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Navy CG(X) Cruiser Program: Background, Oversight Issues, and Options for Congress

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Navy CG(X) Cruiser Program: Background, Oversight Issues, and Options for Congress

Summary

The Navy is currently developing technologies and studying design options for a planned new cruiser called the CG(X). Navy plans call for procuring the first CG(X) in FY2011, at an estimated cost of about $3.2 billion, and 18 more CG(X)s in FY2013 and subsequent years. The 19 planned CG(X)s are intended to replace the Navy's 22 existing Ticonderoga (CG-47) class Aegis cruisers. The Navy wants the CG(X) to be a highly capable multi-mission ship with an emphasis on air defense and ballistic missile defense (BMD).

The context for the CG(X) program includes concerns about the affordability of the Navy's shipbuilding program, the emergence of the Navy's new ballistic missile defense (BMD) mission, interest among some in Congress in having the CG(X) be nuclear-powered, and concerns for the surface combatant industrial base.

The Navy's proposed FY2009 budget requests $370 million for research and development work on the CG(X). The Navy's proposed FY2009 budget does not request any advance procurement funding for the first CG(X). Under normal budgeting procedures, a nuclear-powered CG(X) procured in FY2011 would be funded with several hundred million dollars in FY2009 advance procurement funding for purchasing long-lead time components, including nuclear propulsion components.

The Navy in the past has expressed interest in basing the CG(X) design on the hull design of the Navy's new Zumwalt (DDG-1000) class destroyer. Two DDG-1000s have been procured, and the Navy wants to procure a third in FY2009. At a March 6, 2008, hearing before the House Armed Services Committee on the Department of the Navy's FY2009 budget, certain committee members indicated that they are considering the option of not procuring additional DDG-1000s and instead procuring additional Arleigh Burke (DDG-51) class Aegis destroyers. These DDG-51s, it was stated at the hearing, could act as a bridge to a CG(X) design based on an enlarged version of the DDG-51 hull and powered by one-half of the reactor plant that has been designed for the Navy's new Ford (CVN-78) class nuclear-powered aircraft carriers.

The CG(X) program raises several potential oversight issues for Congress. Congress has several options relating to the program. This report will be updated as events warrant.

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Introduction

The Navy is currently developing technologies and studying design options for a planned new cruiser called the CG(X).[1] Navy plans call for procuring the first CG(X) in FY2011, at an estimated cost of about $3.2 billion, and 18 more CG(X)s in FY2013 and subsequent years. The 19 planned CG(X)s are intended to replace the Navy's 22 existing Ticonderoga (CG-47) class Aegis cruisers. The Navy wants the CG(X) to be a highly capable multi-mission ship with an emphasis on air defense and ballistic missile defense (BMD).

The Navy's proposed FY2009 budget requests $370 million for research and development work on the CG(X). There is interest among some in Congress in having the CG(X) be nuclear-powered. Under normal budgeting procedures, a nuclear-powered CG(X) procured in FY2011 would be funded with several hundred million dollars in FY2009 advance procurement funding for purchasing long-lead time components, including nuclear propulsion components. The Navy's proposed FY2009 budget does not request any advance procurement funding for the first CG(X).

The Navy in the past has expressed interest in basing the CG(X) design on the hull design of the Navy's new Zumwalt (DDG-1000) class destroyer. Two DDG-1000s have been procured, and the Navy wants to procure a third in FY2009.[2] At a March 6, 2008, hearing before the House Armed Services Committee on the Department of the Navy's FY2009 budget, certain committee members indicated that they are considering the option of not procuring additional DDG-1000s and instead procuring additional Arleigh Burke (DDG-51) class Aegis destroyers. These DDG-51s, it was stated at the hearing, could act as a bridge to a CG(X) design based on an enlarged version of the DDG-51 hull and powered by one-half of the reactor plant that has been designed for the Navy's new Ford (CVN-78) class nuclear-powered aircraft carriers.[3]

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[1] In the designation CG(X), C means cruiser, G means guided missile, and (X) means that the ship's design has not yet been determined. For a surface ship, the term *guided missile* means the that ship is equipped with an air-defense system whose range is sufficient to defend not only the ship itself (called point defense), but other ships in the areas as well (called area defense).

[2] For more on the DDG-1000 program, see CRS Report RL32109, *Navy DDG-1000 Destroyer Program: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke.

[3] Source: transcript of spoken remarks of Representatives Gene Taylor and Jim Saxton at

(continued...)

The issue for Congress is whether to approve, reject, or modify the Navy's plans for the CG(X) program. Congress's decisions on this issue could affect Navy capabilities and funding requirements, U.S. BMD capabilities, and the U.S. shipbuilding industrial base.

Background

Context for CG(X) Program

The context for the CG(X) program that includes the following:

- concerns about the affordability of the Navy's shipbuilding program,
- the emergence of the Navy's new BMD mission,
- interest among some in Congress in having the CG(X) be nuclear-powered, and
- concerns for the surface combatant industrial base.

Affordability of Navy Shipbuilding Program. The Navy currently faces challenges in being able to afford all the ships in its shipbuilding program, particularly in FY2011 and subsequent years — the years when the Navy wants to procure CG(X)s.[4] Because the designs of most of the ships in the Navy's shipbuilding program for the next several years are already determined, the CG(X) is one of the Navy's relatively few remaining opportunities to use a new ship design to manage the overall cost of the shipbuilding program.

New Navy Mission of Ballistic Missile Defense. BMD has emerged in recent years as a significant new mission for the Navy. Navy surface ships in coming years may face a threat from theater-range ballistic missiles (TBMs) equipped with maneuvering re-entry vehicles (MaRVs) that are capable of hitting moving ships at sea — a kind of theat the Navy has not previously faced.[5] Navy BMD capabilities could also be used to defend allied or friendly ports, airfields, cities, or forces ashore against enemy TBMs, or to defend the United States against enemy intercontinental ballistic missiles (ICBMs).[6] The Navy's desire for the CG(X) to be a high-capability

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[3] (...continued)
the hearing.

[4] For more on the prospective affordability of the Navy's shipbuilding program, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

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

[6] For further discussion of the Navy's BMD program, see CRS Report RL33745, *Sea-Based* (continued...)

BMD platform is a principal reason why the Navy wants the CG(X) to carry a radar that is larger and more powerful than the SPY-1 radar on the Navy's current Aegis cruisers and destroyers. The size, weight, energy requirements, and cooling requirements of this radar may help set a lower limit for the size and cost of the CG(X).

Interest in Nuclear Power for Surface Ships. Representatives Gene Taylor and Roscoe Bartlett, the chairman and ranking member, respectively, of the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee, strongly support expanding the use of nuclear power to a wider array of Navy surface ships, beginning with the CG(X).[7] Representative John Murtha, the chairman of the Defense subcommittee of the House Appropriations Committee, has referred to the CG(X) as a nuclear-powered ship.[8] Section 1012 of the FY2008 defense authorization act (H.R. 4986/P.L.110-181 of January 28, 2008) makes it the policy of the United States to build new classes of ships like the CG(X) with nuclear power unless the Secretary of Defense submits a notification to Congress that using nuclear power would not be in the national interest. The conference report on P.L. 110-181 contained extensive report language relating to Section 1012 (see **Appendix A**). The issue of nuclear power for Navy surface ships is discussed in more detail in another CRS report.[9]

Concern for Surface Combatant Industrial Base. All cruisers, destroyers, and frigates procured by the Navy since FY1985 have been built by either General Dynamics' Bath Iron Works (GD/BIW) in Bath, ME, or the Ingalls shipyard in Pascagoula, MS, that forms part of Northrop Grumman Ship Shipbuilding (NGSB).[10] The financial health of shipyards that build ships for the Navy, including these two yards, has been a matter of concern at various points since the early 1990s, when the rate of Navy shipbuilding was reduced following the end of the Cold War. The surface combatant industrial base also includes hundreds of additional firms that supply materials and components, and the financial health of some of these firms has been a matter of concern in recent years, particularly because some of them are the sole sources for what they make for Navy surface combatants.

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[6] (...continued)
Ballistic Missile Defense — Background and Issues for Congress, by Ronald O'Rourke.

[7] See, for example, the remarks of Representatives Taylor and Bartlett at the March 14, 2008, hearing before the Seapower and Expeditionary Forces subcommittee on the Navy's FY2009 shipbuilding program.

[8] See, for example, Ashley Roque, "Murtha, Young Press Navy on Shipbuilding Plan, Look To Alter 2009 Budget," *CongressNow, February 27, 2008.*

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

[10] NGSB also includes the Avondale shipyard near New Orleans, LA, Newport News Shipbuilding of Newport News, VA, and a composite-manufacturing facility at Gulfport, MS.

CG(X) Program in Brief

Announcement of CG(X) Program. The CG(X) program was announced on November 1, 2001, when the Navy stated that it was launching a Future Surface Combatant Program aimed at acquiring a family of next-generation surface combatants. This new family of surface combatants, the Navy stated, would include three new classes of ships:[11]

- **a destroyer called the DD(X)** — later renamed the DDG-1000 or Zumwalt class — for the precision long-range strike and naval gunfire mission,[12]
- **a cruiser called the CG(X)** for the air defense and ballistic missile defense mission, and
- **a smaller combatant called the Littoral Combat Ship (LCS)** to counter submarines, small surface attack craft, and mines in heavily contested littoral (near-shore) areas.[13]

CG(X)s to Replace CG-47s. The Navy wants to procure 19 CG(X)s as replacements for its 22 existing Ticonderoga (CG-47) class Aegis cruisers, which are projected to reach their retirement age of 35 years between 2021 and 2029.[14] The 19

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[11] The Future Surface Combatant Program replaced an earlier Navy surface combatant acquisition effort, begun in the mid-1990s, called the Surface Combatant for the 21st Century (SC-21) program. The SC-21 program encompassed a planned destroyer called DD-21 and a planned cruiser called CG-21. When the Navy announced the Future Surface Combatant Program in 2001, development work on the DD-21 had been underway for several years, but the start of development work on the CG-21 was still years in the future. The DD(X) program, now called the DDG-1000 or Zumwalt-class program, is essentially a restructured continuation of the DD-21 program. The CG(X) might be considered the successor, in planning terms, of the CG-21. 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 the DDG-1000 and CG(X).

[12] For more on the DDG-1000 program, see CRS Report RL32109, *Navy DDG-1000 (DD(X)) Destroyer Program: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke.

[13] 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.

[14] CG-47s are equipped with the Aegis combat system and are therefore referred to as Aegis cruisers. A total of 27 CG-47s were procured for the Navy between FY1978 and FY1988; the ships entered service between 1983 and 1994. The first five, which were built to an earlier technical standard, were judged by the Navy to be too expensive to modernize and were removed from service in 2004-2005. The Navy is currently modernizing the remaining 22 to maintain their mission effectiveness to age 35; for more information, see CRS Report RS22595, *Navy Aegis Cruiser and Destroyer Modernization: Background and Issues for Congress*, by Ronald O'Rourke.

CG(X)s would form part of a planned force of 88 cruisers and destroyers within the Navy's planned total fleet of 313 ships.[15]

Planned CG(X) Procurement Schedule. The FY2009-FY2013 Future Years Defense Plan (FYDP) submitted to Congress in February 2008 calls for procuring the first CG(X) in FY2011 and the second in FY2013. The FY2009-FY2038 Navy 30-year shipbuilding plan submitted to Congress in February 2008 calls for building 17 more CG(X)s between FY2014 and FY2023, including two CG(X)s per year for the seven-year period FY2015-FY2021.

CG(X) Mission Orientation. The Navy's Aegis cruisers are highly capable multi-mission ships with an emphasis on air defense (which the Navy calls anti-air warfare, or AAW) and, as a more recent addition, BMD. The Navy similarly wants the CG(X) to be a highly capable multi-mission ship with an emphasis on AAW and BMD.

Potential CG(X) Design Features. Although many design features of the CG(X) have not been determined, it is expected that the CG(X) will incorporate many basic technologies developed for the DDG-1000, including technologies permitting a crew that is significantly smaller in number than the crews of current cruisers and destroyers.

The CG(X) is expected to feature a radar that is larger and more powerful than the SPY-1 radar on the Navy's current Aegis cruisers and destroyers or the dual-band radar that is to be carried by the DDG-1000. The Navy has testified that the power requirement of the CG(X) combat system, including the new radar, could be about 30 or 31 megawatts, compared with about 5 megawatts for the Aegis combat system.[16] The CG(X) radar's greater power is intended, among other things, to give the CG(X) more capability for BMD operations than Navy's Aegis cruisers and destroyers (or the DDG-1000, for which BMD is not a principal mission).

The CG(X) is expected to feature more missile-launch tubes than the DDG-1000 (which has 80), and possibly more than the Navy's current Aegis destroyers (90 or 96 each) or Aegis cruisers (122 each).

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[15] The 88 cruisers and destroyers would include 19 CG(X)s, 7 DDG-1000s, and 62 older Arleigh Burke (DDG-51) class Aegis destroyers. 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. DDG-51s are equipped with the Aegis combat system and are therefore referred to as Aegis destroyers. A total of 62 DDG-51s were procured between FY1985 and FY2005. The first entered service in 1991. By the end of FY2006, 49 had entered service and the remaining 13 were in various stages of construction, with the final ships scheduled to be delivered in 2010 or 2011. The Navy plans to modernize the DDG-51s to maintain their mission effectiveness to age 35; see CRS Report RS22595, op cit.

[16] Source: Spoken testimony of Navy officials to the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee, March 1, 2007.

The CG(X) may be equipped with only one 155mm Advanced Gun System (AGS), or none at all, compared with two AGSs on the DDG-51, two five-inch (127mm) guns on the Navy's Aegis cruisers, and one five-inch gun on the Navy's Aegis destroyers.

CG(X) Analysis of Alternatives (AOA). The Navy has assessed CG(X) design options, including the option of nuclear power, in a study called the CG(X) Analysis of Alternatives (AOA), known more formally as the Maritime Air and Missile Defense of Joint Forces (MAMDJF) AOA. As of mid-March 2008, the Navy had not publicly released the results of the AOA. The Navy testified on March 14, 2008, that:

> The results of the Navy's Analysis of Alternatives (AOA) for the Maritime Air and Missile Defense of Joint Forces capability are currently within the Navy staffing process. Resulting requirements definition and acquisition plans, including schedule options and associated risks, are being evaluated in preparation for CG(X) Milestone A, planned to occur in FY 2008. This process includes recognition of the requirement of the FY 2008 National Defense Authorization Act, that all major combatant vessels of the Untied States Navy strike forces be constructed with an integrated nuclear power plant, unless the Secretary of Defense determines this not to be in the best interest of the United States.[17]

Past Stated Preference for CG(X) Design Based on DDG-1000. Although the CG(X) AOA examined a range of design options for the CG(X), the Navy has publicly stated in the past that it prefers a CG(X) design based on the conventionally powered DDG-1000 hull design. The potential for using the DDG-1000 hull design as the basis for the CG(X) was one of the Navy's arguments for moving ahead with the DDG-1000 program. At an April 5, 2006, hearing, a Navy admiral in charge of shipbuilding programs, when asked what percentage of the CG(X) design would be common to that of the DDG-1000, stated the following:

> [W]e haven't defined CG(X) in a way to give you a crisp answer to that question, because there are variations in weapons systems and sensors to go with that. But we're operating under the belief that the hull will fundamentally be — the hull mechanical and electrical piece of CG(X) will be the same, identical as DD(X). So the infrastructure that supports radar and communications gear into the integrated deckhouse would be the same fundamental structure and layout. I believe to accommodate the kinds of technologies CG(X) is thinking about arraying, you'd probably get 60 to 70 percent of the DD(X) hull and integrated (inaudible) common between DD(X) and CG(X), with the variation being in that last 35 percent for weapons and that sort of [thing]....
>
> The big difference [between CG(X) and DDG-1000] will likely [be] the size of the arrays for the radars; the numbers of communication apertures in the

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[17] 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 [hearing] on Navy Force Structure and Shipbuilding, March 14, 2008, p. 9.

> integrated deckhouse; a little bit of variation in the CIC [Combat Information Center — in other words, the] command and control center; [and] likely some variation in how many launchers of missiles you have versus the guns.[18]

July 2007 Press Report on Potential Dual-Design Solution. A July 23, 2007, defense trade press report stated that analysts conducting the CG(X) AOA were considering dividing the CG(X) program into two groups of ships — 14 smaller, conventionally powered CG(X)s based on the 14,500-ton DDG-1000 hull design for AAW operations, and 5 larger, nuclear-powered CGN(X)s,[19] displacing 23,000 tons to 25,000 tons each, for BMD operations. The report stated:

> Under pressure from the U.S. Navy to develop a new cruiser based on the DDG 1000 Zumwalt-class hull form, and from Congress to incorporate nuclear power, a group of analysts working on the next big surface combatant may recommend two different ships to form the CG(X) program.
>
> One ship would be a 14,000-ton derivative of the DDG 1000, an "escort cruiser," to protect aircraft carrier strike groups. The vessel would keep the tumblehome hull of the DDG 1000[20] and its gas turbine power plant.
>
> The other new cruiser would be a much larger, 25,000-ton nuclear-powered ship with a more conventional flared bow, optimized for the ballistic missile defense (BMD) mission.
>
> In all, five large CGN(X) ships and 14 escort cruisers would be built to fulfill the cruiser requirement in the Navy's 30-year, 313-ship plan, which calls for replacing today's CG 47 Ticonderoga-class Aegis cruisers and adding a specially designed sea-based missile defense force....
>
> The analysis group is said to be firm in its recommendation for the smaller escort cruiser. Details are less developed on the nuclear-powered variant, sources said.

The article also stated:

> The anti-missile cruiser also wouldn't require the high level of stealth provided by the Zumwalt's tumblehome hull, analysts said, since the ship would be radiating its radars to search for missiles. Returning to a more conventional,

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[18] Source: Transcript of spoken testimony of Rear Admiral Charles Hamilton II, Program Executive Officer For Ships, Naval Sea Systems Command, before the Projection Forces Subcommittee of House Armed Services Committee, April 5, 2006. The inaudible comment may have been a reference to the DDG-1000's integrated electric-drive propulsion system. Between the two paragraphs quoted above, the questioner (Representative Gene Taylor) asked: "So the big difference [between CG(X) and DDG-1000] will be what?"

[19] If the ship is nuclear-powered, its designation would become CGN(X), with the "N" standing for nuclear power.

[20] A tumblehome hull slopes inward as it rises up from the waterline. A tumblehome hull is thought to be less visible to enemy radars than a conventional flared hull, which slopes outward as it rises up from the waterline, creating a corner reflector between the water and the hull that can strongly reflect enemy radar beams.

flared-bow hull form would free designers from worries about overloading the untried tumblehome hull.

"There will be great reluctance to use the wave-piercing tumblehome hull form for the larger ship," said one experience[d] naval engineer. He noted the DDG 1000 stealth requirement is necessary for the ship's ability to operate in waters near coastlines, but that the open-ocean region where a BMD ship would operate "means you don't need to go to the extremes of the tumblehome form."

Splitting the CG(X) into two designs also makes political sense, sources said.

"There's a concern that the DDG hull has stability problems and doesn't have growth margin," said a congressional source. A nuclear-powered option, the source said, also would placate Congress, and "a cash-strapped Navy wouldn't be fully committed to a nuclear ship....

The nuclear ship also would need to be larger than the DDG 1000. In separate statements, Navy officials have been hinting that a 20,000-ton-plus ship could be in the works.

Sources said early analyses of the CGN(X) showed a 25,000-ton ship, which the Navy said was too large. More realistic, one source said, would be about 23,000 tons.[21]

October 2007 Press Report on AOA. An October 29, 2007, defense trade press report on the CG(X) AOA stated:

A study refining the definition of the future CG(X) cruiser was recently completed and will be vetted by Navy officials in the near future, a top shipbuilding official said here last week.

Rear Adm. Bernard McCullough, the Navy's director of warfare integration (N8F), told Inside the Navy on Oct. 24 that the analysis of alternatives (AOA) for the new cruiser recommends "about four" variants.

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[21] Christopher P. Cavas, "U.S. May Build 25,000-Ton Cruiser, Analysis of Alternatives Sees Nuclear BMD Vessel," *Defense News*, July 23, 2007. The article also stated:

According to sources, the AoA looked at two possible nuclear powerplants based on existing designs: doubling the single-reactor Seawolf SSN 21 submarine plant, and halving two-reactor nuclear carrier plants.

Doubling the 34 megawatts of the Seawolf plant would leave the new ship far short of power requirements — and not even match the 78 megawatts of the Zumwalts.

But halving the 209-megawatt plant of current nuclear carriers would yield a bit more than 100 megawatts, enough juice for power-hungry BMD radars plus an extra measure for the Navy's desired future directed-energy weapons and railguns.

> One of those options calls for splitting the ship program and building two different size hulls for the surface combatant, one based on the DDG-1000 destroyer and one that is larger, he confirmed.
>
> "There's about four options and that's one of the options," McCullough told [*Inside the Navy*] at an expeditionary warfare conference in Panama City, FL.
>
> The analysis — conducted by researchers at the Center for Naval Analyses — will be "briefed out to Navy leadership, starting in about another two weeks," McCullough said....
>
> Further Navy analysis of the AOA will examine the life-cycle and acquisition costs of the options, McCullough said. The Navy's surface warfare directorate will then make a presentation to officials including Navy Secretary Donald Winter, he said.[22]

January 2008 Press Report on AOA. A January 21, 2008, defense trade press report on the CG(X) AOA stated:

> Navy staff members are in the midst of answering Chief of Naval Operations Adm. Gary Roughead's questions on a lengthy study of options for the configuration of the service's next cruiser, naval officials told Inside the Navy.
>
> Rear Adm. Victor Guillory, director of surface warfare (N86), described the analysis of alternatives (AOA) on the future CG(X) as a roughly 500-page document that includes "a collection of options of analysis from various sources" into aspects of the next-generation cruiser.
>
> The CG(X) analysis delivered last year by the Center for Naval Analyses (CNA) — which Navy and industry sources said describes a handful of possible variants for the ship, including a nuclear-powered vessel — is just part of what is now the CG(X) AOA, Guillory told ITN [Inside the Navy] Jan. 15 at the Surface Navy Association's [SNA's] annual symposium in Arlington, VA.
>
> Guillory said the current AOA does not include "specific options that this is one version of the ship, this is another version."
>
> "The options are the next level down," he said. " So, what are all the potential propulsion options for the ship . . . Then you look at the combat systems level, you look at the weapons level, you look at the manning level, you look at the shore-infrastructure-support level."
>
> Roughead "has not made a determination that the analysis satisfies all his questions, so we're still answering questions," Guillory said. A lot of those questions don't require CNA's input, because they are questions Navy staff has to answer, he added.

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[22] Emelie Rutherford, "Analysis Of Alternatives For FutureCG(X) Cruiser Completed," *Inside the Navy*, October 29, 2007.

"There may be questions related to some other aspect of [the] Navy," Guillory said. "For instance, how will CG(X) impact our replenishment ships? Do we need more oilers? That's not necessarily a CG(X) question, but it is a Navy question."

Vice Adm. Bernard McCullough, deputy chief of naval operations for integration of capabilities and resources, said there has been one briefing session on the CG(X) AOA with Roughead in recent weeks.

"We're briefing the study report to CNO," McCullough told ITN on Jan. 16 in a brief interview at the SNA conference. "We've had one session with him; I imagine it will take a couple more."

McCullough added one would expect the service chief to have questions on an investment of the magnitude of the new cruiser.

The report also stated:

Guillory said Navy staff will continue to answer Roughead's questions on the AOA "until further notice . . . until we satisfy all of his questions."

"There's no timetable for when he has to be satisfied, he can continue to ask me questions forever," Guillory said. "At some point, then, they will be passed over to the secretary of the Navy, the secretariat side, for their approval and then forwarding on to [the Office of the Secretary of Defense], who ultimately is the receiver of the analysis of alternatives."

Guillory said the AOA is "a lot to read," and that it is his responsibility "to make that discussion palatable at every level" for Roughead.

While parts of the AOA are made up of the CNA's analysis, Guillory said the document also includes work by Naval Sea Systems Command and other entities such as laboratories.

"There are a lot of sources of information that [go] into this body of work," he said.

Nuclear power is one of many options for the CG(X) propulsion system, with other alternatives including steam, sail, marine gas turbine and diesel, Guillory said.

"And then every aspect of that, not only how much it costs to build one but then to maintain one," he said. "Does it take more people for a nuclear ship than it does for a gas turbine ship, what's the life-cycle cost of that."...

Roughead told SNA conference attendees on Jan. 15 that nuclear power is being weighed for the CG(X).

"I believe as we look to the future and you look at CG(X), to go down that path and not be examining nuclear power, given what that power can produce for us operationally, but also looking at the realities of the future, we have to take that into account and put that into our calculus," Roughead said.

> "As we look to the future we have to be considering it," the CNO added. "If you look around the country there are a lot of other people that are considering nuclear power as well." [23]

CG(X) Program Funding. **Table 1** shows actual, requested, and programmed funding for the CG(X) program through FY2013. The $3,234-million procurement cost shown in the table for the first CG(X) is a notional "placeholder" figure, pending the final design of the CG(X), that appears broadly consistent with a Navy-estimated cost of a CG(X) design based on the DDG-1000 hull design.

Table 1. CG(X) Program Funding, FY2005-FY2013

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

	05	06	07	08	09	10	11	12	13	Total thru FY13
Research, Development, Test and Evaluation, Navy (RDTEN) account										
PE0604300N (DDG-1000 [previously SC-21] Total Ship System Engineering)										
Project 3105[a]	0	0	0	1	0	0	0	0	0	1
Project 3106[b]	0	0	9	30	58	80	91	93	95	456
Project 3107[c]	0	48	15	85	172	222	240	245	249	1276
PE0604307N (Aegis Combat System Engineering)										
Project 3044[d]	3	11	30	0	0	0	0	0	0	44
PE0604501N (Advanced Above Water Sensors)										
Project 3186[e]	0	0	0	107	140	149	179	182	186	943
Subtotal	**3**	**59**	**54**	**223**	**370**	**451**	**510**	**520**	**530**	**2720**
Shipbuilding and Conversion, Navy (SCN) account										
CG(X) 1	0	0	0	0	0	0	3234	0	0	3234
CG(X) 2	0	0	0	0	0	0	0	0	3064	3064
TOTAL	**3**	**59**	**54**	**223**	**370**	**451**	**3744**	**520**	**3594**	**9018**

Source: Navy FY2009, FY2008, and FY2007 budget submissions.

a. Block II Seeker Technology Development.

b. Combat System Integration.

c. CG(X) Development.

d. Solid State SPY Radar. Funding transferred to Project 3186 within PE 0604501N starting in FY2008.

e. Air and Missile Defense Radar. Funding transferred from Project 3044 within PE 0604307N starting in FY2008.

[23] Emelie Rutherford, "Navy Staff Answering CNO's Questions On Next-Gen Cruiser Analysis," *Inside the Navy*, January 21, 2008.

Oversight Issues for Congress

Absence of an Announced Top-Level Design

Although the Navy wants to procure the lead CG(X) in FY2011, the Navy has not yet announced a top-level design for the CG(X), meaning a basic scheme for the ship's size, hull design, and principal design features. As discussed in the "Background" section, Navy officials have stated that they are still examining requirements and design options for the ship. The absence at this point of an announced top-level design for the CG(X) raises at least two potential oversight questions for Congress:

- Is the Navy leaving itself enough time, following the eventual announcement of a top-level CG(X) design, to do the remaining design work needed to support the procurement of a lead CG(X) in FY2011? Is the Navy, in other words, at risk of getting into a situation of having to rush the CG(X) design effort?

- Because a nuclear-powered CG(X) procured in FY2011 would normally receive advance procurement funding in FY2009, at what point would the continued passage of time without an announcement of a top-level design for the CG(X) impinge on the timely execution of the option of procuring a nuclear-powered lead CG(X) in FY2011?

Accuracy of Navy Cost Estimate

CBO believes that the Navy is substantially underestimating DDG-1000 procurement costs[24] and consequently is also substantially underestimating likely CG(X) procurement costs. CBO testified in March 2008 that it believes the first two CG(X)s would cost roughly twice as much as the Navy estimates, and that the average unit cost for all 19 CG(X)s would be about 40% more than the Navy estimated in 2007. CBO also believes that its own cost estimates for the CG(X) may be prove to be too low. CBO testified in March 2008 that:

> CBO's estimates for the first two ships of the class are about double the Navy's estimates. CBO assumed that a CG(X) would use the same hull as a DDG-1000. The Navy's budget estimates for the 2011 and 2013 cruisers are based on the same assumption; the Navy expects those ships to cost $2.8 billion and $2.5 billion, respectively.... [A] version of the CG(X) built using the DDG-1000 hull is only one of the options considered in the [CG(X)] AoA. The Navy says it is studying other options that would be larger and more capable than a CG(X) built using the DDG-1000 hull, including ships using nuclear propulsion.... The Navy does not appear to be considering a ship smaller than the DDG-1000 as the basis for the CG(X). Any design for the CG(X) larger than the

[24] Statement of Eric J. Labs, Senior Analyst, [on] Current and Projected navy Shipbuilding Programs, before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives, March 14, 2008, pp. 18-20.

DDG-1000 is likely to be substantially more expensive than the DDG-1000. Using the [Arleigh Burke] DDG-51 [class] as an analogy [for cost-estimating purposes], CBO estimates that the lead CG(X)s will cost $5.2 billion. The average cost for the class would be about $4.2 billion apiece, assuming that the CG(X) is conventionally powered and uses the DDG-1000 hull [compared to a 2007 Navy estimate of $3.0 billion apiece].[25] CBO also assumed, consistent with the DDG-1000 program, that two shipyards would build the CG(X)s.

Moreover, CBO's estimate for the cost of the CG(X) may be optimistic. The last time the Navy reused a hull design for a new class of surface combatants was in the 1970s, when the service built the Spruance class destroyers and Ticonderoga class cruisers. Both ship classes shared the same hull but were designed for different missions. The Spruances were general-purpose destroyers used to escort other Navy ships in the event of war and were designed in particular for antisubmarine warfare. The Ticonderoga class cruisers incorporated the Aegis antiair combat system, the SPY-1 radar, and surface-to-air missiles to counter the threat to Navy carrier battle groups posed by Soviet naval aviation. Reflecting its more complex combat systems, the cost per thousand tons [of displacement] of the lead Ticonderoga was more than 60 percent higher than the cost of the lead Spruance, notwithstanding their many common hull and mechanical systems.[26]

CBO also testified in March 2008 that:

Building a future nuclear cruiser, a CGN(X), would probably cost more than what the Congressional Budget Office (or the Navy) has currently estimated for the CG(X). A Navy report on the cost-effectiveness of nuclear propulsion estimates that the additional cost to install nuclear propulsion in a conventionally powered surface combatant would be approximately $700 million. If a CGN(X) has to be much larger than the DDG-1000, then there would probably be additional costs. Press reports have indicated that a CGN(X) could displace as much as 23,000 to 25,000 tons, or 60 percent to 70 percent more than the DDG-1000. (A large ship may be necessary, for example, if the Navy were to use for the CGN(X) one of the reactors now used in the CVN-78 class of aircraft carrier because, according to the Navy, that reactor's size, weight, and supporting systems could not be accommodated within a hull the size of the DDG-1000.) If that is the case, the larger, nuclear-powered CGN(X) could cost much more than the DDG-1000.[27]

CBO also testified in March 2008 that:

The relatively simple design of the LCSs and the substantial cost increases that have occurred in the program suggest that the Navy may also have trouble

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[25] The 2007 Navy estimate of $3.0 billion apiece appears in Table 4 (page 17) of the CBO testimony being quoted here.

[26] Ibid, p. 20-21.

[27] Ibid, p. 21 (Box 1).

> meeting its cost targets for the larger, much more complex surface combatants in its shipbuilding plan, such as the DDG-1000 and the CG(X).[28]

Nuclear Power

A major issue for the CG(X) program is whether some or all CG(X)s should be nuclear-powered. As mentioned in the "Background" section, the chairman and ranking member of the Seapower and Expeditionary Forces subcommittee of the House Armed Services Committee strongly support making the CG(X) a nuclear-powered ship, and the chairman of the Defense subcommittee of the House Appropriations Committee has referred to the CG(X) as a nuclear-powered ship. As also mentioned earlier, Section 1012 of the FY2008 defense authorization act (H.R. 4986/P.L.110-181 of January 28, 2008) makes it the policy of the United States to build new classes of ships like the CG(X) with nuclear power unless the Secretary of Defense submits a notification to Congress that using nuclear power would not be in the national interest. The conference report on P.L. 110-181 contained extensive report language relating to Section 1012 (see **Appendix A**).

The Navy's proposed FY2009 budget does not request any advance procurement funding for the first CG(X). Under normal budgeting procedures, a nuclear-powered CG(X) procured in FY2011 would be funded with several hundred million dollars in FY2009 advance procurement funding for purchasing nuclear propulsion components and other long-lead time components.

The Navy reported to Congress in January 2007 that equipping a ship like the CG(X) with a nuclear power plant instead of a conventional (i.e., fossil-fuel) power plant would, other things held equal, increase the unit procurement cost of follow-on ships in the class by about $600 million to $700 million in constant FY2007 dollars. The report concluded that if oil prices in coming years are high, much or all of the increase in unit procurement cost could be offset over the ship's service life by avoided fossil-fuel costs.

A nuclear-powered CG(X) would be more capable than a corresponding conventionally powered version because of the mobility advantages of nuclear propulsion, which include, for example, the ability to make long-distance transits at high speeds in response to distant contingencies without need for refueling. Navy officials have also stated that a nuclear power plant might be appropriate for the CG(X) in light of the high energy requirements of the CG(X)'s powerful BMD-capable radar.[29]

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[28] Ibid, p. 24.

[29] See, for example, the comments of Rear Admiral Kevin McCoy at a June 25, 2007, conference in Arlington, VA, sponsored by the American Society of Naval Engineers (ASNE). A news article reporting McCoy's remarks stated in part:

> McCoy has cautioned that the [Navy's] alternate propulsion study [submitted to Congress in January 2007] is not a specific recommendation for using nuclear propulsion for the CG(X) cruisers, which are intended to perform

(continued...)

As mentioned earlier, one potential oversight question for Congress is at what point the continued passage of time without an announcement of a top-level design for the CG(X) would impinge on the timely execution of the option of procuring a nuclear-powered lead CG(X) in FY2011.

For more on the issue of nuclear power for Navy surface ships, see CRS Report RL33946, *Navy Nuclear-Powered Surface Ships: Background, Issues, and Options for Congress*, by Ronald O'Rourke.

Technical Risk

The CG(X) is to use many new technologies being developed for the DDG-1000. The Navy is now working to retire the technical risks associated with these technologies, so that they will be ready for installation on the two lead DDG-1000s, which were procured in FY2007.[30]

A potential key technical risk specific to the CG(X) program concerns its powerful new BMD-capable radar. Delays in the development of this radar could lead to delays in the construction of a CG(X) procured in FY2011. A November 29, 2007, press article reported that Rear Admiral Alan Hicks, the director of the Aegis ballistic missile defense (BMD) program, "cautioned" that

> the Navy shouldn't attempt to go with a radically advanced radar for CG (X), at least not initially. Rather, he said, it might be wiser to go with incremental upgrades, steadily improving radar technology on the future cruiser that will take shape in the next decade, just as the existing Aegis system on cruisers and destroyers today has been upgraded steadily over two decades.
>
> "Lots of people want to build this incredible radar," Hicks said. On the one hand, he sees that as a valid eventual goal. But "I do believe you need to get there in a stepped function. Jumping to a radar that is three generations ahead in one leap is going to be terribly challenging, and may drive costs" skyward, imperiling the need to make CG (X) affordable, he said. "So we need to be very careful how we get a risk-reduction package to get to that cruiser," perhaps by using existing

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[29] (...continued)
missile defense.

> "Really the issue I'll tell you is not so much about the power plant but it's about the mission," McCoy said June 25. "And if you think the mission is sitting off a hostile coast looking for a BMD type mission for one-beam cycles on the big high-powered radar, we're talking the radar is costing in the 30 megawatts range. Then alternatives like nuclear power start to come in."
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> (Emelie Rutherford, "Despite Hill Pressure, Navy Noncommittal On Nuclear Power For CG(X)," *Inside the Navy*, July 2, 2007.)

[30] For more on technical risks in the DDG-1000 program, see CRS Report RL32109, op cit.

radar technology as a base to help reduce that development risk, he said, pointing to the success of the Aegis modernization program.[31]

Hull Design

In addition to the issue of nuclear power, another ship-design issue for the CG(X) is whether the ship should use the DDG-1000's tumblehome hull or some other hull. Potential alternative hulls include existing hulls such as the DDG-51 hull and the LPD-17 amphibious ship hull, both of which are conventional flared hulls, or a new flared hull design. As mentioned earlier, the Navy in the past has expressed interest in basing the CG(X) design on the DDG-1000 hull, while some members of the House Armed Services Committee have expressed interest in basing the CG(X) design on an enlarged version of the DDG-51 hull.

A tumblehome hull, with its reduced radar detectability, is viewed as useful for accomplishing the DDG-1000's mission of using its 155mm guns to strike targets ashore — a mission that could require the DDG-1000 to operate fairly close to enemy shore-based radars. Some observers believe that a hull with reduced detectability is less critical for the CG(X), because the CG(X)'s AAW and BMD missions might not require it to approach enemy shores as closely, and because the energy radiating from the ship's powerful BMD-capable radar will in any event provide enemy sensors with an indication of the ship's location. Other observers might argue that even if a ship's location is known, a hull with reduced detectability can improve the ship's ability to evade (or to use decoys to confuse) the homing devices in enemy anti-ship cruise missile and torpedoes, or the fusing mechanisms in enemy mines.

Even if the CG(X) does not require the reduced radar detectability of a tumblehome hull, reusing the DDG-1000's tumblehome hull for the CG(X) might still have economic advantages in terms of avoiding the cost of designing a new hull (which could easily be in the hundreds of millions of dollars) and taking advantage of production learning-curve efficiencies achieved from earlier construction of DDG-1000s. Designing a new hull would incur hull-design costs and sacrifice the opportunity to take advantage of DDG-1000 production learning-curve benefits. On the other hand, a new-design hull might more easily accommodate the power plant and combat system desired for the CG(X), and be designed with the latest features for reducing its production cost.

One option for making the CG(X) a nuclear-powered ship would be to equip it with one-half of the new twin-reactor plant that the Navy has designed for its new Ford (CVN-78) class aircraft carriers.[32] Reusing the Ford-class reactor plant would avoid the costs of developing a new reactor plant for the CG(X) — a cost that could

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[31] Dave Ahearn, "Large Number of Aegis Ships Would Be Needed To Shield Europe: Admiral," *Defense Daily*, November 29, 2007.

[32] For more on the Ford-class program, see CRS Report RS20643, *Navy Ford (CVN-78) Class (CVN-21) Aircraft Carrier Program: Background and Issues for Congress*, by Ronald O'Rourke.

exceed $1 billion.[33] The DDG-1000 hull (or an enlarged version of the DDG-51 hull) might be too small to easily accommodate one-half of a Ford-class plant, at least not without making changes to the plant. Using one-half of the Ford-class plant without making changes to it might require designing a new hull that is larger than the DDG-1000 hull. If so, then using one-half of the Ford-class plant would pose a tradeoff between avoided reactor plant design costs and additional hull-design costs.

Unit Affordability vs. Unit Capability

Issues such as the question of nuclear power and the ship's hull design form part of a more general potential general oversight issue for Congress concerning whether the Navy has achieved the best balance in the CG(X) design between unit affordability and unit capability. As mentioned in the "Background" section, the CG(X) is one of the Navy's relatively few remaining opportunities to use a new ship design to manage the overall cost of the Navy's shipbuilding program. Navy officials are aware of this, but they also want the CG(X) to be capable of performing certain intended missions, including the BMD mission that drives the need for the CG(X) to carry a large and powerful new radar. Navy officials are seeking a design solution for the CG(X) that represents the best balance between unit affordability and unit capability. Achieving such a balance is a classic ship-design challenge.

Concerns about the potential affordability of the CG(X) have been reinforced by the experience with DDG-1000, which turned out to be much more expensive than originally envisaged. The Navy originally planned a total of 16 to 24 DDG-1000s and a sustaining procurement rate of two DDG-1000s per year. Due in part to the ship's cost, this was reduced to a total of 7 DDG-1000s to be procured at a rate of about one ship per year.

A dual-design solution for the CG(X) program, such as the one reportedly considered in the CG(X) AOA (see "Background" section), is one possible strategy for striking a balance between affordability and capability in the CG(X) program. A dual-design solution could permit the Navy and Congress to respond to changes in the strategic or budgetary environment by altering the numbers of smaller and larger CG(X)s to be procured.[34]

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[33] The estimated development cost of the Ford-class plant is roughly $1.5 billion.

[34] A dual-design solution might also be viewed as reminiscent of the so-called high-low mix approach that was adopted in the 1970s and 1980s for the procurement of Navy surface combatants and Air Force fighters. The high-low mix approach involved procuring a mix of more-capable, more-expensive platforms (the "high" end of the mix) and less-capable, less-expensive platforms (the "low" end). In the 1970s and 1980s, the Navy procured nuclear-powered cruisers and Aegis cruisers as its high-end ships and Spruance (DD-963) class destroyers and Oliver Hazard Perry (FFG-7) class frigates as its low-end ships. The Air Force procured F-15s as its high-end fighters and F-16s as its low-end fighters. The Air Force today might be viewed as again implementing a high-low mix approach through its planned procurement of a combination of high-end F-22 fighters and more-affordable F-35 Joint Strike Fighters (JSFs). The capability ratio of a 23,000- to 25,000-ton, nuclear-powered CG(X) relative to that of a 14,000-ton, conventionally powered CG(X) might not necessarily be the same as that of the 1970s/1980s high-end surface combatants relative to

(continued...)

BMD Impact on CG(X) Numbers and Schedule

An additional potential oversight issue for Congress concerns the possible effect of the BMD mission on the required number of CG(X)s and the schedule for procuring CG(X)s. The currently planned total of 19 CG(X)s reflects, in part, certain assumptions about the Navy's future role in U.S. BMD operations. The Navy's future in U.S. BMD operations, however, has not yet been fully defined. It is possible that as the role becomes better defined, the total required number of CG(X)s could change.[35]

A related question is whether the schedule for procuring CG(X)s is properly aligned with foreign-country ballistic missile development programs. A 2005 defense trade press report, for example, states that "navy officials project" that China could field TBMs capable of hitting moving ships at sea by about 2015 — about three years before the first CG(X) is scheduled to enter service.[36] Given the time needed to develop the CG(X)'s new radar, it might not be possible to accelerate the procurement of the first CG(X) from FY2011 to an earlier year. Once CG(X) procurement were to begin, however, it might be possible to accelerate the procurement dates of later ships in the program, so as to get more of the ships in service sooner. Accelerating procurement of CG(X)s to earlier years could, in a situation of constrained Navy funding, leave less funding available in those years for meeting other Navy needs.

Industrial-Base Implications

The question of whether some or all CG(X)s should be nuclear-powered has significant potential implications for the surface combatant industrial base because the two shipyards that have built all the Navy's cruisers and destroyers in recent years — GD/BIW and the Ingalls yard that forms part of NGSB — are not licensed to build nuclear-powered ships.[37]

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[34] (...continued)
the 1970s/1980s low-end surface combatants, or of the F-15 relative to the F-16, or of the F-22 relative to the F-35. The merits of the high-low mix approach as a strategy for balancing unit capability against unit affordability have been debated on and off for years.

[35] For more on this issue, see CRS Report RL33745, *Sea-Based Ballistic Missile Defense — Background and Issues for Congress*, by Ronald O'Rourke.

[36] Yihong Chang and Andrew Koch, "Is China Building A Carrier?" *Jane's Defence Weekly*, August 17, 2005. The article states that "navy officials project [that such missiles] could be capable of targeting US warships from sometime around 2015." A 2007 press report states that another observer believes that a MARV-equipped version of China's CSS-6 TBM may be close to initial operational status. (Bill Gertz, "Inside the Ring," Washington Times, July 20, 2007: 6. [Item entitled "New Chinese Missiles"]. The article stated that it was reporting information from forthcoming report on China's military from the International Assessment and Strategy Center authored by Richard Fisher.)

[37] GD/BIW has never built nuclear-powered ships, and has never been licensed to do so. The Ingalls yard within NGSS built nuclear-powered submarines until the early 1970s but is no longer licensed to build nuclear-powered ships. (Ingalls built 12 nuclear-powered (continued...)

The only two U.S. shipyards currently licensed to build nuclear-powered ships for the Navy are Newport News Shipbuilding of Newport News, VA, a part of NGSB, which builds nuclear-powered surface ships and submarines, and General Dynamics' Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI, which builds nuclear-powered submarines. These two yards have built every nuclear-powered ship procured for the Navy since FY1969.

There are at least three potential approaches for building nuclear-powered CG(X)s:

- Build them at Newport News, with GD/EB possibly contributing to the construction of the ships' nuclear portions.
- License GD/BIW and/or Ingalls to build nuclear-powered ships, and then build the CG(X)s at those yards.
- Build the nuclear portions of the CG(X)s at Newport News and/or GD/EB, the non-nuclear portions at GD/BIW and/or Ingalls, and perform final assembly, integration, and test work for the ships at either
  - Newport News and/or GD/EB, or
  - GD/BIW and/or Ingalls.

These options have significant potential implications for workloads and employment levels at each of these shipyards.

On the question of what would be needed to license Ingalls and/or GD/BIW to build nuclear-powered ships, the director of Naval Reactors (NR) — the office in charge of the Navy's nuclear propulsion program — testified in March 2007 that

> Just the basics of what it takes to have a nuclear-certified yard, to build one from scratch, or even if one existed once upon a time as it did at Pascagoula, and we shut it down, first and foremost you have to have the facilities to do that. What that includes, and I have just some notes here, but such things as you have to have the docks and the dry-docks and the pier capability to support nuclear ships, whatever that would entail. You would have to have lifting and handling equipment, cranes, that type of thing; construction facilities to build the special nuclear components, and to store those components and protect them in the way that would be required.
>
> The construction facilities would be necessary for handling fuel and doing the fueling operations that would be necessary on the ship — those types of things. And then the second piece is, and probably the harder piece other than just kind of the brick-and-mortar type, is building the structures, the

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[37] (...continued)
submarines, the last being the Parche [SSN-683], which was procured in FY1968, entered service in 1974, and retired in 2005. Ingalls also overhauled or refueled 11 nuclear-powered submarines. Ingalls's nuclear facility was decommissioned in 1980.)

> organizations in place to do that work, for instance, nuclear testing, specialized nuclear engineering, nuclear production work. If you look, for instance, at Northrop Grumman Newport News, right now, just to give you a perspective of the people you are talking about in those departments, it is on the order of 769 people in nuclear engineering; 308 people in the major lines of control department; 225 in nuclear quality assurance; and then almost 2,500 people who do nuclear production work. So all of those would have to be, you would have to find that workforce, certify and qualify them, to be able to do that.[38]

The director of NR testified that Newport News and GD/EB "have sufficient capacity to accommodate nuclear-powered surface ship construction, and therefore there is no need to make the substantial investment in time and dollars necessary to generate additional excess capacity."[39] In light of this, the Navy testified, only the first and third options above are "viable."[40] The director of NR testified that:

> my view of this is we have some additional capacity at both Electric Boat and at Northrop Grumman Newport News. My primary concern is if we are serious about building another nuclear-powered warship, a new class of warship, cost is obviously going to be some degree of concern, and certainly this additional costs, which would be — and I don't have a number to give you right now, but I think you can see it would be substantial to do it even if you could. It probably doesn't help our case to move down the path toward building another nuclear-powered case, when we have the capability existing already in those existing yards.[41]

With regard to the third option of building the nuclear portions of the ships at Newport News and/or GD/EB, and the non-nuclear portions at Ingalls and/or GD/BIW, the Navy testified that the "[l]ocation of final ship erection would require additional analysis." One Navy official, however, expressed a potential preference for performing final assembly, integration, and test work at Newport News or GD/EB, stating that:

> we are building warships in modular sections now. So if we were going to [ask], "Could you assemble this [ship], could you build modules of this ship in different yards and put it together in a nuclear-certified yard?", the answer is yes, definitely, and we do that today with the Virginia Class [submarine program]. As you know, we are barging modules of [that type of] submarine up and down the coast.

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[38] Spoken testimony of Admiral Kirkland Donald before the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee, March 1, 2007.

[39] Statement of Admiral Kirkland H. Donald, U.S. Navy, Director, Naval Nuclear Propulsion Program, before the House Armed Services Committee Seapower and Expeditionary Forces Subcommittee on Nuclear Propulsion For Surface Ships, 1 March 2007, p. 13.

[40] Source: Statement of The Honorable Dr. Delores M. Etter, Assistant Secretary of the Navy (Research, Development and Acquisition), et al., before the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee on Integrated Nuclear Power Systems for Future Naval Surface Combatants, March 1, 2007, p. 7.

[41] Spoken testimony of Admiral Kirkland Donald before the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee, March 1, 2007.

> What I would want is, and sort of following along with what [NR director] Admiral [Kirkland] Donald said, you would want the delivering yard to be the yard where the reactor plant was built, tooled, and tested, because they have the expertise to run through all of that nuclear work and test and certify the ship and take it out on sea trials.
>
> But the modules of the non-reactor plant, which is the rest of the ship, could be built theoretically at other yards and barged or transported in other fashion to the delivering shipyard. If I had to do it ideally, that is where I would probably start talking to my industry partners, because although we have six [large] shipyards [for building large navy ships], it is really two corporations [that own them], and those two corporations each own what is now a surface combatant shipyard and they each own a nuclear-capable shipyard. I would say if we were going to go do this, we would sit down with them and say, you know, from a corporation standpoint, what would be the best work flow? What would be the best place to construct modules? And how would you do the final assembly and testing of a nuclear-powered warship?[42]

For further discussion of the issue, see CRS Report RL33946, *Navy Nuclear-Powered Surface Ships: Background, Issues, and Options for Congress*, by Ronald O'Rourke.

Visibility of CG(X) Research and Development Costs

Another potential oversight issue for Congress is whether CG(X) research and development costs are sufficiently visible in Navy budget-justification documents. As indicated in **Table 1**, CG(X) research and development costs are currently found in the Research, Development, Test and Evaluation, Navy (RDTEN) appropriation account in:

- Projects 3105, 3106, and 3107 of Program Element (PE) PE0604300N (DDG-1000 Total Ship System Engineering; Previously SC-21 Total Ship System Engineering); and
- Project 3186 of PE0604501N (Advanced Above Water Sensors).

As shown in the notes to **Table 1**, although the name for Project 3107 includes the term CG(X), the names for PEs 0604300N and 0604501N, and for Projects 3105, 3106, and 3186 do not, making it more potentially difficult to recognize that funding for the CG(X) program might be contained in these PEs and projects. This could make it more difficult to understand and track the total amount of CG(X) research and development funding in the Navy's budget.

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[42] Spoken testimony of Vice Admiral Paul E. Sullivan, Commander, Naval Sea Systems Command, to the Seapower and Expeditionary Forces Subcommittee of the House Armed Services Committee, March 1, 2007.

Options for Congress

Potential Near-Term Options

Potential near-term options for Congress for the CG(X) program, some of which could be combined, include but are not limited to the following:

- approve the CG(X) program as proposed by the Navy;
- institute increased requirements for the Navy to report to Congress on the goals and status of the CG(X) program;
- request independent analyses of the CG(X) program by GAO or CBO;
- modify the CG(X) program's proposed research and development funding request;
- pass legislation, or include report language, on questions such as the following:
  - a potential target procurement cost of the CG(X), or
  - other aspects of the CG(X) acquisition strategy, such as the use of competition in the awarding of construction contracts for the ships;
- add several hundred million dollars in advance procurement funding to the Navy's FY2009 budget to support the procurement of the first CG(X) in FY2011 as a nuclear-powered ship; and
- defer or reject the CG(X) program in favor of potential alternatives, such as a service-life extension program (SLEP) for the Navy's 22 Aegis cruisers that would include a more robust upgrading of the ships' AAW and BMD capabilities than currently planned.[43]

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[43] An October 2006 journal article by a two retired Navy admirals (including a former Vice Chief of Naval Operations) proposed modernizing and extending the service lives of the Navy's Aegis cruisers and destroyers through a service life extension program (SLEP). Robert J. Natter and Donald Pilling, "Achieving the Right Mix," *U.S. Naval Institute Proceedings*, October 2006: 14-16. The authors state that five to eight Aegis ships per year might be modernized under such a program, at a cost of about $300 million to $500 million per ship. The article suggests that the program could be a part of a scenario in which constraints on Navy shipbuilding funding limit, for a time at least, procurement of DDG-1000s and CG(X)s to combined rate of one per year. The article provides no figures on the service lives of the Aegis ships before or after the extension, so it is unclear whether the authors are proposing to extend their lives from 35 years (or some lower figure) to 40 years (or some other figure).

Whether it would be feasible or cost effective today to extend the lives of the Aegis cruisers (continued...)

Potential Longer-Term Options

Potential longer-term options for Congress for the CG(X) program, some of which could be combined, and some of which overlap with options for the DDG-1000 program, include but are not limited to the following:

- use a block-buy contract or a multiyear procurement (MYP) arrangement for procuring CG(X)s in future years;
- accelerate procurement of CG(X)s into earlier years, perhaps in part by procuring three CG(X)s in FY2011, FY2012, and FY2013 in lieu of the fifth, sixth, and seventh DDG-1000s planed for those same years;[44]
- procure more than 19 CG(X)s;
- defer procurement of the first CG(X) beyond FY2011 to permit additional time for development of the CG(X)'s radar, or additional time for procurement of DDG-1000s prior to commencement of CG(X) procurement;
- as an annual affordability measure, limit DDG-1000/CG(X) procurement to a combined total of no more than one ship per year;[45] and
- as total-program affordability measure, limit DDG-1000/CG(X) procurement to a combined total of 12 ships (one for each of 12 planned carrier strike groups [CSGs]).

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[43] (...continued)
is unclear. Depending on how intensively they are used in coming years, the Aegis cruisers might be worn out in terms of their basic structural or mechanical condition by age 35. (Some observers believe they might be worn out by age 30.) If the Aegis cruisers are in good enough structural and mechanical condition to permit operation beyond age 35, experience with past surface combatant designs suggests that the ships might have insufficient space, weight-carrying ability, or electrical power to accommodate the new sensors and weapons that could be needed at that point to keep them mission-effective beyond age 35. The Navy has limited experience operating modern cruisers and destroyers beyond age 35, and thus limited experience with the engineering issues that might arise from attempting to operate such ships to age 40.

[44] Navy plans call for procuring a total of seven DDG-1000s. The first two were procured in FY2007 and were split-funded across FY2007 and FY2008; the remaining five are to be procured at a rate of one ship per year during the period FY2009-FY2013.

[45] Although this option could reduce annual DDG-1000/CG(X) procurement costs, it could increase total DDG-1000/CG(X) procurement costs because of the reduced economies of scale from limiting production to one ship per year.

House Interest In CG(X) Based On DDG-51 Hull

As mentioned earlier, at a March 6, 2008, hearing before the House Armed Services Committee on the Department of the Navy's FY2009 budget, certain committee members indicated that they are considering the option of not procuring additional DDG-1000s and instead procuring additional Arleigh Burke (DDG-51) class Aegis destroyers. These DDG-51s, it was stated at the hearing, could act as a bridge to a CG(X) design based on an enlarged version of the DDG-51 hull and powered by one-half of the reactor plant that has been designed for the Navy's new Ford (CVN-78) class nuclear-powered aircraft carriers.

Legislative Activity for FY2009

The Navy's proposed FY2009 budget was submitted to Congress in early February 2008.

Appendix A. FY2008 Bill and Report Language Relating to Nuclear Power for CG(X)

FY2008 Defense Authorization Act (H.R. 1585/H.R. 4986/S. 1547/P.L. 110-181)

The House Armed Services Committee, in its report (H.Rept. 110-146 of May 11, 2007) on H.R 1585 stated the following:

> The committee believes that the mobility, endurance, and electric power generation capability of nuclear powered warships is essential to the next generation of Navy cruisers. The Navy's report to Congress on alternative propulsion methods for surface combatants and amphibious warfare ships, required by section 130 of the National Defense Authorization Act for Fiscal Year 2006 (Public Law 109-163), indicated that the total lifecycle cost for medium-sized nuclear surface combatants is equivalent to conventionally powered ships. The committee notes that this study only compared acquisition and maintenance costs and did not analyze the increased speed and endurance capability of nuclear powered vessels.
>
> The committee believes that the primary escort vessels for the Navy's fleet of aircraft carriers should have the same speed and endurance capability as the aircraft carrier. The committee also notes that surface combatants with nuclear propulsion systems would be more capable during independent operations because there would be no need for underway fuel replenishment. (Page 387)

Section 1012 of the conference report (H.Rept. 110-477 of December 6, 2007) on H.R. 1585 states:

> SEC. 1012. POLICY RELATING TO MAJOR COMBATANT VESSELS OF THE STRIKE FORCES OF THE UNITED STATES NAVY.
>
> (a) INTEGRATED NUCLEAR POWER SYSTEMS. — It is the policy of the United States to construct the major combatant vessels of the strike forces of the United States Navy, including all new classes of such vessels, with integrated nuclear power systems.
>
> (b) REQUIREMENT TO REQUEST NUCLEAR VESSELS. — If a request is submitted to Congress in the budget for a fiscal year for construction of a new class of major combatant vessel for the strike forces of the United States, the request shall be for such a vessel with an integrated nuclear power system, unless the Secretary of Defense submits with the request a notification to Congress that the inclusion of an integrated nuclear power system in such vessel is not in the national interest.
>
> (c) DEFINITIONS. — In this section:
>
> (1) MAJOR COMBATANT VESSELS OF THE STRIKE FORCES OF THE UNITED STATES NAVY. — The term "major combatant vessels of the strike forces of the United States Navy" means the following:
> (A) Submarines.
> (B) Aircraft carriers.

(C) Cruisers, battleships, or other large surface combatants whose primary mission includes protection of carrier strike groups, expeditionary strike groups, and vessels comprising a sea base.

(2) INTEGRATED NUCLEAR POWER SYSTEM. — The term "integrated nuclear power system" means a ship engineering system that uses a naval nuclear reactor as its energy source and generates sufficient electric energy to provide power to the ship's electrical loads, including its combat systems and propulsion motors.

(3) BUDGET. — The term "budget" means the budget that is submitted to Congress by the President under section 1105(a) of title 31, United States Code.

Regarding Section 1012, the conference report states:

The Navy's next opportunity to apply this guidance will be the next generation cruiser, or "CG(X)". Under the current future-years defense program (FYDP), the Navy plans to award the construction contract for CG(X) in fiscal year 2011. Under this provision, the next cruiser would be identified as "CGN(X)" to designate the ship as nuclear powered. Under the Navy's normal shipbuilding schedule for the two programs that already have nuclear power systems (aircraft carriers and submarines), the Navy seeks authorization and appropriations for long lead time nuclear components for ships 2 years prior to full authorization and appropriation for construction.

The conferees recognize that the milestone decision for the Navy's CG(X) is only months away. After that milestone decision, the Navy and its contractors will begin a significant design effort, and, in that process, will be making significant tradeoff decisions and discarding major options (such as propulsion alternatives). This is the normal process for the Navy and the Department of Defense (DOD) to make choices that will lead to producing a contract design that will be the basis for awarding the construction contract for the lead ship in 2011.

In order for the Navy to live by the spirit of this guidance, the conferees agree that:

(1) the Navy would be required to proceed through the contract design phase of the program with a comprehensive effort to design a CGN(X) independent of the outcome of decisions that the Navy regarding any preferred propulsion system for the next generation cruiser;

(2) if the Navy intends to maintain the schedule in the current FYDP and award a vessel in fiscal year 2011, the Navy would need to request advance procurement for nuclear components in the fiscal year 2009 budget request; and

(3) the Navy must consider options for:

(a) maintaining the segment of the industrial base that currently produces the conventionally powered destroyer and amphibious forces of the Navy;

(b) certifying yards which comprise that segment of the industrial base to build nuclear-powered vessels; or

(c) seeking other alternatives for building non-nuclear ships in the future if the Navy is only building nuclear-powered surface combatant ships for some period of time as it builds CGN(X) vessels; and

(d) identifying sources of funds to pay for the additional near-term costs of the integrated nuclear power system, either from offsets within the Navy's budget, from elsewhere within the Department's resources, or from gaining additional funds for DOD overall.

The conferees recognize that these considerations will require significant additional near-term investment by the Navy. Some in the Navy have asserted that, despite such added investment, the Navy would not be ready to award a shipbuilding contract for a CGN(X) in fiscal year 2011 as in the current FYDP.

Section 128 of the John Warner National Defense Authorization Act for Fiscal Year 2007 (Public Law 109-364) required that the Navy include nuclear power in its Analysis of Alternatives (AOA) for the CG(X) propulsion system. The conferees are aware that the CG(X) AOA is nearing completion, in which case the Navy should have some indications of what it will require to design and construct a CGN(X) class.

Accordingly, the conferees direct the Secretary of the Navy to submit a report to the congressional defense committees with the budget request for fiscal year 2009 providing the following information:

(1) the set of next generation cruiser characteristics, such as displacement and manning, which would be affected by the requirement for including an integrated nuclear power system;

(2) the Navy's estimate for additional costs to develop, design, and construct a CGN(X) to fill the requirement for the next generation cruiser, and the optimal phasing of those costs in order to deliver CGN(X) most affordably;

(3) the Navy's assessment of any effects on the delivery schedule for the first ship of the next generation cruiser class that would be associated with shifting the design to incorporate an integrated nuclear propulsion system, options for reducing or eliminating those schedule effects, and alternatives for meeting next generation cruiser requirements during any intervening period if the cruiser's full operational capability were delayed;

(4) the Navy's estimate for the cost associated with certifying those shipyards that currently produce conventionally powered surface combatants, to be capable of constructing and integrating a nuclear-powered combatant;

(5) any other potential effects on the Navy's 30-year shipbuilding plan as a result of implementing these factors;

(6) such other considerations that would need to be addressed in parallel with design and construction of a CGN(X) class, including any unique test and training facilities, facilities and infrastructure requirements for potential CGN(X) homeports, and environmental assessments that may require long-term coordination and planning; and

(7) an assessment of the highest risk areas associated with meeting this requirement, and the Navy's alternatives for mitigating such risk. (Pages 984-986)