, "Navy to Cancel New Destroyer Program and Buy Older Model," *CongressDaily*, July 24, 2008; Tony Capaccio, "U.S. navy Confirms Plans to Curtail Construction of Destroyers," *Bloomberg News*, July 24, 2008; Robert Weisman and Bryan Bender, "Navy Cancels $20B Purchase Of Destroyers," *Boston Globe*, July 24, 2008: 1; August Cole, "Budget Pressures Weigh On Navy," *Wall Street Journal*, July 24, 2008: 2; Geoff Fein, "Navy To Buy Eight DDG-51s As It Cancels Further Zumwalt Buys," *Defense Daily*, July 25, 2008.

the Navy's proposed FY2009 budget, submitted to Congress in February 2008, requests funding for a third. The three DDG-51s procured in FY2005 were to have been the final ships in the DDG-51 program, and Navy budgets since FY2006 have included funding for closing out the DDG-51 program. Until the July 31 hearing, the Navy for several years had stressed the need for procuring additional DDG-1000s, defended the DDG-1000 program against various criticisms, and rejected proposals for stopping DDG-1000 procurement and for resuming procurement of DDG-51s.

Although the Navy's proposed FY2009 budget requests funding for procuring a third DDG-1000, Navy officials suggested at the July 31 hearing that they would prefer Congress to instead fund the procurement of a DDG-51 in FY2009. 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.

The issue for Congress is how to take the Navy's new position on destroyer procurement into account in marking up the Navy's proposed FY2009 budget. Decisions that Congress makes on this issue could affect future Navy capabilities, Navy funding requirements, and the shipbuilding industrial base.

Background

Zumwalt (DDG-1000) Program

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.

The DDG-1000 is a multimission destroyer with an emphasis on naval surface fire support (NSFS) and littoral (i.e., near-shore) operations. 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.[2] 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).[3]

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[2] 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.

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

The DDG-1000 is to have a reduced-size crew (compared with the Navy's current destroyers and cruisers) of 142 sailors 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,[4] a superstructure made partly of large sections of composite materials rather than steel or aluminum, an integrated electric-drive propulsion system,[5] a total-ship computing system for moving information about the ship, automation technologies for the reduced-sized crew, a dual-band radar, a new kind of vertical launch system (VLS) for storing and firing missiles, and two copies of a 155mm gun called the Advanced Gun System (AGS). The AGS is to fire a new rocket-assisted 155mm shell, called the Long Range Land Attack Projectile (LRLAP), to ranges of more than 60 nautical miles. The DDG-1000 can carry 600 LRLAP rounds (300 for each gun), and additional rounds can be brought aboard the ship while the guns are firing, creating what Navy officials call an "infinite magazine."

With an estimated full load displacement of 14,987 tons, the DDG-1000 design is roughly 55% larger than the Navy's current 9,500-ton Aegis cruisers and destroyers, and larger than any Navy destroyer or cruiser since the nuclear-powered cruiser Long Beach (CGN-9), which was procured in FY1957.

The first two DDG-1000s were procured in FY2007 using split funding (i.e., two-year incremental funding) in FY2007 and FY2008. The Navy estimates their combined procurement cost at $6,325 million. The Navy's proposed FY2009 budget requests funding to procure the third DDG-1000; the Navy estimates its procurement cost at $2,653 million. The third DDG-1000 received $150 million in advance procurement funding in FY2008, and the Navy's proposed FY2009 budget requests the remaining $2,503 million. The Navy's proposed FY2009 budget also requests $51 million in advance procurement funding for the fourth DDG-1000, which the Navy budget plans called for procuring in FY2010.

Table 1 shows DDG-1000 funding through FY2013, as presented in the FY2009-FY2013 Future Years Defense Plan (FYDP) submitted in February 2008. As discussed in the notes to the table, the table does not show about $1.1 billion in research and development funding provided for the predecessor DD-21 program from FY1995 through FY2001, or funding for DDG-1000 research and development costs planned for fiscal years after FY2013, or $513 million in outfitting and post-delivery costs planned for fiscal years after FY2013.

As can be seen in the table, when the $1.1 billion in FY1995-FY2001 research and development costs are included, the DD-21/DD(X)/DDG-1000 program received a total of about $13,385 million in funding from FY1995 through FY2008. This total includes about $6,911 million in research and development funding, and about $6,474 million in procurement funding.

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[4] 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.

[5] 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.

Table 1. DDG-1000 Program Funding, FY2002-FY2013

(millions of then-year dollars, rounded to nearest million; totals may not add due to rounding)

	FY02 thru FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	Total thru FY13
Research, Development, Test and Evaluation, Navy (RDTEN) account									
DDG-1000[a]	4549	756	493	449	521	565	326	174	7832
Shipbuilding and Conversion, Navy (SCN) account									
DDG-1000 and DDG-1001	1010	2557	2757	0	0	0	0	0	6325[b]
DD/NRE[b]	*994*	*893*	*0*	*0*	*0*	*0*	*0*	*0*	*1887*[b]
Construction	*16*	*1664*	*2757*	*0*	*0*	*0*	*0*	*0*	*4437*[b]
DDG-1002	0	0	150	2503	0	0	0	0	2653
DDG-1003	0	0	0	51	2663	0	0	0	2714
DDG-1004	0	0	0	0	51	2377	0	0	2428
DDG-1005	0	0	0	0	0	50	2569	0	2619
DDG-1006	0	0	0	0	0	0	50	2347	2397
Outfitting/post-delivery costs[c]	0	0	0	0	16	61	87	132	295
Subtotal SCN	1010	2557	2907	2554	2730	2488	2706	2479	19430
TOTAL	**5559**	**3313**	**3399**	**3003**	**3250**	**3053**	**3032**	**2653**	**27262**

Source: Navy data provided to CRS on May 8, 2008, and July 7, 2007.

a. DDG-1000 portion of Program Element (PE) 0604300N, DDG-1000 Total Ship System Engineering (previously called SC-21 Total Ship System Engineering). PE0604300N also includes funding the CG(X) cruiser program. Figures shown do not include $1,111.4 million in RDTEN funding provided for DD-21/DD(X) program in FY1995-FY2001. Additional RDTEN funding for the DDG-1000 program required after FY2013. The Navy states that figure for RDTEN for FY2002-FY2006 does not include congressional adds to PE0604300N during that period; budget-justification documents show about $41 million in such additional funding in FY2006 and much smaller amounts in FY2002-FY2005.

b. DD/NRE is detailed design/non-recurring engineering costs for the class. In Navy shipbuilding programs, DD/NRE costs for a class of ships are traditionally included in the procurement cost of the lead ship(s) in the class.

c. $513 million in additional outfitting/post-delivery costs programmed after FY2013.

As can be seen in the table, the Navy has requested $449 million in FY2009 research and development funding for the DDG-1000 program. This $449 million is included within $679 million that the Navy is requesting in FY2009 for a line item (i.e., program element, or PE) in the Navy's research and development account called "DDG-1000 Total Ship System Engineering" (PE0604300N, the 100th line item in the account). This line item was previously called "SC-21 Total Ship System Engineering." Although this line item is named for the DDG-1000 program, it includes research and development funding for both the DDG-1000 and CG(X)

programs. The other $230 million requested in this line item is for the CG(X) program.[6]

Based on the figures in the table, when $1.1 billion in FY1995-FY2001 DD-21/DD(X) research and development costs and $513 million in post-FY2013 outfitting and post-delivery costs are included, the Navy estimated the total acquisition (i.e., development plus procurement) cost of a seven-ship DDG-1000 program at about $28.9 billion in then-year dollars, or an average of about $4.1 billion per ship, not including additional DDG-1000 research and development costs after FY2013.

Several major technologies developed for the DDG-1000 are to be used on the CG(X) cruiser and other future Navy ships, so at least some portion of the DDG-1000 program's research and development costs might be viewed as not truly specific to the DDG-1000 program. Based on the figures in the table, when the DDG-1000 program's research and development costs are excluded, the Navy estimates the total procurement cost of a seven-ship DDG-1000 program (including $513 million in post-FY2013 outfitting and post-delivery costs) at about $19.9 billion in then-year dollars, or an average of about $2.8 billion per ship.

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

Arleigh Burke (DDG-51) Program

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.

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 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 52 were in service as of the end of FY2007, and the 62nd is scheduled to enter service in 2011.

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[6] As discussed in a previous footnote, SC-21 means surface combatant for the 21st Century and refers to the Navy's pre-November 2001 SC-21 program to develop a destroyer called the DD-21 (now called the DDG-1000) and an eventual cruiser called the CG-21 (now called CG(X)).

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.

Between 2004 and 2008, 15 DDG-51s (and also three CG-47s) have been 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.[7]

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.[8] 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.[9]

The Navy has also studied the option of extending the service lives of DDG-51s from 35 years to 40 years, and has assumed a 40-year life for DDG-51s as part of its 30-year shipbuilding plan for maintaining the Navy's desired 313-ship fleet.[10] The Navy, however, has not yet funded a program to perform the additional maintenance work that would be needed to extend the ships' lives to 40 years.

Older CRS reports provide additional historical and background information on the DDG-51 program.[11]

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

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

[9] 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.

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

[11] See CRS Report 94-343 F, *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 F, *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 pf print and available directly from the author]

Surface Combatant Construction Industrial Base

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 Pascagoula, MS, that forms part of Northrop Grumman Shipbuilding (NGSB).[12] 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. Navy surface combatants are overhauled, repaired, and modernized at GD/BIW, NGSB, other private-sector U.S. shipyards, and government-operated naval shipyards (NSYs).

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's combat system (the Aegis system), and Raytheon is the lead contractor for the DDG-1000's combat system. Lockheed has a share of the DDG-100 combat system, and Raytheon has a share of the DDG-51 combat system.

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.

Planned Surface Combatant Force Structure

Until the Navy's testimony at the July 31, 2008, hearing, the Navy in coming years had wanted to achieve and maintain, as part of its desired fleet of 313 ships,[13] a force of 88 cruisers and destroyers, including 7 DDG-1000s, 19 CG(X)s, and 62 DDG-51s.

Navy's New Position on Destroyer Procurement

The following discussion of the Navy's new 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

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[12] 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.

[13] For more on the proposed 313-ship fleet, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Expeditionary Forces subcommittee of the House Armed Services Committee.[14] The Navy's prepared statement for the hearing is reprinted in its entirety as **Appendix B**.

Number of New DDG-51s Proposed. *How many DDG-51s does the Navy now want to procure?*

Table 2 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 new proposal for destroyer procurement.

Table 2. Destroyer Procurement Plans

(FY2007-FY2015)

	07	08	09	10	11	12	13	14	15
Program of record from FY2009 budget submission									
DDG-51									
DDG-1000	2[a]		1	1	1	1	1		
CG(X)					1		1	1	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 now wants to procure a total of eight DDG-51s in the period FY2010-FY2015. The Navy testified that this is the profile the service has proposed to OSD for approval as part of the process for preparing the proposed DOD FY2010 budget 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 has directed the Navy to support the procurement of a

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[14] 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.

third DDG-1000 in FY2009.[15] The Navy testified on July 31 that it remains ready to execute construction of a third DDG-1000, should a third DDG-1000 be funded in FY2009.

A September 5, 2008, press report stated:

> Navy Secretary Donald Winter hopes that Congress funds a surface warship in this year's budget, and while he'd prefer a third Zumwalt-class destroyer, he'd still be happy if lawmakers funded an older Arleigh Burke-class destroyer, Winter said Thursday [September 4].
>
> The Navy has a major stake in keeping U.S. shipyards healthy, Winter told Navy Times, so they, in turn, are able to keep the employees and production gear in place to keep building warships.
>
> "This is a very important part of our fleet and we have to be mindful of the need to continue to invest and to maintain the industrial base that supports that investment and production activity," he said. "In many aspects, making certain that we have — I'll just say, a destroyer — in the [fiscal 2009] budget is more important than whether that's a DDG 1000 or a DDG 51. I want a surface combatant this year."...
>
> Winter said that "within the building," meaning the Pentagon, the sea service has reached a consensus for what it wants this year — a surface warship — and what it will ask for as it plans for future years.

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[15] 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 FY 2009 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 FY 2009 and related planning 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.

> "Everybody's got their own little impressions and beliefs and, 'I'd rather this, I'd rather that,' but in the end, I think we would be able to make good use of a DDG 1000. That is what is in the president's budget request on the Hill right now, and I'm hopeful that we can get the political support to enable us to acquire an additional DDG 1000 in '09."
>
> Just the same, Winter reiterated the Navy's recent worries about the threat from anti-ship and ballistic missiles, which has become a common Big Navy theme as service officials have made the case for buying more Arleigh Burke-class destroyers with the Aegis Ballistic Missile Defense system. So if Congress decides to support the production of DDG 51 components or long-lead items, that's also helpful, Winter said.[16]

The FY2015 date shown in **Table 2** for procurement of the lead CG(X) under the Navy's proposed new plan is somewhat speculative. It has been reported that the date for procuring the lead CG(X) cruiser may slip from the currently planned year of FY2011 to FY2015 or later.[17] The fact that the Navy is proposing to procure one DDG-51 (rather than two) in FY2015 suggests (but does not prove) that the Navy now plans to procure the lead CG(X) in FY2015, since that would result in a total procurement of two surface combatants (one DDG-51 and one CG(X)) in FY2015. If the procurement date for the lead CG(X) slips to FY2016, FY2017, or FY2018, the Navy may elect to procure DDG-51s in those years as well, which would increase the total number of DDG-51s procured under the Navy's proposal.

Construction of Two DDG-1000s Procured in FY2007. *What are the Navy's plans regarding the two DDG-1000s procured in FY2007?*

The Navy testified at the July 31, 2008, hearing that it wants to proceed with the construction of the two DDG-1000s procured in FY2007, and with DDG-1000 research and development work, which is needed to support the construction of the two DDG-1000s and to make DDG-1000 technologies available for use in future Navy ships. This is why the Navy refers to the DDG-1000 program as being truncated rather than canceled or terminated.

Navy's Reasons for Its Change in Position. *Why did the Navy change its position on destroyer procurement?*

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-

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[16] Philip Ewing, "SecNav: Navy Needs a Destroyer This Year," *NavyTimes.com*, September 5, 2008.

[17] Christopher P. Cavas, "DDG 1000 Destroyer Program Facing Major Cuts," *DefenseNews.com*, July 14, 2008.

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)[18], and modern non-nuclear-powered submarines capable of blue-water operations.[19] 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, 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[20] or BMD operations, and its sonar system is not optimized for blue-water ASW operations. Navy officials also testified that modifying the DDG-1000 design to make it capable of these operations would be unaffordable from the Navy's standpoint. 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.

Although the Navy at one point in its spoken testimony stated that affordability was not a factor behind its new position, 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

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

[19] 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.

[20] 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.

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 stated earlier, 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."

An August 31, 2008 press report 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[21] 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.
>
> 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.

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

> "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."[22]

Potential Relationship to CG(X) Developments. *How might the Navy's new position on destroyer procurement relate to the CG(X) program?*

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 is not clear, however, that the Navy still considers the DDG-1000 hull as the best hull design for the CG(X):

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

- 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."[23]

- 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.[24] 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.

If the 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, as mentioned earlier, the date for procuring the lead CG(X) reportedly has slipped from FY2011 to FY2015 or later. The CG(X) is intended to provide the fleet with improved AAW and BMD capabilities. If the date for procuring the lead CG(X) has slipped several years, this 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.

Design of New DDG-51s. *What version of the DDG-51 does the Navy want to procure?*

The Navy testified that the DDG-51s it wants to procure in coming years would be Flight IIA ships with a combat system essentially the same as the one that existing DDG-51s will receive under the DDG-51 modernization program. 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.[25] It is

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[23] Letter dated July 2, 2008 from John Young to Representative Taylor, p. 1.

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

[25] 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.

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 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.[26] The Navy's testimony at the July 31 hearing indicated that the Navy is not contemplating procuring DDG-51s with such design modifications.

Procurement Cost of New DDG-51s. *What would the new DDG-51s cost to procure?*

The Navy's prepared statement for the July 31 hearing states:

> 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.[27]

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

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[26] 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.

[27] 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.

> 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.[28]

Status of Navy Proposal within OSD. *Has the Navy's new proposal been approved by OSD?*

At a July 22, 2008, meeting between senior OSD and Navy officials, OSD agreed to allow the Navy to brief its proposal to Congress, 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 discussion was necessary before there was agreement."[29] The 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.[30]

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[28] 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.

[29] 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.)

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

Oversight Issues for Congress

The Navy's new position on destroyer procurement raises several potential oversight issues for Congress, including but not necessarily limited to those discussed below.

Timing of Announcement of Navy's New Position

One potential oversight issue for Congress concerns 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 is, Why did the Navy not announce its changed position prior to the budget submission, or at least prior to the spring budget-review hearings?

Availability of Navy's Analytical Basis for Its New Position

A second potential oversight issue concerns 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 include the following:

- 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 concerns the Navy's changed threat assessment. Potential oversight questions for Congress include 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.)

- 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?

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 mmoving aircraft, and near shore targets. Additionally, four IOWA Class BBs [battleships] were brought back into service to provie 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 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 vrious 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 greaer 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].[31]

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:

> 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.[32]

The Commandant's views and recommendations state in part:

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[31] *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.

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

> 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 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.[33]

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

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

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.[34]

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.[35] The ERGM was intended to extend the firing range of the Aegis ships'

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

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

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.[36] 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.

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

A fourth potential oversight issue for Congress concerns 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 include 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 C**, 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 C**.) 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?

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[35] (...continued)
Matthews, "End of ERGM Spotlights Other Future Guns," *NavyTimes.com*, April 1, 2008.

[36] 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.

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 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[37] 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[38] 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."[39]

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

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

[39] 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.

Regarding the question of comparative costs for procuring DDG-1000s or DDG-51s, the Congressional Budget Office (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 D**.) 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.[40]

Table 3, 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 2**.

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[40] 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.

Table 3. 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.

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 concerns 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.[41] 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.

[41] 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'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.[42]

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*
>
> "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."... [43]

Potential oversight questions for Congress include the following:

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[42] 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).

[43] 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.

- 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 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?

Industrial Base Implications

An additional potential oversight issue for Congress concerns the industrial-base implications of the Navy's new position on destroyer procurement. Policymakers have expressed concern about the potential impact on the shipbuilding industrial base of a decision to stop DDG-1000 procurement and restart DDG-51 procurement. Particular concern has been expressed about GD/BIW, because construction of surface combatants is that yard's primary source of work.

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.[44] 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.[45] (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 A** 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.

As shown earlier in **Table 1**, under the Navy's proposal, a total of six DDG-51s would be procured through FY2013 (plus two more DDG-51s in FY2014 and FY2015). The total of 6 DDG-51s through FY2013 is less than the calculation of 9.3 to 10.3 DDG-51s through FY2013 shown above. This suggests that if DDG-51s are procured as the Navy is now proposing, and if policymakers wish to fully replace the shipyard labor hours that would have been provided by procuring ships 3 through 7 in the 7-ship DDG-1000 program of record, then policymakers might wish to consider the option of funding, between now and FY2013, supplementary forms of work for the shipyards that would provide the equivalent of roughly three or four DDG-51s' worth of additional shipyard labor hours. There are multiple options for supplementing DDG-51 construction work so as to meet such a goal. 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);

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

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

- assigning Aegis cruiser (i.e., CG-47 class) modernizations to the two yards that built the ships (again, GD/BIW and the Ingalls yard);[46]

- having GD/BIW participate in the construction of Littoral Combat Ships (LCSs) that are built to the General Dynamics LCS design;[47]

- 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);[48]

- procuring additional LHA-type amphibious assault ships, and perhaps have GD/BIW build parts of those ships;[49]

- having GD/BIW and/or Ingalls participate in the construction of Joint High Speed Vessels (JHSVs) being acquired for the Navy and Army, and perhaps also accelerating the procurement of these ships;

- procuring adjunct non-combat radar ships (an option discussed in **Appendix C**) 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 C**) — and perhaps have GD/BIW builds parts of those ships;

- procuring a third DDG-1000 in FY2009 (a position that, as discussed earlier, OSD has directed the Navy to support) as the final ship in the DDG-1000 program;[50]

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[46] For more on the Navy's program for modernizing its existing Aegis ships (both CG-47s and DDG-51s), see CRS Report RL22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

[47] 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.

[48] 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.

[49] 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.

[50] Procurement of a third and final DDG-1000 could be viewed as somewhat analogous to the procurement of the third and final Seawolf (SSN-21) class submarine, which was procured in part to help maintain the submarine construction industrial base while the successor Virginia (SSN-774) class design was being readied for procurement.

- procuring two new polar icebreakers for the Coast Guard, and assigning construction of those ships to NGSB and/or GD/BIW;[51]

- 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.[52]

Some of these options would be available for implementation sooner than others. Those available the soonest might be of the most use for bridging a work gap between the winding down of DDG-1000 production and the restart of DDG-51 production. 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 ships' reduction gears.[53]

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 below 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 C** 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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[51] 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).

[52] 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.

[53] A ship's reduction gears take the high-speed revolutions of the ship's turbine engines and reduce them to the lower-speed revolutions of the ship's propellers.

Options For Congress

Congress, in its consideration of the FY2009 defense authorization and appropriations bills, has at least three general options regarding the Navy's new position on destroyer procurement:

- **Support the Navy's new position.** This option would involve supporting the procurement in FY2009 of a third and final DDG-1000 (or, alternatively, the procurement of a DDG-51 in FY2009), and supporting procurement of DDG-51s in FY2010 and beyond. In addition to procuring a third and final DDG-1000 (or, alternatively, a DDG-51) in FY2009, this option could involve providing FY2009 advance procurement funding for restarting DDG-51 procurement in FY2010.

- **Reject the Navy's new position and support its prior position.** This option would involve supporting the procurement of a total of seven DDG-1000s, including a third DDG-1000 in FY2009 and a fourth in FY2010, and rejecting the Navy's proposal to restart DDG-51 procurement. This option would involve funding the procurement of a third DDG-1000 in FY2009, providing FY2009 advance procurement funding for a fourth DDG-1000 to be procured in FY2010, providing no FY2009 advance procurement funding to restart DDG-51 procurement, and directing continued execution of prior-year funding for closing down the DDG-51 production line.

- **Adopt an intermediate position.** This option could take many forms. It could, for example, involve providing FY2009 funding for procuring either a DDG-1000 or DDG-51 in FY2009, with the choice perhaps to be made by the Navy (or, alternatively, providing advance procurement funding in FY2009 for the procurement of either a DDG-1000 or DDG-51 in FY2010, with the choice perhaps to be made by the Navy), while leaving open the question of what kind of destroyers to procure in subsequent years. It could also involve providing funding for modifying either the DDG-51 or DDG-1000 design so as to improve its capabilities for BMD, area-defense AAW, and open-ocean ASW — design options described in **Appendix C**.

Supplementary options, which could be combined with any of the three general options above, include the following:

- Request or require the Navy to provide additional information, in the form of briefings or reports, on its new position regarding destroyer procurement, including information on its changed threat assessment and on its assessment of ship-procurement options for responding to that changed assessment.

- Request GAO or some other independent entity to review and assess the Navy's analysis of the changed threat environment and ship-procurement options for responding to that changed assessment.

- Request CBO to provide an updated estimate of comparative DDG-1000 and DDG-51 procurement costs, using the Navy's proposed DDG-51 procurement file as shown in **Table 2**.

- Prohibit the Navy from expending certain FY2009 funding until it takes certain actions, such as providing information that Congress has requested regarding the Navy's new position on destroyer procurement.

- Implement one or more of the options outlined earlier for supplementing destroyer-construction work at GD/BIW and/or Ingalls with other forms of work.

In a more general sense, if policymakers decide that procurement of surface combatants over the next several years should be oriented toward a goal of adding to or improving the fleet's BMD, area-AAW, and open-ocean ASW capabilities, then potential ship-procurement options include:

- the current Flight IIA DDG-51 design, including a BMD capability and a towed array sonar (this is the option now supported by the Navy);

- a modified version of the Flight IIA DDG-51 design with the above features, plus additional features for reducing the ship's O&S costs, and perhaps also additional missile-launch tubes and/or an improved radar;

- a modified version of the DDG-1000 design that can fire the SM-2 AAW interceptor and the SM-3 BMD interceptor, and is equipped with a sonar better optimized for open-ocean ASW;

- a modified version of the DDG-1000 with the above features, plus additional missile-launch tubes and/or an improved radar; and

- a non-combat ship equipped with a powerful radar to act as an adjunct platform for BMD operations and perhaps also AAW operations.

Alternatively, if policymakers decide that procurement of surface combatants over the next several years should be oriented toward a goal of improving the fleet's NSFS capabilities, then potential ship-procurement options include:

- the current DDG-1000 design;

- a modified version of the Flight IIA DDG-51 design incorporating features for reducing the ship's O&S costs and equipped with an AGS; and

- a modified version of the current San Antonio (LPD-17) class hull design equipped with two AGSs.

For additional information on both of the above sets of ship-procurement options, see **Appendix C**.

Legislative Activity

Table 4 summarizes congressional action on the Navy's FY2009 request for research and development, procurement, and advance procurement funding for the DDG-1000 program.

Table 4. Congressional Action on FY2009 Funding Request

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

		Authorization			Appropriation		
	Request	**HASC**	**SASC**	**Conf.**	**HAC[d]**	**SAC**	**Conf.**
DDG-1000 research and development[a]	449	449	449		n/a	n/a	
Destroyer procurement[b]							
DDG-1000 procurement	2503	0	2503		0	2503	
DDG-1000 advance procurement	51	400[c]	51		450	0?	
DDG-51 advance procurement	0		0		0	397	
DDG-51 procurement	0	0	0		0	0	
Total procurement	2554	400[c]	2554		450	2900?	

Source: FY2009 Navy budget submission, committee reports on the FY2009 defense authorization bill, and committee press releases on FY2009 defense appropriation bills.

Notes: HASC is House Armed Services Committee; SASC is Senate Armed Services Committee, HAC is House Appropriations Committee; SAC is Senate Appropriations Committee; Conf. is conference report. n/a = not available.

a. Research, Development, Test, and Evaluation, Navy (RDT&EN) account.
b. Shipbuilding and Conversion, Navy (SCN) account.
c. To be used "for the construction of DDG 51 class destroyers or DDG 1000 class destroyers."

d. Figures shown are those recommended by the Defense subcommittee of the HAC, as presented in July 30, 2008, press release issued by Representative John Mutha, the subcommittee chairman.

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.)

FY2009 Defense Appropriations Bill

House. 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 that day of the FY2009 defense appropriations bill. The press release stated that the subcommittee recommended a total of $450 million in advance procurement funding, and no procurement funding, for the DDG-1000 program.[54]

Senate. On September 10, 2008, the Senate Appropriations Committee issued a press release summarizing the markup that day by the committee's Defense subcommittee of the FY2009 defense appropriations bill. 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."[55]

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[54] Source: 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.

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

Appendix A. Additional Background Information on DDG-1000 Program

This appendix presents additional background information on the DDG-1000 program. It presents information on the DDG-1000 program *as it existed just prior to the Navy's 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:[56]

- **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,[57] 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.[58]

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.[59]

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[56] 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).

[57] 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.

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

[59] For more on Navy ship names, see CRS Report RS22478, *Navy Ship Names: Background*

(continued...)

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

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[59] (...continued)
For Congress, by Ronald O'Rourke.

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.[60] 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.[61] 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.

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.[62] 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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[60] 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.

[61] 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.

[62] 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).[63]

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.

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

Appendix B. Navy Testimony for July 31, 2008, Hearing

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.[64] 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.

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[64] 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.

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

Challenges

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

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

Future Force

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

The DDG 1000 program is developing a capable ship which meets the requirements for which it was designed. The DDG 1000, with its Dual Band Radar and sonar suite design are optimized for the littoral environment. However, in the current program of record, the DDG 1000 cannot perform area air defense; specifically, it cannot successfully employ the Standard Missile-2

(SM-2), SM-3 or SM-6 and is incapable of conducting Ballistic Missile Defense. Although superior in littoral ASW, the DDG 1000 lower power sonar design is less effective in the blue water than DDG-51 capability. DDG 1000's Advanced Gun System (AGS) design provides enhanced Naval Fires Support capability in the littorals with increased survivability. However, with the accelerated advancement of precision munitions and targeting, excess fires capacity already exists from tactical aviation and organic USMC fires. Unfortunately, the DDG 1000 design sacrifices capacity for increased capability in an area where Navy already has, and is projected to have sufficient capacity and capability.

The DDG 51 is a proven, multi-mission guided missile destroyer. She is the Navy's most capable ship against ballistic missile threats and adds capacity to provide regional ballistic missile defense. DDG 51 spirals will better bridge the ballistic missile defense gap to the next generation Cruiser. Production costs of DDG 51s are known. The risks associated with re-opening the DDG 51 line are less than the risks of continuing the DDG 1000 class beyond 2 ships when balanced with the capability and capacity of pursuing the 313 ship fleet.

Current Execution

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

DDG 51 Destroyer Program and Production Restart Assessment

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

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

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

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

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

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

DDG 1000 Class Destroyer Program

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

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

As such, the maturity of the ship design, critical technologies, and mission systems support commencement of production. However, it is accurate that the integration of a complex, lead ship, surface combatant with significant new

technologies always entails risk. And though the Navy cost estimate for DDG 1000 is based on a detailed, bottoms-up approach, this complex integration does increase the cost risk.

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

Conclusion

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

Appendix C. 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,[65] 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.

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[65] 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.

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 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.[66]

(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] 14 officers 106 enlisted	[Total 296] 24 Officers 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.

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

Reducing Crew Size. Admiral Roughead's letter states that the above table "does not include personnel reduction savings expected from the DDG Modernization program." The Navy informed CRS on July 25, 2008, that the DDG-51 modernization is not expected to reduce DDG-51 crew size, but that the size of the DDG-51 crew has, for other reasons, been reduced recently from the figure of 296 shown in the table to 278, a reduction of 18 people.[67]

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.[68] The House Armed Services Committee's report (H.Rept. 108-491 of May 14, 2004) on the FY2005 defense authorization bill (H.R. 4200) similarly stated:

> The committee notes that the Navy is scheduled to commence a DDG-51 modernization plan in fiscal year 2005 with new construction and subsequently extend modernization to in-service destroyers. The committee is aware that the foundations for DDG-51 modernization are: increased warfighting capability, leverage of the DDG — 51 shipbuilding program, reduction of total ship ownership costs, and use of open architecture. In addition to those factors, the committee believes that reduction in crew size from the present approximately 300 to an objective of 200 personnel should also be part of the foundation of an even more aggressive modernization program.
>
> According to the Navy, a DDG-51 class ship costs $25.0 million per year to operate, including $13.0 million for the crew. The Navy estimate is that its present modernization plan could reduce the crew cost per ship by $2.7 million per year. A larger reduction in crew size would clearly appear to result in significant savings over the estimated 18 years of remaining normal service life, especially noting that per capita personnel costs may be expected to increase during that period.[69]

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,[70] 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

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

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

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

[70] 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.

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.[71]

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.[72] If fuel in coming years costs more than $112.14 per barrel, the dollar savings associated with a 3.9% reduction in fuel use would be greater than $2.5 million per year. The obverse would be true if fuel in coming years costs less than $112.14 per barrel.

Adding a Near-Surface Bow Bulb. As discussed in a CRS report,[73] 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%.[74]

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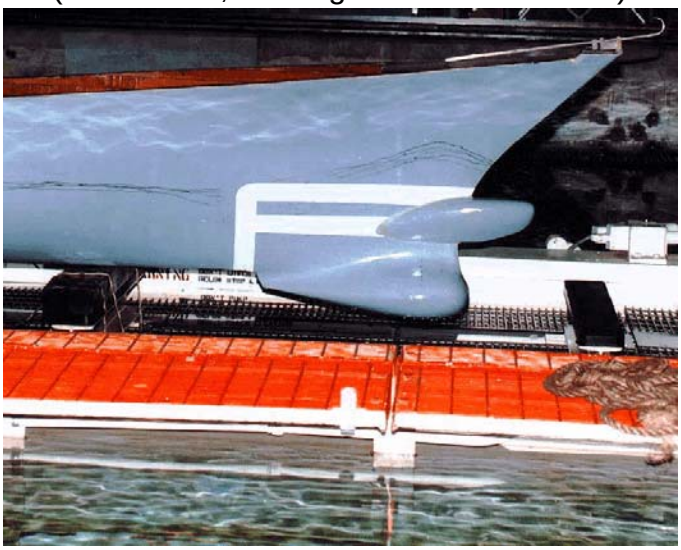
[71] Source: Briefing by the firm DRS dated December 19, 2007, with estimated percentage fuel-savings and cost figures reconfirmed by telephone call with CRS on July 17, 2008. DRS also stated in the phone call that one Navy official had stated that the reduction in fuel use could be greater than DRS 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").

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

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

[74] 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, 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. (continued...)

Figure 1. Near-Surface Bow Bulb Design for DDG-51
(bulb above, existing sonar dome below)



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

> Ship performance improvement was projected for the entire ship speed range across all sea states tested, resulting in significant annual fuel savings.
>
> Analysis of seakeeping data and extreme sea wave load tests indicate that the bow bulb had no significant impact on ship motions or hull girder loads. Acoustic transfer function tests data from a vibracoustic model concluded that the bow bulb should have little noticeable impact on the sonar self-noise levels.[75]

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 5**, 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

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[74] (...continued)
Available online at [https://www.denix.osd.mil/denix/Public/Library/Air/Climate_Change/dodclimatechange.pdf].)

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

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 5. 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.

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.[76]

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

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

> 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.[77]

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;[78] the maximum possible hull extension might be 55 or 56 feet.[79] 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 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

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[77] 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.)

[78] 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 F, *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.

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

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.[80] In 1997, to support research that CRS was conducting into possible alternatives to the Navy's proposed Arsenal Ship,[81] 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 6**, 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.

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[80] See CRS Report 94-343 F, *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.

[81] 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 F, *Navy/DARPA Arsenal Ship Program: Issues and Options for Congress*, by Ronald O'Rourke, and CRS Report 97-1004 F, *Navy/DARPA Maritime Fire Support Demonstrator (Arsenal Ship) Program: Issues Arising From Its Termination*, by Ronald O'Rourke.

Table 6. 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 F, *Navy DDG-51 Destroyer Procurement Rate: Issues and Options for Congress*, by Ronald O'Rourke [April 25, 1994; out of print and available directly from the author]). The cost figures in the table are rough order of magnitude (ROM) estimates and do not reflect any detailed design or engineering costs typically reflected in a lead-ship cost. The cost estimates provided by the Navy to CRS, though ROM estimates, were more precise than shown here, and were labeled business sensitive. They have been rendered more approximate by CRS for presentation in this table. The costs of the options as estimated by the Navy did not differ from one another in exact increments of 5%. See also Figure 6 on page 131 from Dean A. Rains, "Methods For Ship Military Effectiveness Analysis," *Naval Engineers Journal*, March 1994: 126-135; and Table 3 on page 26 from Dean A. Rains, "Naval Ship Affordability," *Naval Engineers Journal*, July 1996: 19-30.

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

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

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

If the DDG-51 hull is not lengthened, then modifying the DDG-51 design to include an improved radar would require removing the 5-inch gun to make space and weight available for additional equipment needed to support operations with the improved radar. Lengthening the hull might provide enough additional space and weight capacity to permit the 5-inch gun to be retained.[82] Supporting equipment to be installed would include an additional electrical generator and additional cooling equipment.[83] The best location for the generator might be in one of the ship's two helicopter hangar spots, which would reduce the ship's helicopter hangar capacity from two helicopters to one.

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

Version with Reduced O&S, Additional Tubes, and an Improved Radar. This version of the DDG-51 design would include both additional vertical-launch tubes and an improved radar, as well as features for reducing O&S costs. The purpose in procuring this version would be to provide the fleet with improved IAMD capabilities. This option would require the hull to be lengthened. The resulting ship would be more expensive in all respects (nonrecurring design and engineering costs, procurement costs, and annual O&S costs) and more capable than the other options discussed here.[84] 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[85] 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

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

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

[84] 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.

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

- 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.

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.

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.[86] 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)[87] 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.

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[86] 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]

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

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.[88]

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

Appendix D. 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.[89]

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.

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[89] 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.

> 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 $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.[90]

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.[91]

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

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[90] 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.

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

an 80 percent confidence level (in the case of DDG 1000 at around 45 percent) — increasing the likelihood that costs will grow above budget.[92]

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%.[93] 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 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.[94]

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.

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[92] 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.

[93] 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.

[94] "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.

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 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.
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> 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.[95]

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.[96]

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[95] 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. 3-6.

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

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[97] 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).[98]

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.

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

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

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.[99] 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.[100]

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....
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> 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.[101]

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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[99] 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.

[100] Ibid, pp. 6-7.

[101] 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."[102]

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 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.[103]

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;[104]
- 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....

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

[103] 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.)

[104] 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.

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....

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.[105]

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

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[105] 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.

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 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 E. 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.

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.[106]

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[106] 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.

June 10, 2005, Navy Briefing to CRS

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

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

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

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

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

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

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

C4I/Networking Bandwidth. The C4I[107] and networking systems on the DDG-1000 would have five times as much bandwidth as those on the DDG-51. The C4I/networking capability of the DDG-1000 is equivalent to that on the LHD-8 amphibious assault ship. In addition to improved warfighting capability, this increased bandwidth would provide sailors aboard the DDG-1000 a better ability to "reach back" to information sources ashore when conducting at-sea maintenance of shipboard equipment, potentially increasing the availability rates of shipboard equipment.

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

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

The two designs would use the same types of area-defense and point-defense interceptor missiles.[108] 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

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

[108] 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.

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

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

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

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

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

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

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

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

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

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

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

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 7**.

Table 7. DDG-1000 Capabilities Relative to DDG-51 Capabilities

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

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 7**, another slide in the Navy briefing stated that the DDG-1000's radar cross section will be similar to that of a fishing boat.[109] 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.[110]

In elaborating on the point in **Table 7** 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:

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

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

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:

(FY$M)	DDG 51 (FY09)	DDG 51 (FY09)	DDG 1000 (FY09)
Qty	1	2	1
Plans/Basic [construc-tion]	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 106 enlisted	24 Officers 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.[111]

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 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.[112]

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

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[111] 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.

[112] 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.

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 wold 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.

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.[113]

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[113] 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.