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

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Summary

The Navy began procuring Arleigh Burke (DDG-51) class destroyers, also known as Aegis destroyers, in FY1985, and a total of 87 have been procured through FY2021, including two in FY2021. From FY1989 through FY2005, DDG-51s were procured in annual quantities of two to five ships per year. Since FY2010, they have been procured in annual quantities of one to three ships per year.

DDG-51s are being procured in FY2018-FY2022 under a multiyear procurement (MYP) contract that Congress approved as part of its action on the Navy's FY2018 budget. DDG-51s procured in FY2017 and subsequent years are being built to a design called the Flight III design, which incorporates a new and more capable radar called the SPY-6 radar.

The Navy's proposed FY2022 budget requests the procurement of one DDG-51 in FY2022, rather than the two DDG-51s that are called for FY2022 under the FY2018-FY2022 DDG-51 MYP contract, and that were projected for FY2022 under the Navy's FY2021 budget submission. A key issue for Congress for the DDG-51 program in FY2022 is whether to fund the procurement of one DDG-51, two DDG-51s, or some other number of DDG-51s (such as zero or three).

When procured at a rate of two per year, DDG-51s cost roughly $2.0 billion each. Due to the reduced production economies of scale that would occur at a production rate of one ship per year, the one DDG-51 requested for procurement in FY2022 has an estimated cost of $2,401.7 million (i.e., about $2.4 billion). Under the Navy's proposed FY2022 budget, the one requested DDG-51 would receive $384.9 million in prior-year Economic Order Quantity (EOQ) funding—a type of advance procurement (AP) funding that occurs under an MYP contract. Taking this prior-year EOQ funding into account, the Navy's proposed FY2022 budget requests the remaining $2,016.8 million (i.e., about $2.0 billion) needed to complete the ship's estimated procurement cost of $2,401.7 million. The Navy's proposed FY2022 budget also requests $45.8 million in cost-to-complete funding to pay for cost growth on DDG-51s procured in prior years, bringing the total amount of procurement funding requested for the DDG-51 program to $2,062.5 million (i.e., about $2.1 billion)

Procuring one DDG-51 rather than two DDG-51s in FY2022 would prevent the Navy from fulfilling its obligations in the final year of the FY2018-FY2022 DDG-51 MYP contract. Navy officials state that as a result, the Navy would need to pay a $33 million penalty to the DDG-51 shipbuilders (unless the Navy and the shipbuilders were to reach an agreement to amend the terms of the MYP contract).

Navy officials have stated that requesting procurement of one DDG-51 rather than two DDG-51s was an affordability measure—a means of helping the Navy remain within its budget topline while meeting funding needs for other Navy programs. Procuring a second DDG-51 in FY2022 is the number one item on the Navy's FY2022 Unfunded Priorities List (UPL)—the service's list of programs it would prefer to be funded in FY2022, if additional funding were to become available.

The UPL states that procuring two DDG-51s rather than one DDG-51 in FY2022 would require an additional $1,659.2 million (i.e., about $1.7 billion) in shipbuilding funding. That figure is not the cost of the second DDG-51—the second DDG-51's procurement cost would be roughly $2.0 billion. Adding the second DDG-51, however, would reduce the estimated procurement cost of the first DDG-51 due to the resulting increased production economies of scale. The figure of $1,659.2 million is thus the *net* increase in shipbuilding funding that would be needed to procure two DDG-51s rather than one DDG-51 in FY2022.

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Introduction

This report presents background information and potential oversight issues for Congress on the Navy's Arleigh Burke (DDG-51) and Zumwalt (DDG-1000) class destroyer programs. The Navy began procuring DDG-51s, also known as Aegis destroyers, in FY1985, and a total of 87 have been procured through FY2021, including two in FY2021. The Navy procured three DDG-1000 class destroyers in FY2007-FY2009 and plans no further procurement of DDG-1000s.

The Navy's proposed FY2022 budget requests the procurement of one DDG-51 in FY2022, rather than the two DDG-51s that are called for FY2022 under the FY2018-FY2022 DDG-51 multiyear procurement (MYP) contract, and that were projected for FY2022 under the Navy's FY2021 budget submission. Procuring a second DDG-51 in FY2022 is the number 1 item on the Navy's FY2022 Unfunded Priorities List (UPL)—the service's list of programs it would prefer to be funded in FY2022, if additional funding were to become available. A key issue for Congress for the DDG-51 program in FY2022 is whether to fund the procurement of one DDG-51, two DDG-51s, or some other number of DDG-51s (such as zero or three).

Other issues for Congress concern the Navy's future force-level goal for large surface combatants (or LSCs, meaning cruisers and destroyers), the DDG-51 procurement rate in FY2023 and subsequent fiscal years, and how the Navy proposes to transition several years from now from procurement of DDG-51s to procurement of a successor destroyer design now in development called the DDG(X). Decisions that Congress makes on these issues could substantially affect Navy capabilities and funding requirements, and the U.S. shipbuilding industrial base.

For more on the DDG(X) program, see CRS In Focus IF11679, *Navy DDG(X) Future Large Surface Combatant Program: Background and Issues for Congress*, by Ronald O'Rourke.

Background

Navy's Force of Large Surface Combatants (LSCs)

LSC Definition

Decades ago, the Navy's cruisers were considerably larger and more capable than its destroyers. In the years after World War II, however, the Navy's cruiser designs in general became smaller while its destroyer designs in general became larger. As a result, since the 1980s there has been substantial overlap in size and capability of Navy cruisers and destroyers. (The Navy's new Zumwalt [DDG-1000] class destroyers, in fact, are considerably larger than the Navy's cruisers.)

In part for this reason, the Navy now refers to its cruisers and destroyers collectively as *large surface combatants (LSCs)*, and distinguishes these ships from the Navy's *small surface combatants (SSCs)*, the term the Navy now uses to refer collectively to its frigates, Littoral Combat Ships (LCSs), mine warfare ships, and patrol craft. The Navy's annual 30-year shipbuilding plan, for example, groups the Navy's surface combatants into LSCs and SSCs.[1]

[1] The Navy sometimes also uses the term *Cru-Des* (an abbreviation of cruiser-destroyer, pronounced "crew-dez") to refer collectively to its cruisers and destroyers.

LSC Force Levels

Current Force-Level Goal

The Navy's current force-level goal, released in December 2016, calls for achieving and maintaining a fleet of 355 ships, including 104 LSCs.[2]

Potential New Force-Level Goal

The Navy and the Department of Defense (DOD) have been working since 2019 to develop a successor for the 355-ship force-level goal. On December 9, 2020, the outgoing Trump Administration released a document that can be viewed as its own vision for future Navy force structure and/or a draft version of the FY2022 30-year Navy shipbuilding plan. The document presents an envisioned Navy force-level goal for achieving by 2045 a Navy with a more distributed fleet architecture, including 382 to 446 manned ships and 143 to 242 large unmanned vehicles. Within the total of 382 to 446 manned ships, the document calls for maintaining a force of 73 to 88 LSCs. In determining its Navy force-level goals and shipbuilding plans, the Biden Administration can choose to adopt, revise, or set aside this document.[3]

Actual Force Level as of End of FY2020

As of the end of FY2020, the Navy's force of LSC's included 91 LSCs, including 22 Ticonderoga (CG-47) class cruisers,[4] 68 DDG-51s, and one Zumwalt (DDG-1000) class destroyer.

DDG-51 Program

Overview

The DDG-51 program was initiated in the late 1970s.[5] The first DDG-51 was procured in FY1985 and entered service in 1991. A total of 87 DDG-51s have been procured through FY2021, including two in FY2021. From FY1989 through FY2005, DDG-51s were procured in annual quantities of two to five ships per year. Since FY2010, they have been procured in annual quantities of one to three ships per year. (The Navy did not procure any DDG-51s during the period FY2006-FY2009. Instead, the Navy in FY2007-FY2009 procured three Zumwalt [DDG-1000] class destroyers, which are discussed later in this report.) The DDG-51 program is one of the longest-running shipbuilding programs in Navy history, and the DDG-51 class, in terms of number of hulls, is one of the Navy's largest classes of ships since World War II.

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[2] For more on the 355-ship force-level goal, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[3] For more on the December 9, 2020 document, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[4] A total of 27 CG-47s (CGs 47 through 73) were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five ships in the class (CGs 47 through 51), which were built to an earlier technical standard in certain respects, were judged by the Navy to be too expensive to modernize and were removed from service in 2004-2005, leaving 22 ships in operation (CGs 52 through 73).

[5] The program was initiated with the aim of developing a surface combatant to replace older destroyers and cruisers that were projected to retire in the 1990s. The DDG-51 was conceived as an affordable complement to the Navy's Ticonderoga (CG-47) class Aegis cruisers. For an early discussion of the DDG-51 program, see Alva M. Bowen and Ronald O'Rourke, "DDG-51 and the Future Surface Navy," *U.S. Naval Institute Proceedings*, May 1985: 176-189.

DDG-51s (**Figure 1**) are multi-mission destroyers with an emphasis on air defense (which the Navy refers to as anti-air warfare, or AAW) and blue-water (mid-ocean) operations. DDG-51s, like the Navy's 22 Ticonderoga (CG-47) class cruisers, are equipped with the Aegis combat system, an integrated ship combat system named for the mythological shield that defended Zeus. CG-47s and DDG-51s consequently are often referred to as Aegis cruisers and Aegis destroyers, respectively, or collectively as Aegis ships. The Aegis system has been updated several times over the years. Many DDG-51s (and also some CG-47s) have a capability for conducting ballistic missile defense (BMD) operations.[6]

Figure 1. DDG-51 Class Destroyer

Source: U.S. Navy file photograph.

Design Changes

The DDG-51 design has been modified and updated periodically over the years. The first 28 DDG-51s (DDGs 51 through 78) are called Flight I/II DDG-51s. In FY1994, the Navy shifted DDG-51 procurement to the Flight IIA DDG-51 design, which incorporated certain changes, including the addition of a helicopter hangar. A total of 47 Flight IIA DDG-51s (DDGs 79 through 124 and DDG-127) were procured in FY1994-FY2016. In FY2017, the Navy shifted DDG-51 procurement to the Flight III DDG-51 design, which incorporates a new and more capable radar called the SPY-6 radar or the Air and Missile Defense Radar (AMDR), as well as associated changes to the ship's electrical power and cooling systems. DDGs 125 and higher, except for DDG-127 as noted above, are to be Flight III DDG-51s.

[6] For more on Navy BMD programs, see CRS Report RL33745, *Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress*, by Ronald O'Rourke.

Multiyear Procurement (MYP)

As part of its action on the Navy's FY2018 budget, Congress granted the Navy authority to use a multiyear procurement (MYP) contract for DDG-51s planned for procurement in FY2018-FY2022. This is the fourth MYP contract for the DDG-51 program—previous DDG-51 MYP contracts covered DDG-51s procured in FY2013-FY2017, FY2002-FY2005, and FY1998-FY2001.

Shipbuilders, Combat System Lead, and Radar Makers

DDG-51s are built by General Dynamics/Bath Iron Works (GD/BIW) of Bath, ME, and Huntington Ingalls Industries/Ingalls Shipbuilding (HII/Ingalls) of Pascagoula, MS. Lockheed is the lead contractor for the Aegis system installed on all DDG-51s. The SPY-6—the primary radar for the Aegis system on Flight III DDG-51s—is made by Raytheon.

Modernization of In-Service Ships

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

FY2022 Procurement Funding Request

The Navy's proposed FY2022 budget requests the procurement of one DDG-51 in FY2022, rather than the two DDG-51s that are called for FY2022 under the FY2018-FY2022 DDG-51 MYP contract, and that were projected for FY2022 under the Navy's FY2021 budget submission. When procured at a rate of two per year, DDG-51s cost roughly $2.0 billion each. Due to the reduced production economies of scale that would occur at a production rate of one ship per year, the one DDG-51 requested for procurement in FY2022 has an estimated cost of $2,401.7 million (i.e., about $2.4 billion).

Under the Navy's proposed FY2022 budget, the one requested DDG-51 would receive $384.9 million in prior-year Economic Order Quantity (EOQ) funding—a type of advance procurement (AP) funding that occurs under an MYP contract.[8] Taking this prior-year EOQ funding into account, the Navy's proposed FY2022 budget requests the remaining $2,016.8 million (i.e., about $2.0 billion) needed to complete the ship's estimated procurement cost of $2,401.7 million. The Navy's proposed FY2022 budget also requests $45.8 million in cost-to-complete funding to pay for cost growth on DDG-51s procured in prior years, bringing the total amount of procurement funding requested for the DDG-51 program to $2,062.5 million (i.e., about $2.1 billion)

Procuring one DDG-51 rather than two DDG-51s in FY2022 would prevent the Navy from fulfilling its obligations in the final year of the FY2018-FY2022 DDG-51 MYP contract. Navy officials state that as a result, the Navy would need to pay a $33 million penalty to the DDG-51

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

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

shipbuilders[9] (unless the Navy and the shipbuilders were to reach an agreement to amend the terms of the MYP contract).

Navy officials have stated that requesting procurement of one DDG-51 rather than two DDG-51s was an affordability measure—a means of helping the Navy remain within its budget topline while meeting funding needs for other Navy programs. Procuring a second DDG-51 in FY2022 is the number one item on the Navy's FY2022 Unfunded Priorities List (UPL)—the service's list of programs it would prefer to be funded in FY2022, if additional funding were to become available.

The UPL states that procuring two DDG-51s rather than one DDG-51 in FY2022 would require an additional $1,659.2 million (i.e., about $1.7 billion) in shipbuilding funding. That figure is not the cost of the second DDG-51—the second DDG-51's procurement cost would be roughly $2.0 billion. Adding the second DDG-51, however, would reduce the estimated procurement cost of the first DDG-51 due to the resulting increased production economies of scale. The figure of $1,659.2 million is thus the *net* increase in shipbuilding funding that would be needed to procure two DDG-51s rather than one DDG-51 in FY2022.

DDG-1000 Program

As noted earlier, in FY2007-FY2009, during the time when the Navy was not procuring DDG-51s, the Navy instead procured three Zumwalt (DDG-1000) class destroyers. The Navy plans no further procurement of DDG-1000s.

DDG-1000s are multi-mission destroyers with an originally intended emphasis on naval surface fire support (NSFS) and operations in littoral (i.e., near-shore) waters. NSFS is the use of naval guns to provide fire support for friendly forces operating ashore. Consistent with that mission orientation, the ship was designed with two new-design 155mm guns called Advanced Gun Systems (AGSs). The AGSs were to fire a new 155mm, gun-launched, rocket-assisted guided projectile called the Long-Range Land-Attack Projectile (LRLAP, pronounced LUR-lap). In November 2016, however, it was reported that the Navy had decided to stop procuring LRLAP projectiles because the projected unit cost of each projectile had risen to at least $800,000.[10]

In December 2017, it was reported that, due to shifts in the international security environment and resulting shifts in Navy mission needs, the mission orientation of the DDG-1000s will be shifted from an emphasis on NSFS to an emphasis on surface strike, meaning the use of missiles to attack surface ships and perhaps also land targets.[11]

In April and May 2021, it was reported that the Navy plans to remove the AGSs on the three ships and replace them with vertical launch tubes for the Navy's new hypersonic Conventional Prompt Strike (CPS) missile, with a goal of fielding CPSs on a DDG-1000 class ship by 2025.[12]

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[9] See, for example, Christopher P. Cavas, "Updated: Fleet Growth Stymied by Navy Budget Request," *USNI News*, May 28 (updated May 30), 2021.

[10] Christopher P. Cavas, "New Warship's Big Guns Have No Bullets," *Defense News*, November 6, 2016; Sam LaGrone, "Navy Planning on Not Buying More LRLAP Rounds for Zumwalt Class," *USNI News*, November 7, 2016; Ben Guarino, "The Navy Called USS Zumwalt A Warship Batman Would Drive. But at $800,000 Per Round, Its Ammo Is Too Pricey to Fire," *Washington Post*, November 8, 2016.

[11] Megan Eckstein, "New Requirements for DDG-1000 Focus on Surface Strike," *USNI News*, December 4, 2017. See also Richard Abott, "Navy Will Focus Zumwalt On Offensive Surface Strike," *Defense Daily*, December 5, 2017; David B. Larter, "The Navy's Stealth Destroyers to Get New Weapons and a New Mission: Killing Ships," *Defense News*, February 15, 2018.

[12] See, for example, Sam LaGrone, "CNO: Hypersonic Weapons at Sea to Premiere on Zumwalt Destroyers in 2025," *USNI News*, April 28, 2021; Jason Sherman, "Navy to Rip Out DDG-1000 Advanced Gun System Mounts to Make

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

Surface Combatant Construction Industrial Base

All cruisers and destroyers procured since FY1985 have been built at GD/BIW and HII/Ingalls. Both of these shipyards 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 HII/Ingalls' ship-construction work. (HII/Ingalls also builds amphibious ships for the Navy and cutters for the Coast Guard.) Navy surface combatants are overhauled, repaired, and modernized at GD/BIW, HII/Ingalls, and other U.S. shipyards.

Lockheed Martin and Raytheon are generally considered the two leading Navy surface combatant radar makers and combat system integrators. Lockheed is the lead contractor for the DDG-51 combat system (the Aegis system), while Raytheon is the lead contractor for the DDG-1000 combat system, the core of which is called the Total Ship Computing Environment Infrastructure (TSCE-I). Lockheed has a share of the DDG-1000 combat system, and Raytheon has a share of the DDG-51 combat system. Lockheed, Raytheon, and Northrop competed to be the maker of the AMDR to be carried by the Flight III DDG-51. On October 10, 2013, the Navy announced that it had selected Raytheon to be the maker of the AMDR, now called the SPY-6 radar.

The surface combatant construction industrial base also includes hundreds of additional firms that supply materials and components. The financial health of Navy shipbuilding supplier firms has been a matter of concern in recent years, particularly since some of them are the sole sources for what they make for Navy surface combatants. Several Navy-operated laboratories and other facilities support the Aegis system and other aspects of the DDG-51 and DDG-1000 programs.

Issues for Congress

Number of DDG-51s to Procure in FY2022

A key issue for Congress for the DDG-51 program in FY2022 is whether to fund the procurement of one DDG-51, two DDG-51s, or some other number of DDG-51s (such as zero or three).

Supporters of procuring one DDG-51 might argue that in a situation of finite defense resources, funding the procurement of two DDG-51s could require reducing funding for other Navy or DOD programs by about $1.7 billion, which could reduce Navy or DOD capabilities in other ways; that the Navy's new fleet architecture may result in a reduction in the force-level goal for large surface combatants; and that the DDG-51 industrial base (both shipyards and supplier firms) will be adequately supported by their existing backlog of DDG-51s and other Navy shipbuilding work.

Supporters of procuring two DDG-51s might argue that it would help accelerate the introduction of Flight III DDG-51s, with their SPY-6 radars, into the fleet; that it would improve production

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Room for Hypersonic Weapons," *Inside Defense*, May 26, 2021. See also Paul McLeary, "Exclusive[:] Eying China, CNO Plans Hypersonics & Lasers On Zumwalt Destroyers," *Breaking Defense*, February 26, 2021; Joseph Trevithick, "Navy Wants Triple-Packed Hypersonic Missile Modules On Its Stealthy Zumwalt Destroyers," *The Drive*, March 19, 2021; David B. Larter, "What Should Become of the Zumwalt Class? The US Navy Has Some Big Ideas," *Defense News*, March 25, 2021.

For more on the CPS program, see CRS Report R41464, *Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues*, by Amy F. Woolf.

economies of scale in the DDG-51 program; and that it would more strongly support the DDG-51 industrial base. The second DDG-51's position at the top of the Navy's FY2022 UPL, they might argue, shows that the second ship is a high-priority item for the Navy to fund with offsetting reductions that Congress might be able to identify in reviewing and marking up DOD's proposed FY2022 budget.

Future LSC Force-Level Goal

Another issue for Congress concerns the future LSC force-level goal. In connection with this issue, it can be noted that, compared to the Navy's current force-level goal for a fleet of 355 ships, including 104 LSCs, the December 9, 2020, shipbuilding document released by the outgoing Trump Administration calls for a larger total number of manned ships (382 to 446) but a smaller number of LSCs (73 to 88). This is because the December 9, 2020, shipbuilding document proposes shifting the Navy to a more distributed force architecture that would feature

- a smaller proportion of larger ships (such as large-deck aircraft carriers, cruisers, destroyers, large amphibious ships, and large resupply ships);
- a larger proportion of smaller ships (such as frigates, corvettes, smaller amphibious ships, smaller resupply ships, and perhaps smaller aircraft carriers); and
- a new third tier of surface vessels about as large as corvettes or large patrol craft that will be either lightly manned, optionally manned, or unmanned, as well as large unmanned underwater vehicles (UUVs).

Navy and DOD leaders believe that shifting to a more distributed fleet architecture is

- **operationally necessary**, to respond effectively to the improving maritime anti-access/area-denial (A2/AD) capabilities of other countries, particularly China;
- **technically feasible** as a result of advances in technologies for unmanned vehicles (UVs) and for networking widely distributed maritime forces that include significant numbers of UVs; and
- **affordable**—no more expensive, and possibly less expensive, than the current fleet architecture, for a given aggregate level of Navy capability.[13]

Reducing the LSC force-level goal from 104 ships to a smaller number could affect issues such as when to retire older LSCs and how many new LSCs to procure each year.

Section 121 of the FY2021 National Defense Authorization Act (H.R. 6395/P.L. 116-283 of January 1, 2021) states:

> SEC. 121. LIMITATION ON ALTERATION OF THE NAVY FLEET MIX.
>
> (a) LIMITATION.—
>
> (1) IN GENERAL.—The Secretary of the Navy may not deviate from the large surface combatant requirements included in the 2016 Navy Force Structure Assessment until the date on which the Secretary submits to the congressional defense committees the certification under paragraph (2) and the report under subsection (b).
>
> (2) CERTIFICATION.—The certification referred to in paragraph (1) is a certification, in writing, that the Navy can mitigate the reduction in multi-mission large surface combatant

[13] For additional discussion about shifting the Navy to a more distributed architecture, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

requirements, including anti-air and ballistic missile defense capabilities, due to having a reduced number of DDG–51 Destroyers with the advanced AN/SPY–6 radar in the next three decades.

(b) REPORT.—Not later than 90 days after the date of the enactment of this Act, the Secretary of the Navy shall submit to the congressional defense committees a report that includes—

(1) a description of likely detrimental impacts to the large surface combatant industrial base, and a plan to mitigate such impacts, if the fiscal year 2021 future-years defense program is implemented as proposed;

(2) a review of the benefits to the Navy fleet of the new AN/SPY–6 radar to be deployed aboard Flight III variant DDG–51 Destroyers, which are currently under construction, as well as an analysis of impacts to the warfighting capabilities of the fleet should the number of such destroyers be reduced; and

(3) a plan to fully implement section 131 of the National Defense Authorization for Fiscal Year 2020 (Public Law 116–92; 133 Stat. 1237), including subsystem prototyping efforts and funding by fiscal year.

Future DDG-51 Procurement Rate and Transition to DDG(X)

Another issue for Congress concerns the DDG-51 procurement rate in FY2023 and subsequent fiscal years, and how the Navy proposes to transition several years from now from procurement of DDG-51s to procurement of a successor destroyer design now in development called the DDG(X). Navy plans for transitioning from procurement of DDG-51s to procurement of DDG(X)s were an oversight focus for the defense committees in their reviews and markups of the Navy's proposed FY2020 and FY2021 budgets. Decisions regarding the future DDG-51 procurement rate and the transition to DDG(X) procurement will affect Navy capabilities and funding requirements and the U.S. shipbuilding industrial base. Recent documents have shown the following:

- The Navy's FY2020 budget submission and FY2020 30-year shipbuilding plan projected DDG-51s being procured during the period FY2022-FY2025 in annual quantities of 2-3-3-2, with FY2025 being the final year of DDG-51 procurement and the year that the first DDG(X) would be procured.
- The Navy's FY2021 budget submission projected DDG-51s being procured during the period FY2022-FY2025 in annual quantities of 2-1-2-1, and for DDG-51 procurement to end with the procurement of two final ships that would be procured in either FY2026 (both ships) or FY2026 and FY2027 (one ship each year). Under this budget submission, DDG(X) procurement might begin around FY2028.
- The December 9, 2020, document released by the outgoing Trump Administration projected DDG-51s being procured during the period FY2022-FY2026 in annual quantities of 2-2-2-2-2. The document did not specify the final year of DDG-51 procurement, but press reports suggest that the Navy wants to procure the first DDG(X) around FY2028.

For more on the DDG(X) program, see CRS In Focus IF11679, *Navy DDG(X) Future Large Surface Combatant Program: Background and Issues for Congress*, by Ronald O'Rourke.

Potential Impact of COVID-19 Pandemic

Another issue for Congress concerns the potential impact of the COVID-19 pandemic on the execution of U.S. military shipbuilding programs, including the DDG-51 program. For additional discussion of this issue, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Cost, Technical, and Schedule Risk in Flight III DDG-51 Effort

Another issue for Congress concerns cost, technical, and schedule risk for the Flight III DDG-51. A June 2020 Government Accountability Office (GAO) report assessing selected DOD acquisition programs stated the following in its assessment of the Flight III DDG-51:

> **Current Status**
>
> Flight III ships include considerable changes to DDG 51's design to incorporate the AN/SPY-6(V)1 radar and restore ship weight and stability safety margins. The program delayed the start of power and integration testing for the AN/SPY-6(V)1 radar from January 2019 to April 2020 due to software-related deficiencies that, according to program officials, are now resolved. Despite this delay, the Navy plans to deliver equipment, complete testing and installation on the ship, and activate the combat system for shipboard testing by January 2022. Further, it expects both the radar and software developed for the ship's combat system to be delivered before the power and integration testing is completed at the combat system development site, limiting opportunities to fix any issues prior to activation.
>
> The Navy plans to complete an integrated test and evaluation master plan for the ship, AN/SPY-6(V)1 radar, and the Aegis combat system by the time of combat system activation in January 2022. The plan, according to Navy officials, will not include the use of an unmanned self-defense test ship, although DOD's Director, Operational Test and Evaluation and the Navy previously disagreed on whether an unmanned ship was necessary to validate the end-to-end performance of Flight III ships—including the self-defense capability—during operational testing.
>
> The Navy continues construction on the lead Flight III ship, DDG 125, with plans for delivery in fiscal year 2023. Construction of the second ship is planned to start in April 2020. Officials report that the Navy has procured 11 ships using multiyear procurement authority and plans to award a contract for a 12th ship in fiscal year 2020. The current acquisition strategy includes 22 ships but, according to Navy officials, the total number of Flight III ships depends on the Navy's plans for its future large surface combatant ships.
>
> **Program Office Comments**
>
> We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program stated it has delivered 67 ships and is on track for delivery and initial capability of the first Flight III ship. According to the program, it rebaselined the radar test and delivery schedule to better align production and testing and is on track to complete radar testing prior to the start of shipboard testing. Further, the program said the development of the radar and software are on track to support integration.[14]

Regarding the AMDR specifically, the report stated the following:

> **Technology Maturity, Design Stability, and Production Readiness**

[14] Government Accountability Office, *Defense Acquisitions Annual Assessment[:] Drive to Deliver Capabilities Faster Increases Importance of Program Knowledge and Consistent Data for Oversight*, GAO-20-439, June 2020 p. 145.

In April 2019, the Navy approved AMDR to procure its 10th low-rate initial production radar in fiscal year 2020. According to the program, it has mature critical technologies, a stable design, and production processes in control. However, we continue to disagree that the technologies are fully mature. While the Navy continues to demonstrate some technologies through land-based testing at its Pacific Missile Range Facility (PMRF) and plans to integrate AMDR with the Aegis combat system at a separate land-based site for simulation and testing, AMDR's critical technologies cannot be assessed as fully mature until the Navy integrates AMDR and Aegis on the lead DDG 51 Flight III ship in 2022 during the Aegis Light Off (ALO) event. Following ALO, the Navy will operationally test AMDR and Aegis in a realistic, at-sea environment on the lead DDG 51 Flight III ship in 2023. While AMDR's design is currently stable, it remains at risk for disruption until the Navy completes this testing. In part, this risk is driven by the fact that the Navy is procuring more than two-thirds of its 22 total radars prior to completing operational testing. Any deficiencies the Navy discovers during at-sea testing could require revisions to existing design drawings or retrofitting to already built radars, which would likely increase costs or delay radar deliveries.

In order to support initial radar integration and testing with Aegis beginning in 2020, the Navy plans to install production radar components at the Aegis combat system land-based test site in New Jersey. Program officials said this is the first opportunity for AMDR and Aegis contractors to integrate the systems to test interfaces and software compatibility. The land-based tests will inform software development and integration of AMDR and Aegis in support of ALO on the lead DDG 51 Flight III ship in 2022.

AMDR is well into low-rate initial production but has yet to demonstrate statistical control of its critical manufacturing processes—an approach inconsistent with acquisition best practices. In December 2019, the program exercised contract options that brought the number of low-rate production units purchased to nine. However, the contractor continues to experience cost and schedule growth on production radars due to issues with its Digital Receiver Exciter (DREX)—a critical technology—and price variances on component materials, which could affect the program's procurement cost estimate if issues are not resolved. Officials said a DREX subcomponent does not meet its vibration specifications, despite a recent contractor redesign. The program is exploring multiple mitigation options. The contractor reported that these issues have delayed delivery of the first radar to at least August 2020, 4 months later than the contract's delivery date. Program officials said they could mitigate the issue by delivering the radar to the ship without the DREX unit and installing the unit later with minimal impact to the schedule. However, delays have already consumed schedule margin and may threaten the first DDG 51 Flight III installation in 2020 as well as AMDR/DDG 51 Flight III operational testing in 2023.

Software and Cybersecurity

AMDR has completed six of its nine software deliveries to support core radar capabilities, but additional development remains to add capabilities, integrate cybersecurity measures, and integrate AMDR with Aegis. Software is incrementally released every 4 months for testing before the final build is delivered to the end user every 10-12 months. Program officials said this aligns with Aegis software development, which is being developed concurrently. AMDR and Aegis software development will continue through 2021 while both systems integrate and test software.

The Navy has conducted some initial cybersecurity testing with AMDR but will not fully test cybersecurity capabilities with Aegis until at least 2023. However, the program reports some cost growth due to implementing cybersecurity controls. If cybersecurity issues arise during testing, additional software development may cause further cost growth or disrupt operational testing.

Other Program Issues

The program is developing an Advanced Distributed Radar (ADR) capability that leverages existing Navy technologies. The ADR capability increased the program's cost estimate, and the Navy projects it will require additional development funds through 2027. ADR is expected to improve AMDR capability through radar enhancements. ADR will be integrated on existing AMDR systems through software upgrades. The Navy plans to finalize ADR requirements and begin development in 2020. Full ADR capability will not be fielded until after the first AMDR-equipped DDG 51 Flight III is fielded in 2024.

Program Office Comments

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. It stated that AMDR design is stable but software deficiencies might be discovered during testing; AMDR's demonstrated performance exceeded its performance thresholds during land-based testing; and initial radar and Aegis integration began in 2016 and is on track to support ALO and operational testing. The program office also said the contract type for the low-rate initial production units minimizes the impact of component price variances and some radar components have been delivered to support DDG 51 Flight III construction schedules. According to the program office, initial cybersecurity updates are on track to complete in 2021.[15]

Legislative Activity for FY2022

Summary of Congressional Action on FY2022 Funding Request

Table 1 summarizes congressional action on the Navy's FY2022 procurement funding requests for the DDG-51 and DDG-1000 programs.

Table 1. Congressional Action on FY2022 Funding Request

Millions of dollars, rounded to nearest tenth

		Authorization			Appropriation		
	Request	HASC	SASC	Conf.	HAC	SAC	Conf.
DDG-51 procurement	2,016.8						
DDG-51 advance procurement (AP)	0.0						
DDG-51 cost to complete	45.8						
DDG-1000 procurement	56.6						

Source: Table prepared by CRS based on Navy's FY2022 budget submission, committee and conference reports, and explanatory statements on FY2022 National Defense Authorization Act and FY2022 DOD Appropriations Act.

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 agreement.

[15] Government Accountability Office, *Weapon Systems Annual Assessment[:] Limited Use of Knowledge-Based Practices Continues to Undercut DOD's Investments*, GAO-20-439, June 2020, p. 116.

Appendix. Additional Background Information on DDG-1000 Program

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

Overview

The DDG-1000 program was initiated in the early 1990s.[16] DDG-1000s (**Figure A-1**) are multi-mission destroyers with an originally intended emphasis on naval surface fire support (NSFS) and operations in littoral (i.e., near-shore) waters. (NSFS is the use of naval guns to provide fire support for friendly forces operating ashore.)

Figure A-1. DDG-1000 Class Destroyer

Source: U.S. Navy photo 151207-N-ZZ999-435, posted December 8, 2015, with a caption that reads in part: "The future USS Zumwalt (DDG 1000) is underway for the first time conducting at-sea tests and trials in the Atlantic Ocean Dec. 7, 2015."

DDG-1000s were originally intended to replace, in a technologically more modern form, the large-caliber naval gun fire capability that the Navy lost when it retired its Iowa-class battleships in the early 1990s,[17] to improve the Navy's general capabilities for operating in defended littoral

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

[17] 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.

waters, and to introduce several new technologies that would be available for use on future Navy ships. The DDG-1000 was also intended to serve as the basis for a planned cruiser called CG(X) that was subsequently canceled.[18]

DDG-1000s are to have reduced-size crews of 175 sailors (147 to operate the ship, plus a 28-person aviation detachment), compared to roughly 300 on the Navy's Aegis destroyers and cruisers, so as to reduce its operating and support (O&S) costs. The DDG-1000 design incorporates a significant number of new technologies, including an integrated electric-drive propulsion system[19] and automation technologies enabling its reduced-sized crew.

With an estimated full load displacement of 15,656 tons, the DDG-1000 design is substantially larger than the Navy's Aegis cruisers and destroyers, which have displacements of up to about 9,700 tons, and are larger than any Navy destroyer or cruiser since the nuclear-powered cruiser *Long Beach* (CGN-9), which was procured in FY1957.

The first two DDG-1000s were procured in FY2007 and split-funded (i.e., funded with two-year incremental funding) in FY2007-FY2008; the Navy's FY2021 budget submission estimates their combined procurement cost at $9,450.8 million. The third DDG-1000 was procured in FY2009 and split-funded in FY2009-FY2010; the Navy's FY2021 budget submission estimates its procurement cost at $3,855.1 million.

The first DDG-1000 was commissioned into service on September 7, 2016. Its delivery date was revised multiple times. In the Navy's FY2021 budget submission, the ship's delivery date was revised to March 2020. The ship's actual delivery date reportedly was April 2020.[20] This created an unusual situation in which a ship was commissioned into service more than three years prior to its delivery date. The delivery dates for the second and third ships have also been revised multiple times.[21] In the Navy's FY2022 budget submission, the delivery dates for the two ships were revised to March 2022 and April 2024, respectively.

Program Origin

The program known today as the DDG-1000 program was announced on November 1, 2001, when the Navy stated that it was replacing a destroyer-development effort called the DD-21 program, which the Navy had initiated in the mid-1990s, with a new Future Surface Combatant Program aimed at developing and acquiring a family of three new classes of surface combatants:[22]

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

[19] 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.

[20] See Aidan Quigley, "Final Delivery of Zumwalt-class Destroyer Monsoor Delayed," *Inside Defense*, January 21, 2021.

[21] The revised delivery dates for the three ships reflect Section 121 of the FY2017 National Defense Authorization Act (S. 2943/P.L. 114-328 of December 23, 2016), a provision that establishes standards for determining vessel delivery dates and which also required the Secretary of the Navy to certify that the delivery dates for certain ships, including the three DDG-1000s, had been adjusted in accordance with the provision. The Navy's original plan for the DDG-1000 program was to install certain elements of each DDG-1000's combat system after delivering the ship and commissioning it into service. Section 121 of P.L. 114-328 in effect requires the Navy to defer the delivery date of a DDG-1000 until those elements of the combat system are installed. By the time P.L. 114-328 was enacted, DDG-1000, per the Navy's original plan, had already been commissioned into service without those elements of its combat system.

[22] 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

- **a destroyer called DD(X)** for the precision long-range strike and naval gunfire mission;
- **a cruiser called CG(X)** for the air defense and ballistic missile mission; and
- **a smaller combatant called the Littoral Combat Ship (LCS)** to counter submarines, small surface attack craft (also called "swarm boats"), and mines in heavily contested littoral (near-shore) areas.[23]

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, would be named *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.[24]

New Technologies

The DDG-1000 incorporates a significant number of new technologies, including a wave-piercing, tumblehome hull design for reduced detectability,[25] a superstructure on the first two ships, but not the third that is made partly of large sections of composite (i.e., fiberglass-like) materials rather than steel or aluminum, an integrated electric-drive propulsion system,[26] a total-ship computing system for moving information about the ship, automation technologies enabling its reduced-sized crew, a dual-band radar (that was later changed to a single-band radar), a new kind of vertical launch system (VLS) for storing and firing missiles, and two copies of a new 155mm gun called the Advanced Gun System (AGS).

Shipbuilders and Combat System Prime Contractor

GD/BIW is the builder for all three DDG-1000s, with some portions of each ship being built by HII/Ingalls for delivery to GD/BIW. Raytheon is the prime contractor for the DDG-1000's combat system (its collection of sensors, computers, related software, displays, and weapon launchers).

Under a DDG-1000 acquisition strategy approved by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD AT&L) on February 24, 2004, the first DDG-1000 was to have been built by HII/Ingalls, the second ship was to have been built by GD/BIW, and

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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).

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

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

[25] 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.

[26] 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.

contracts for building the first six were to have been equally divided between HII/Ingalls[27] and GD/BIW.

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

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

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

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

On November 23, 2005, the USD AT&L granted Milestone B approval for the DDG-1000, permitting the program to enter the System Development and Demonstration (SDD) phase. As part of this decision, the USD AT&L approved the Navy's proposed dual-lead-ship acquisition strategy and a low rate initial production quantity of eight ships (one more than the Navy subsequently planned to procure).

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

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

On January 12, 2009, it was reported that the Navy, HII/Ingalls, and GD/BIW in the fall of 2008 began holding discussions on the idea of having GD/BIW build both the first and second DDG-1000s, in exchange for HII/Ingalls receiving a greater share of the new DDG-51s that would be procured under the Navy's July 2008 proposal to stop DDG-1000 procurement and restart DDG-51 procurement.[28]

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

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

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

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

Reduction in Procurement to Three Ships

Navy plans for many years called for ending DDG-51 procurement in FY2005, to be followed by procurement of up to 32 DDG-1000s and some number of CG(X)s. In subsequent years, the planned total number of DDG-1000s was reduced to 16 to 24, then to 7, and finally to 3.

At the end of July 2008, in a major reversal of its destroyer procurement plans, the Navy announced that it wanted to end procurement of DDG-1000s and resume procurement of DDG-51s. In explaining this reversal, which came after two DDG-1000s had been procured, the Navy stated that it had reevaluated the future operating environment and determined that its destroyer procurement now needed to emphasize three missions: open-ocean antisubmarine warfare (ASW), countering anti-ship cruise missiles (ASCMs), and countering ballistic missiles. Although the DDG-1000 could perform the first two of these missions and could be modified to perform the third, the Navy concluded that the DDG-51 design could perform these three missions adequately and would be less expensive to procure than the DDG-1000 design.

The Navy's proposal to stop procuring DDG-1000s and resume procuring DDG-51s was presented in the Navy's proposed FY2010 budget, which was submitted to Congress in 2009. Congress, in acting on the Navy's FY2010 budget, approved the idea of ending DDG-1000 procurement and restarting DDG-51 procurement, and procured a third DDG-1000 as the final ship in the class.

In retrospect, the Navy's 2008 reversal in its destroyer procurement plans can be viewed as an early indication of the ending of the post-Cold War era (during which the Navy focused its planning on operating in littoral waters against the land- and sea-based forces of countries such as Iran and North Korea) and the shift in the international security environment to renewed great power competition (during which the Navy is now focusing its planning more on being able to operate in mid-ocean waters against capable naval forces from near-peer competitors such as China and Russia).[29]

Increase in Estimated Procurement Cost

As shown in **Table A-1** below, the estimated combined procurement cost for all three DDG-1000s, as reflected in the Navy's annual budget submission, has grown by $4,328.8 million, or 48.2%, since the FY2009 budget (i.e., the budget for the fiscal year in which the third DDG-1000 was procured).

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

[29] For additional discussion, see CRS Report R43838, *Renewed Great Power Competition: Implications for Defense—Issues for Congress*, by Ronald O'Rourke, and CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by Ronald O'Rourke.

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

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

Budget submission	Estimated combined procurement cost (millions of dollars)	Change from prior year's budget submission	Cumulative change from FY2009 budget submission
FY09	8,977.1	—	—
FY10	9,372.5	+395.4 (+4.4%)	+395.4 (+4.4%)
FY11	9,993.3	+620.8 (+6.6%)	+1,016.2 (+11.3%)
FY12	11,308.8	+1,315.5 (+13.2%)	+2,331.7 (+26.0%)
FY13	11,470.1	+161.3 (+1.4%)	+2,493.0 (+27.8%)
FY14	11,618.4	+148.3 (+1.3%)	+2,641.3 (+29.4%)
FY15	12,069.4	+451.0 (+3.9%)	+3,092.3 (+34.4%)
FY16	12,288.7	+219.3 (+1.8%)	+3,311.6 (+36.9%)
FY17	12,738.2	+449.5 (+3.7%)	+3,761.1 (+41.9%)
FY18	12,882.0	+143.8 (+1.1%)	+3,904.0 (+43.5%)
FY19	13,032.2	+150.2 (+1.2%)	+4,055.1 (+45.1%)
FY20	13,195.5	+163.3 (+1.3%)	+4,218.4 (+47.0%)
FY21	13,275.6	+80.1 (+ 0.6%)	+4,298.5 (+47.9%)
FY22	13,305.9	+30.3 (+0.2+%)	+4,328.8 (+48.2%)

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

The Navy states that the cost growth shown through FY2015 in the table reflects, among other things, a series of incremental, year-by-year movements away from an earlier Navy cost estimate for the program, and toward a higher estimate developed by the Cost Assessment and Program Evaluation (CAPE) office within the Office of the Secretary of Defense (OSD). As one consequence of a Nunn-McCurdy cost breach experienced by the DDG-1000 program in 2010 (see discussion below), the Navy was directed to fund the DDG-1000 program to CAPE's higher cost estimate for the period FY2011-FY2015, and to the Navy's cost estimate for FY2016 and beyond. The Navy states that it implemented this directive in a year-by-year fashion with each budget submission from FY2010 through FY2015, moving incrementally closer each year through FY2015 to CAPE's higher estimate. The Navy stated in 2014 that even with the cost growth shown in the table, the DDG-1000 program as of the FY2015 budget submission was still about 3% below the program's rebaselined starting point for calculating any new Nunn-McCurdy cost breach on the program.[30]

Technical Risk and Test and Evaluation Issues

June 2020 GAO Report

A June 2020 GAO report assessing selected major DOD weapon acquisition programs stated the following of the DDG-1000 program:

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

Technology Maturity, Design Stability, and Production Readiness

The DDG 1000 program has fully matured most, but not all, of its nine original current critical technologies and reports a stable design. According to the Navy, the vertical launch system, infrared signature, and total ship computing environment are each continuing to approach maturity. The Navy expects to fully mature these systems as it completes ship construction, certification, and testing over the next 2 years. In addition to these nine technologies, the Navy has now added three critical technologies to meet its new mission: a communication system, an intelligence system, and the seeker on an offensive strike missile. These technologies are planned to be mature when they are integrated onto the ship, but this integration will not occur until several years after the ship undergoes testing. The Navy plans to complete operational testing of the lead ship in September 2021.

As of January 2020, the DDG 1000 program continues to finish construction on all three ships while still maturing the remaining critical technologies and further defining the ship's new mission. The Navy planned to complete delivery of the DDG 1000 with its combat systems in April 2020—a delay of 6 months from last year's review. In total, the lead ship is now 2 years late compared to the Navy's original plans to complete this milestone.

The Navy plans to complete delivery of the DDG 1001 with its combat systems in September 2020. Navy program officials stated that by leveraging lessons learned from DDG 1000 combat system activation, they can complete DDG 1001 combat systems delivery in less than 3 years. Lastly, the Navy plans to deliver DDG 1002 with its combat systems in September 2022—a 9-month delay from last year's estimate.

Software and Cybersecurity

As we reported last year, the Navy plans to complete software development for the class in September 2020—a delay of 24 months since our 2018 assessment largely due to optimistic schedules for development. As a result, the Navy has had to delay some testing that the ship must complete before it is ready to deploy. In addition, although the lead ship was delivered in 2016, the program is still continuing to deliver software builds that achieve some of the promised automation. Since the software is not as capable and does not enable as much automation as originally planned, among other things, the Navy has permanently added 31 sailors to the crew compared to initial estimates, increasing life-cycle costs.

The program plans to complete a cybersecurity vulnerability evaluation in fiscal year 2021 connected with section 1647 of the National Defense Authorization Act for Fiscal Year 2016. The program expects that this evaluation, along with the remainder of a 2-year regimen of certifications and several different tests in September 2020, will demonstrate the full functionality of the ship's systems, including cybersecurity capability. According to program officials, no cybersecurity issues have been identified to date.

Other Program Issues

In January 2018, the Navy changed the ship class's primary mission from land attack to offensive surface strike and updated its requirements document to reflect this new mission in July 2018. To begin to enable the new surface strike mission over the next 5 or more years, the Navy is requesting $160 million for four new systems for the ships: two missile systems, a communications system, and an intelligence system. One missile system is planned to be installed on all three ships by September 2021 at a cost of $66 million. The second missile system is not planned to be installed on any of the ships for at least 5 years and needs significant development at a cost of $45 million—additional funds will be needed to purchase and install the system. The communications system will be installed on all three ships by fiscal 2023 and costs $22 million. Lastly, the intelligence system is not planned to be installed on any of the ships for at least 5 years and needs significant development at a cost of $40 million—additional funds will be needed to purchase and install the system.

The cost to develop and install these four systems is in addition to the program's procurement cost as it is accounted for in other procurement and research and development funding. According to Navy officials, the Navy may continue to add capability to support the new mission.

Program Office Comments

We provided a draft of this assessment for program office review and comment. The program office provided technical comments, which we incorporated where appropriate. The office stated that it is making good progress in delivering DDG 1000 class ships to the fleet. After our date for assessing new information from programs, the office stated that in March 2020 the DDG 1000 had achieved sufficient combat system installation and activation for the Navy to take delivery and transition to the next phase of developmental and integrated at-sea testing. Further, the office said that in 2019, the DDG 1000 spent more than 100 days at sea to maintain crew proficiency, support fleet operations, conduct testing and provide an early opportunity for the ship to engage in operational scenarios. It also said the DDG 1001 completed its combat availability in March 2020 with a successful sea trial and is transitioning to combat systems activation. The office also said the final ship of the class, DDG 1002, is under construction and 93 percent complete, and that integration of the new systems will add offensive capability against targets afloat and ashore across the DDG 1000 class.[31]

Procurement Cost Cap

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

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

On February 1, 2010, the Navy notified Congress that the DDG-1000 program had experienced a critical cost breach under the Nunn-McCurdy provision. The Nunn-McCurdy provision (10 U.S.C. 2433a) requires certain actions to be taken if a major defense acquisition program exceeds (i.e., breaches) certain cost-growth thresholds and is not terminated. Among other things, a program that experiences a cost breach large enough to qualify under the provision as a critical cost breach has its previous acquisition system milestone certification revoked. (In the case of the DDG-1000 program, this was Milestone B.) In addition, for the program to proceed rather than be terminated, DOD must certify certain things, including that the program is essential to national security and that there are no alternatives to the program that will provide acceptable capability to meet the joint military requirement at less cost.[32]

The Navy stated in its February 1, 2010, notification letter that the DDG-1000 program's critical cost breach was a mathematical consequence of the program's truncation to three ships.[33] Since

[31] Government Accountability Office, *Defense Acquisitions Annual Assessment[:] Drive to Deliver Capabilities Faster Increases Importance of Program Knowledge and Consistent Data for Oversight*, GAO-20-439, June 2020, p. 122.

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

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

the DDG-1000 program has roughly $9.3 billion in research and development costs, truncating the program to three ships increased to roughly $3.1 billion the average amount of research and development costs that are included in the average acquisition cost (i.e., average research and development cost plus procurement cost) of each DDG-1000. The resulting increase in program acquisition unit cost (PAUC)—one of two measures used under the Nunn-McCurdy provision for measuring cost growth[34]—was enough to cause a Nunn-McCurdy critical cost breach.

In a June 1, 2010, letter (with attachment) to Congress, Ashton Carter, the DOD acquisition executive (i.e., the Under Secretary of Defense for Acquisition, Technology and Logistics), stated that he had restructured the DDG-1000 program and that he was issuing the certifications required under the Nunn-McCurdy provision for the restructured DDG-1000 program to proceed.[35] The letter stated that the restructuring of the DDG-1000 program included the following:

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

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

> As part of the Nunn-McCurdy certification process, the Volume Search Radar (VSR) hardware was identified as an acceptable opportunity to reduce cost in the program and thus was removed from the current baseline design....
>
> Modifications will be made to the SPY-3 Multi-Function Radar (MFR) with the focus of meeting ship Key Performance Parameters. The MFR modifications will involve software changes to perform a volume search functionality. Shipboard operators will be able to optimize the SPY-3 MFR for either horizon search or volume search. While optimized for volume search, the horizon search capability is limited. Without the VSR, DDG 1000 is still expected to perform local area air defense....
>
> The removal of the VSR will result in an estimated $300 million net total cost savings for the three-ship class. These savings will be used to offset the program cost increase as a result of the truncation of the program to three ships. The estimated cost of the MFR

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

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

> software modification to provide the volume search capability will be significantly less than the estimated procurement costs for the VSR.[36]

Regarding the figure of $300 million net total cost savings in the above passage, the Navy during 2011 determined that eliminating the SPY-4 VSR from the DDG-1000 increased by $54 million the cost to integrate the dual-band radar into the Navy's new Gerald R. Ford (CVN-78) class aircraft carriers.[37] Subtracting this $54 million cost from the above $300 million savings figure would bring the net total cost savings to about $246 million on a Navy-wide basis.

A July 26, 2010, press report quotes Captain James Syring, the DDG-1000 program manager, as stating the following: "We don't need the S-band radar to meet our requirements [for the DDG-1000]," and "You can meet [the DDG-1000's operational] requirements with [the] X-band [radar] with software modifications."[38]

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

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

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

An attachment to the letter directed the Navy to "return for a Defense Acquisition Board (DAB) review in the fall 2010 timeframe when the program is ready to seek approval of the new

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

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

[38] Cid Standifer, "Volume Radar Contracted For DDG-1000 Could Be Shifted To CVN-79," *Inside the Navy*, July 26, 2010. See also Joseph Trevithick and Tyler Rogoway, "Navy's Troubled Stealth Destroyers May Have Radars Replaced Before Ever Sailing On A Mission," *The Drive*, October 15, 2020.

Milestone B and authorization for production of the DDG-1002 [i.e., the third ship in the program]."

On October 8, 2010, DOD reinstated the DDG-1000 program's Milestone B certification and authorized the Navy to continue production of the first and second DDG-1000s and commence production of the third DDG-1000.[39]

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