

June 9, 2008

Honorable Gene Taylor
Chairman
Subcommittee on Seapower and Expeditionary Forces
Committee on Armed Services
U.S. House of Representatives
Washington, DC 20515-6035

Dear Mr. Chairman:

In response to your request, the Congressional Budget Office (CBO) has assessed the long-term resource implications of the Navy's recently reported shipbuilding plan for fiscal year 2009. CBO's analysis of that plan and of information from the Navy about specific ship programs indicates the following:

- Executing the Navy's most recent 30-year shipbuilding plan would cost an average of about \$27 billion a year (in 2009 dollars), or more than double the \$12.6 billion a year that the Navy has spent, on average, since 2003. (Unless otherwise indicated, the cost figures presented in this letter are expressed in billions of 2009 dollars of budget authority, and years denote fiscal years.) Since CBO testified on this topic on March 14, the Navy provided additional information that led CBO to increase its estimate of the annual cost of the shipbuilding plan from \$25 billion to \$27 billion.
- After releasing its 2009 report, the Navy discovered a calculation error that caused the costs initially reported in the 2009 plan to be about 10 percent higher than the Navy now expects them to be. After correcting for that error, the Navy's estimate of the costs of implementing its 30-year shipbuilding plan is about 10 percent less than the estimates that CBO has prepared during the past three years.
- The Navy's 2009 budget request appears to depart from all of the budgetary assumptions used to develop the service's 2007 and 2008 shipbuilding plans.

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- CBO's estimates of the costs of the Navy's shipbuilding program through the period covered by the 2009–2013 Future Years Defense Program are about 30 percent higher than the Navy's estimates. In particular, CBO estimates that the DDG-1000 guided-missile destroyer and the CG(X) future cruiser would probably cost significantly more than the Navy currently estimates.
- For the 2009–2020 period—described as the “near term” in the Navy's plan—CBO estimates that new-ship construction alone would cost about 13 percent more than the Navy indicates.
- For the period beyond 2020—described as the “far term” in the Navy's plan—CBO estimates that costs would be about 8 percent greater than the Navy projects.

Those estimates are based on a number of assumptions that CBO made about the size and characteristics of the various types of ships that the Navy would buy and about the timing of those purchases. Different assumptions could produce different estimates.

The enclosure describes CBO's analysis. If you would like further details, we would be pleased to provide them. The analysis was prepared by Eric J. Labs, who can be reached at (202) 226-2920, and Raymond Hall, who can be reached at (202) 226-8841.

Sincerely,



Peter R. Orszag
Director

Enclosure

cc: Honorable Roscoe G. Bartlett, Ranking Member
Subcommittee on Seapower and Expeditionary Forces

Honorable Ike Skelton, Chairman
House Committee on Armed Services

Honorable Duncan Hunter, Ranking Member
House Committee on Armed Services

**Resource Implications of the
Navy's Fiscal Year 2009
Shipbuilding Plan**

June 9, 2008

Note

On June 10, 2008, the Navy provided updated information on the status of the first two littoral combat ships, which has been incorporated on page 27.

Overview

In response to a Congressional directive, the Department of the Navy issues reports on an annual basis that describe its plans for ship construction over a 30-year period. In the report released in February 2006, the Navy presented its fiscal year 2007 plan, which called for expanding its fleet from 285 battle force ships in 2006 to 313 by 2020 and beyond.¹ In May 2006, the Congressional Budget Office (CBO) issued a study analyzing that plan and estimating its potential costs.²

Since May 2006, the Navy has provided two updates to its 313-ship plan, one for fiscal year 2008 and one for fiscal year 2009.³ The plans differ in several ways. For instance, although the 2007 and 2008 plans both assumed annual costs of \$16.1 billion for new construction, the 2008 plan increased the total number of ships scheduled for purchase over the 30-year period to 293, compared with 280 under the 2007 plan. That increase in the number of proposed ship purchases mainly reflected an acceleration of the building of the DDG(X) destroyer, which is intended to replace today's Arleigh Burke class of guided-missile destroyers, and a shift in the time period under consideration. (Because the Navy intended to buy more ships in 2037 than in 2007, moving from a 2007–2036 planning window to a 2008–2037 window increased the number of vessels scheduled for purchase over 30 years). The 2009 plan envisions purchasing three more ships than indicated in the 2008 plan—296—and increases the Navy's estimate of the costs to implement the plan by about 30 percent (see Table 1).

Although the overall number of ships slated for purchase under the 2008 and 2009 plans differs only slightly, the Navy made significant changes in the types of ships it would purchase under the two plans. For example, delays in completing the purchase

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1. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2007* (February 2006). Battle force ships comprise aircraft carriers, surface combatants, submarines, amphibious ships, and some logistics ships.
 2. Congressional Budget Office, *Options for the Navy's Future Fleet* (May 2006). CBO uses the relationship between the cost and weight of analogous ships to estimate the price of future naval vessels. (Specifically, CBO uses the cost per thousand tons of lightship displacement—the weight of the ship itself without its crew, materiel, weapons, or fuel.) That method assumes, broadly speaking, that what has happened in the past will be repeated in the future. CBO takes into account changes or productivity improvements in shipbuilding practices and procedures; but such changes are frequently offset by, for example, additional requirements or new technologies. In Congressional testimony, some Navy officials have characterized CBO's methodology as “worst-case analysis” or an “extremely conservative” estimating technique that seeks to include all possible sources of cost risk. Nevertheless, that method would have understated the actual costs of the littoral combat ship, the LPD-17 amphibious warfare ships, and the CVN-76 and CVN-77 aircraft carriers, and it would have closely approximated the cost of the lead Virginia class attack submarine.
 3. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2008* (February 2007); and Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009* (February 2008).

Table 1.

Comparison of the Navy's Shipbuilding Plans for Fiscal Years 2007, 2008, and 2009

	2007 Shipbuilding Plan (2007 to 2036)	2008 Shipbuilding Plan (2008 to 2037)	2009 Shipbuilding Plan (2009 to 2038)
Number and Type of Ships Purchased			
Aircraft carriers	7	7	7
Large surface combatants	53	66	69
Littoral combat ships	78	85	75
Attack submarines	51	51	53
Ballistic missile submarines	14	14	12
Amphibious ships	22	20	20
MPF(F) ships	11	11	9
Support ships	44	39	51
Total	280	293	296
Total 30-Year New-Ship Construction Costs (Billions of 2009 dollars)			
Navy's estimate, corrected ^a	483	483	688 ^b
CBO's estimate	624	648	749 ^c
Average Price Per Ship (Billions of 2009 dollars)			
Navy's estimate	1.7	1.6	2.3
CBO's estimate	2.2	2.2	2.5

Source: Congressional Budget Office.

Note: MPF(F) = Maritime Prepositioning Force (Future).

- a. An error in the Navy's estimate of the costs of new-ship construction caused those costs to be overstated by about 10 percent in the graphic displayed in the Navy's 2009 shipbuilding plan.
- b. The estimate includes CBO's projected costs for ballistic missile submarines.
- c. After receiving additional information from the Navy, CBO increased its estimate from that provided on March 14, 2008, in testimony before the Subcommittee on Seapower and Expeditionary Forces of the House Armed Services Committee.

of 55 littoral combat ships (LCSs) translated into a two-year postponement in the scheduled replacement of those ships at the end of their service life; thus, fewer of those ships would be acquired by 2038.⁴ At the same time, the Navy increased the number of support ships it planned to buy over the next 30 years.

The 2009 shipbuilding plan includes a graphic on page 10 indicating that, for new-ship construction alone, the estimated costs of implementing the plan would average

4. LCSs are small, fast surface combatants designed to focus on specific missions.

\$22.4 billion a year (or \$20.7 billion in 2007 dollars). (That estimate excludes the cost of replacing the Navy's existing Ohio class ballistic missile submarines as well as the cost of refueling nuclear-powered aircraft carriers and submarines—expenses normally associated with the Navy's shipbuilding accounts.) However, after releasing its plan, the Navy informed CBO that, because of a spreadsheet error, costs displayed in the graphic were overstated by about 10 percent. Corrected data provided to CBO indicate that the Navy now estimates implementing the 2009 shipbuilding plan would cost an average of \$20.4 billion per year (or \$18.8 billion in 2007 dollars), excluding the same activities mentioned above. Unless otherwise noted, all subsequent references to the Navy's costs in this analysis refer to that corrected estimate.

The Navy's 2009 Shipbuilding Plan

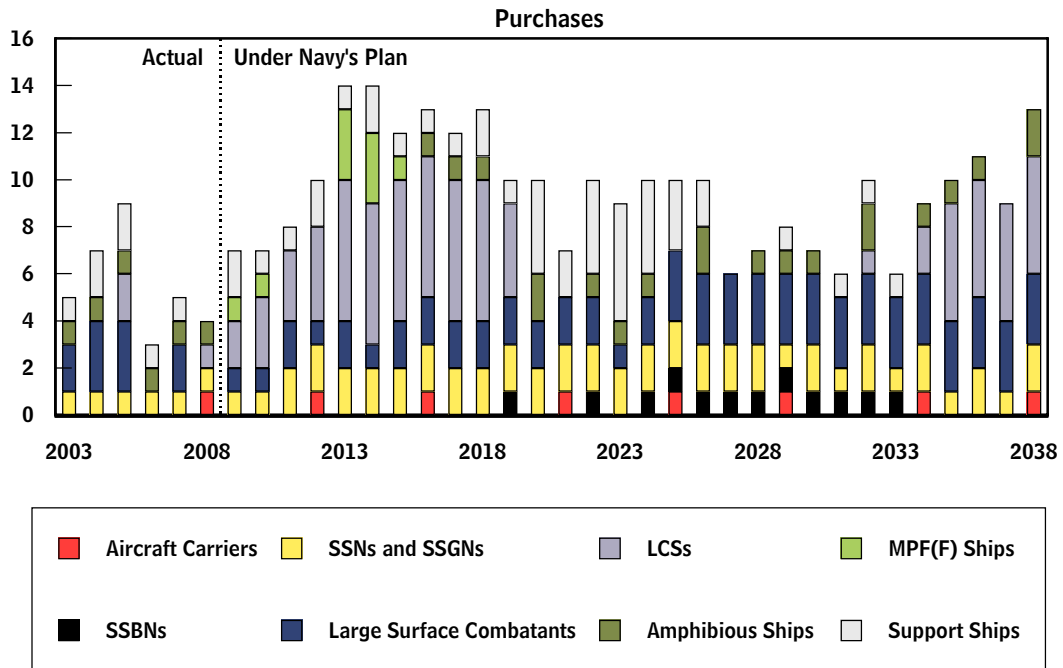
On February 6, 2008, the Secretary of the Navy submitted a report to the Congress describing the Navy's fiscal year 2009 goals for ship construction over the next three decades. The report maintains the requirement for a fleet of 313 ships that was first outlined in the Navy's 2007 report. That fleet is intended to comprise the following battle force ships:

- 11 aircraft carriers;
- 69 guided-missile destroyers;
- 19 guided-missile cruisers;
- 55 littoral combat ships;
- 48 attack submarines;
- 4 guided-missile submarines;
- 14 ballistic missile submarines;
- 31 amphibious ships;
- 12 future maritime prepositioning force, or MPF(F), ships, constituting one MPF(F) squadron; and
- 50 logistics and support ships.

Under the new plan, the Navy would purchase seven ships in 2009 (see Figure 1), acquiring a total of 47 ships between 2009 and 2013—the period covered by the Department of Defense's (DoD's) 2009 Future Years Defense Program (FYDP). From 2014 to 2038, the Navy would buy another 249 vessels under its long-term plan—for

Figure 1.

Annual Ship Purchases and Inventory Implied by the Navy's 2009 Shipbuilding Plan



Source: Congressional Budget Office based on data from the Department of the Navy.

Notes: LCSs = littoral combat ships; MPF(F) = Maritime Prepositioning Force (Future);
 SSBNs = ballistic missile submarines; SSGNs = guided-missile submarines;
 SSNs = attack submarines.

a total of 296 ships, or an average of almost 10 per year, over 30 years.⁵ In the shorter term, the Navy would purchase an average of about 13 ships per year between 2013 and 2018 as production of the littoral combat ships was increased to six per year.

If implemented as described above, the Navy's 2009 plan would keep the fleet at or above the 313-ship goal beginning in 2019 and for most years thereafter. Between 2027 and 2030, the fleet would dip slightly below 313 ships. In contrast, the Navy's 2008 shipbuilding plan envisioned reaching 313 or more ships in 2016. That difference reflects primarily the restructuring of the LCS program.

Although the Navy's 2009 plan calls for at least 313 ships by 2019, it would fall short of the service's stated goals for a number of the fleet's components. Specifically, the Navy would experience shortfalls in the following types of vessels: attack submarines (41 over the 2028–2030 period versus a stated requirement of 48); guided-missile submarines (none after 2028 versus a stated requirement of four); ballistic missile submarines (12 after 2030 versus a stated requirement of 14); LPD-17 amphibious transport docks (nine instead of a stated requirement of 10); and T-AKE logistics ships for the service's future maritime prepositioning squadron (one instead of a stated requirement of three). In meeting an inventory requirement of 88 guided-missile destroyers specified in the 2007 shipbuilding plan, a shortfall of 15 in that plan was partially alleviated by increasing the construction rate of DDG(X)s to three per year in the 2008 plan; the remaining shortfall was eliminated in the 2009 plan by assuming a 40-year service life for existing DDG-51s. That and other service-life issues associated with the Navy's 2009 plan will be discussed in more detail subsequently.

The shortfall of attack submarines that exists in the 2009 plan would result from the Navy's not buying enough ships at the right times to replace retiring Los Angeles class submarines. To offset the effect that not buying enough submarines would have on the Navy's ability to perform future missions, the service would attempt to do the following: reduce the construction time of the Virginia class so that ships procured under the plan entered the fleet more quickly than is currently assumed; extend the service life of a few Los Angeles class submarines; and, if necessary, deploy a small

5. Those increased purchases of ships over the next 30 years are necessary to achieve a 313-ship fleet because during the past 16 years, the Navy purchased 99 ships, less than the number needed to sustain a 313-ship fleet. If the notional service life of ships in the fleet is 35 years, the Navy needs to purchase an average of 8.9 ships per year to sustain a 313-ship fleet. Over the past 16 years, however, the Navy acquired ships at the rate of 6.2 per year.

The rate of acquisition under the 2009 plan would be well below that experienced in the 1980s but higher than the average annual purchases since then. During the period spanning 1981 to 1988—in an attempt to build a 600-ship fleet—the Navy purchased 167 ships at an average annual cost of \$23 billion (or \$1.1 billion per ship) and at a rate of almost 21 ships per year. From 1993 through 2000, the Navy purchased 54 ships at an average annual cost of about \$10 billion (or \$1.4 billion per ship) and at a rate of 6.8 ships per year. During the period spanning 2001 to 2008, the Navy's ship purchases will total 45—a rate of 5.8 ships annually—with an average annual cost of \$12 billion (or \$2.1 billion per ship).

number of submarines for seven months, one month longer than the traditional six-month deployment. The Navy has not yet determined which combination of those initiatives would best meet its goals.

Under the 2009 shipbuilding plan, the number of ballistic missile submarines (SSBNs) would fall below the stated requirement of 14 beginning in 2027. That shortfall stems from a procurement plan that would buy 12 replacement SSBNs, rather than the 14 scheduled for purchase in the 2007 and 2008 plans. Last year, the Chief of Naval Operations (CNO) stated that because SSBNs in the future will have life-of-the-ship reactors (which eliminate the need for refueling at the midpoint of their service life), the submarines will spend less time in dry dock and more time at sea. Therefore, the Navy's requirement for those ships could drop to 12 because, over their lifetime, they would be capable of providing the same number of days at sea as 14 SSBNs that required refueling. The Navy's procurement plan indicates that the service has adopted the view expressed by the CNO, but the 2009 shipbuilding plan has not changed the stated requirement for 14 SSBNs. However, the Navy's cost estimates for the 2009 shipbuilding plan explicitly exclude the funding needed to replace the Ohio class SSBNs.

The 2009 shipbuilding plan also would not replace the Navy's four current guided-missile submarines (SSGNs). Those ships—former Ohio class ballistic missile submarines that were converted to a guided-missile configuration—are scheduled to be retired in the 2020s. The Navy notes the absence of planned replacements, stating: "Plans for the recapitalization of the OHIO Class submarines that have been converted to SSGN have been deferred until the ships are fully operational and their war fighting utility can be assessed. Should their replacement be required, it will be necessary to integrate their procurement with other ship and submarine recapitalization efforts planned for the post-FY2020 period."⁶ That statement—as well as the Navy's retention of an official "requirement" for replacing the existing SSGNs—leaves open the possibility that future 30-year plans may incorporate replacements for those submarines.

Detailed Differences Among the Plans for Fiscal Years 2007, 2008, and 2009

The long-term shipbuilding plan that the Navy submitted to the Congress this year is similar in a number of respects to the fiscal year 2008 plan provided in February 2007.⁷ The procurement schedules and quantities proposed for aircraft carriers,

6. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 8.

7. For a detailed discussion of the differences between the 2007 and 2008 shipbuilding plans, see letter from Peter R. Orszag, Director, Congressional Budget Office, to the Honorable Gene Taylor, *Resource Implications of the Navy's Fiscal Year 2008 Shipbuilding Plan* (March 23, 2007), pp. 6–7.

Table 2.**Number and Type of Ships Projected for Purchase in the Years Common to All Three Navy Plans, 2007 to 2036**

	2007 Shipbuilding Plan	2008 Shipbuilding Plan	2009 Shipbuilding Plan
Aircraft Carriers	7	7	7
Large Surface Combatants	53	65	65
Littoral Combat Ships	78	81	66
Attack Submarines	51	51	52
Ballistic Missile Submarines	14	14	12
Amphibious Ships	22	21	20
MPF(F) Ships	11	11	9
Support Ships	44	40	52
Total	280	290	283

Source: Congressional Budget Office.

Note: MPF(F) = Maritime Prepositioning Force (Future).

attack submarines, guided-missile destroyers, and guided-missile cruisers remain virtually unchanged between the two plans. For other types of ships, however, the Navy's 2009 plan differs from its 2008 plan, and the cumulative changes between the 2007 and 2009 plans are greater. During the years common to all three plans—2007 to 2036—the total number of ships scheduled for purchase does not vary by more than 10; but the number and type of ships scheduled for purchase have changed significantly for every category of vessel except aircraft carriers, attack submarines, and amphibious ships (see Table 2).

- The 2009 plan maintains the increase in procurement quantity of the new guided-missile destroyer, the DDG(X), from two per year (as in the 2007 plan) to three per year (as in the 2008 plan) starting in the mid-2020s.
- The 2009 plan reduces procurement of the new ballistic missile submarine, the SSBN(X), from 14 to 12, causing the inventory of those ships to fall below the Navy's requirement permanently beyond 2026.
- Because of the Navy's restructuring of the LCS ship program, the procurement of 55 of those ships would not be complete until 2019 (compared with 2016 in the 2007 and 2008 plans). Whereas the 2007 and 2008 plans called for the purchase of 34 LCSs between 2007 and 2013, the Navy would purchase only 19 under the 2009 plan. As a result, replacements for the LCS—which is assumed to have a service life of 25 years—would also be purchased later, reducing the number of ships bought in the early 2030s from 40 in the 2008 plan to 23 in the 2009 plan. Presumably, the Navy would eventually buy all 55 LCS replacements.

- The purchase of ships designated for the MPF(F) squadron has been delayed by one to two years, compared with the 2007 and 2008 plans. According to the Navy, the delay gives the service time to “resolve the concept of operations”—in other words, to decide the type of missions the squadron should perform and under what circumstances.⁸ The 2009 plan also reduces the number of MPF(F) T-AKE logistics ships from three to one, pending completion of a study of its concept of operations. The 2009 plan anticipates that those ships will still be needed: “It is expected that the assessment will show that the MPF(F) will need these two T-AKEs.”⁹
- The 2009 plan restores the four large combat logistics ships that were included in the 2007 plan but removed from the 2008 plan. Those ships are intended to replace four existing AOE-6 class logistics ships that are scheduled to be retired in the mid-2030s.
- The 2009 plan increases the proposed number of Joint High Speed Vessels (JHSV)s—fast ferry support ships—that the Navy intends to purchase from three in the 2007 and 2008 plans to seven in the 2009 plan, exceeding the Navy’s stated requirement of three. All seven ships count as battle force ships in the fleet inventory. Seven replacements for the JHSVs are also scheduled to be bought in the 2030s, when the service life of those first-generation ships concludes.
- To meet inventory requirements, the 2009 plan increases the expected service life of many amphibious ships from 38 years to 42 years or more and the service life of guided-missile destroyers from 35 years to 40 years.

Shipbuilding Costs Under the 2009–2013 FYDP

According to the budgetary information provided in the 2009 shipbuilding plan, the Navy estimates that the costs for constructing new ships, refueling its nuclear-powered vessels, purchasing mission modules (combat systems) for littoral combat ships, and modernizing its large surface combatants—activities that CBO defines as “total shipbuilding”—would average about \$16 billion per year (in 2009 dollars) over the period covered by the 2009–2013 Future Years Defense Program. Funding would be about \$14 billion in 2009 and then climb to nearly \$18 billion by 2013. That amount is 25 percent greater than the \$13 billion that the Navy spent, on average, for shipbuilding each year between 2003 and 2008. According to the Navy’s estimates, funding for new construction alone would average \$13 billion per year between 2009 and 2013, compared with an annual average of somewhat more than \$11 billion between 2003 and 2008.

8. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 7.

9. *Ibid.*, p. 9.

CBO's estimates for the costs of the Navy's proposed shipbuilding program indicate that the funding needed during the period spanned by the 2009 FYDP could be higher, however. Annual costs within the FYDP for total shipbuilding would average about \$21 billion, CBO estimates, which is about 30 percent more than the costs projected in the Navy's plan and about 60 percent more than the amounts the Navy has spent on shipbuilding recently. CBO estimates that the annual costs for new construction alone could average \$18 billion through 2013, or about 35 percent more than in the Navy's plan.

In addition, CBO estimates that average annual costs for new-ship construction (excluding ballistic missile submarines) over the 2009–2020 period (which the Navy's plan describes as the near term) would be about \$20 billion per year through 2020. That estimate is 13 percent greater than the Navy's estimate of about \$18 billion per year. Including the costs of ballistic missile submarines produces a similar gap.

The largest differences between the Navy's estimates and CBO's estimates within the FYDP are for the costs of the DDG-1000 Zumwalt class destroyer and the CG(X) future cruiser. The Navy plans to buy five DDG-1000s and two CG(X)s between 2009 and 2013. (The first two DDG-1000s were purchased in 2007.) Whereas the service estimates the cost of those seven ships at a total of \$16.4 billion, CBO's estimate is \$28.5 billion.¹⁰

If CBO's cost estimates for the DDG-1000 and the CG(X) are realized, it would be difficult for the Navy to build a 313-ship fleet without substantially increasing its shipbuilding budgets for the years spanning the 2009 FYDP and beyond. (CBO's cost estimates are discussed in more detail subsequently.) The difference between CBO's and the Navy's estimates for the cost of the DDG-1000 represents more than 12 percent of the Navy's total shipbuilding budget between 2009 and 2013, or about \$10 billion. In the absence of additional resources, paying that difference could require canceling the purchase of either 20 littoral combat ships or most of the MPF(F) ships within the 2009 FYDP.

According to CBO's estimates, the DDG-1000s would cost about 60 percent more than the Navy projects. In addition, CBO's estimate for the cost of the CG(X) is higher than the Navy's because of the relationship between the DDG-1000 and CG(X) programs. Currently, funding for the CG(X) within the 2009 FYDP is based on using the DDG-1000 hull to construct the CG(X), while incorporating within that hull more-sophisticated radars and combat systems than those carried by the DDG-1000. Thus, higher costs for the DDG-1000 would mean higher costs for the two CG(X)s within the FYDP and for the 17 additional CG(X)s the Navy plans to purchase between 2014 and 2023. If CBO's estimate for the cost of the CG(X) is real-

10. See the statement of J. Michael Gilmore, Assistant Director for National Security, Congressional Budget Office, *The Navy's DD(X) Destroyer Program*, before the Subcommittee on Projection Forces of the House Armed Services Committee (July 19, 2005).

ized, the Navy may find it difficult to purchase two CG(X)s a year between 2015 and 2021, as proposed in the 2009 shipbuilding plan. If the service is able to afford only one CG(X) per year, then seven CG(X)s would be either canceled or delayed until the mid- to late 2020s. A delay in CG(X) purchases, rather than a cancellation, could mean that other ship purchases contained in the 2009 plan during the period beyond 2020 might have to be canceled or delayed.

Changes to the Navy's Planned Funding for Ship Construction

In submitting its 2008 shipbuilding plan, the Navy stated that it needed \$16.1 billion in funding for new-ship construction (\$13.4 billion in 2005 dollars) each year for the period spanning 2008 to 2037. Over the past six years, the Navy has received funding averaging \$11.1 billion per year for new-ship construction. In formulating its 2008 plan, the Navy assumed its total obligational authority—the Navy's budgetary "top line"—would not increase annually at more than the rate of inflation. To accommodate a larger budgetary share for ship construction within a budget experiencing no real growth, the Navy needed to make four assumptions:

- Funding for operation and maintenance in the service's accounts would not grow faster than the overall rate of inflation;
- Funding for research and development—which hit a historical high of about \$20 billion in 2006—would fall by \$5 billion or \$6 billion (although the Navy did not specify a time frame for that occurrence) and would not increase thereafter;
- Any increase in pay and benefits for Navy personnel beyond the general rate of inflation would be offset by reductions in the number of personnel (the Navy's end strength); and
- Ongoing ship programs would experience no cost growth, and the costs of prospective new ships would meet strict cost targets.

The cost targets for ships scheduled to be bought after 2013 in the Navy's 2008 shipbuilding plan generally were not based on the costs of either existing ships or cost estimates for notional designs. To develop those targets, the Navy used a top-down approach. It allocated the total amount of money it would devote to new-ship construction over 30 years among different types of ships—surface combatants, amphibious ships, attack submarines, ballistic missile submarines, and aircraft carriers—according to their historical share of Navy funding. The historical share of funding for a particular type of ship was then divided by the number of ships the Navy wanted to buy in that category to calculate the cost target for each type of ship.

The Navy's 2009 budget illustrates the challenges that the service would have faced in realizing the assumptions listed above. For fiscal year 2009, the Navy is requesting a

top-line increase of 5 percent in real (inflation-adjusted) terms. The Navy is also requesting an increase of 3 percent in real terms for spending on operation and maintenance, 3 percent for spending on military personnel, and 11 percent for spending on research and development. At the same time, shipbuilding is slated to decrease by 2 percent in real terms. Thus, the 2009 budget request departs from every budgetary assumption that the Navy made when constructing its previous shipbuilding plans.

In developing its 2009 shipbuilding plan, the Navy appears to have changed its cost target methodology. The 2009 plan states that the Navy needs to devote \$17.1 billion annually to new-ship construction through 2020 (\$15.8 billion in 2007 dollars), whereas the corresponding average annual funding in the Navy's 2008 plan was about \$16.1 billion (\$14.4 billion in 2007 dollars), even though the 2009 plan excludes costs for ballistic missile submarines and the 2008 plan included those costs. The Navy attributes the increase in annual costs during that near-term period to "the FY 2006 Pension Protection Act, rising material costs, increasing labor rates, and the cost risk associated with developing and building new ship classes. Additionally, minimal first-tier shipbuilding capacity is devoted to commercial business, placing the overhead burden largely on Navy shipbuilding programs."¹¹

Figure 1 in the 2009 shipbuilding plan suggests that, over the 30-year period, the Navy would require an average of \$22.4 billion per year in new-ship construction, excluding ballistic missile submarines, to meet its stated goals. However, when CBO requested the detailed ship cost data that supported Figure 1 to compare with the agency's individual ship cost estimates, the Navy discovered that the costs contained in that graphic were overstated, the result of a spreadsheet error. The Navy then provided corrected data to CBO (see Figure 2). Accordingly, the Navy's corrected data indicate that the service believes it would cost an average of \$20.4 billion per year in new-ship construction, excluding ballistic missile submarines, to implement its shipbuilding plan over the 30-year period. That figure represents a 30 percent increase over the Navy's estimates of the previous two years, but it is about 10 percent less than the amount the Navy published in its 2009 shipbuilding plan.

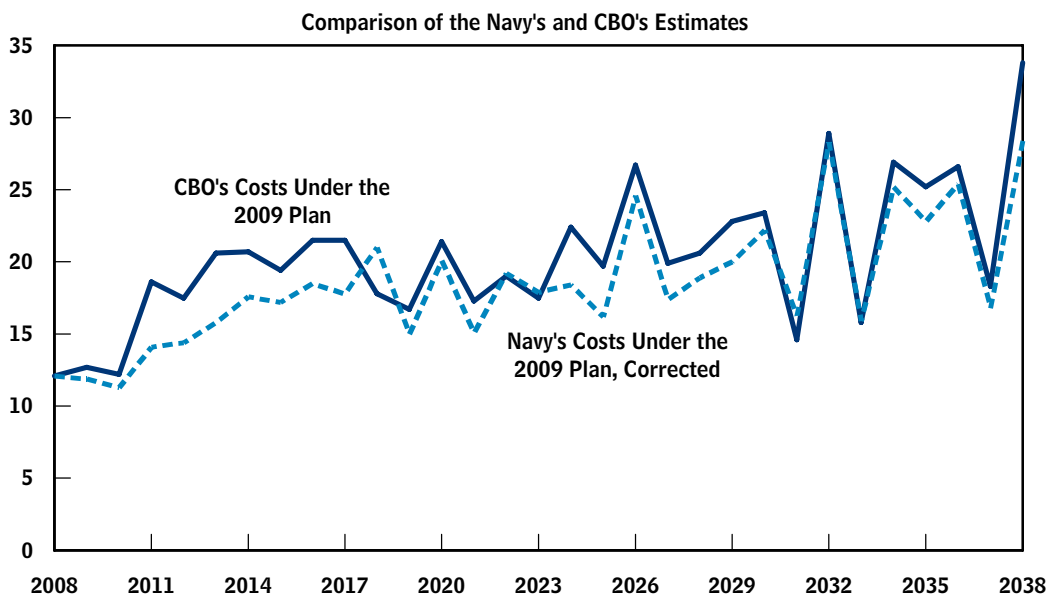
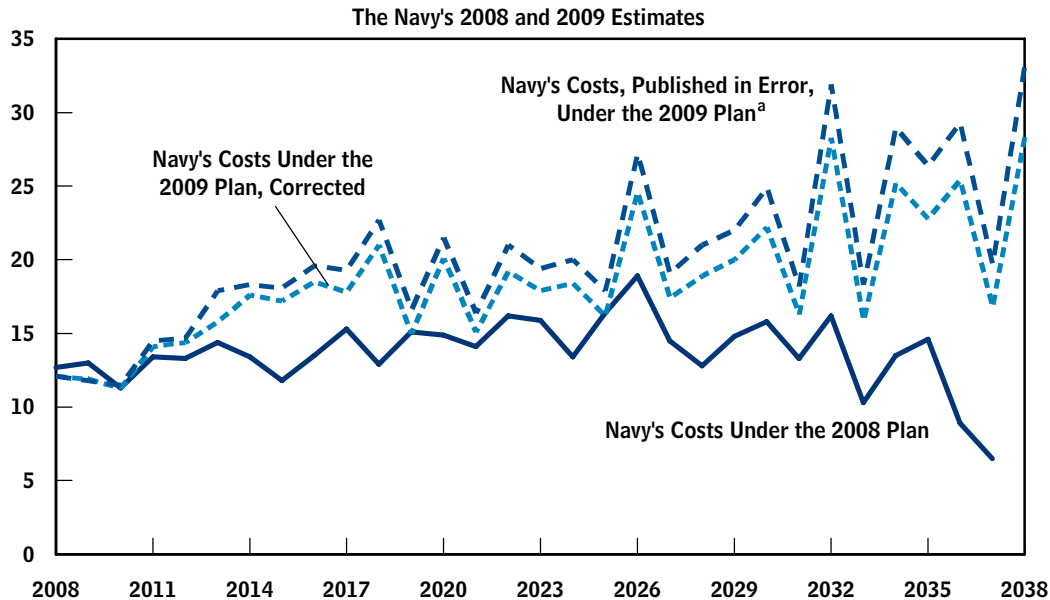
The increase in the costs projected by the Navy is particularly large for the latter part of the 30-year period. Using the corrected data, the Navy anticipates that it will need an average of \$22.2 billion per year (\$20.5 billion in 2007 dollars) between 2021 and 2038 to fund new construction. (The 2008 shipbuilding plan projected average annual construction costs of about \$15 billion for the period spanning 2021–2037.) The 2009 plan lacks any explanation of how the Navy derived the higher costs displayed in its report or why those costs differ substantially from the cost targets presented in the 2007 and 2008 shipbuilding plans. Navy officials have explained to CBO, however, that in developing estimates for ships scheduled to be built in the far term, the service now adopts cost-to-weight relationships using appropriate historical analogies—a method similar to that used by CBO.

11. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 11.

Figure 2.

Estimates of Annual Spending for New-Ship Construction Under the Navy's 2008 and 2009 Shipbuilding Plans

(Billions of 2007 dollars)



Source: Congressional Budget Office based on data from the Department of the Navy.

Notes: This figure is displayed in 2007 dollars because the cost estimates provided by the Navy in both the 2008 and 2009 shipbuilding plans are expressed in 2007 dollars.

In the first panel, the amounts indicated for the Navy's costs under the 2008 plan include the cost of ballistic missile submarines. All other amounts in both panels exclude the cost of ballistic submarines.

a. An error in the Navy's estimate of the costs of new-ship construction caused those costs to be overstated by about 10 percent in the graphic displayed in the Navy's 2009 shipbuilding plan.

The Navy's projection of \$20.4 billion (\$18.8 billion in 2007 dollars) in average annual costs for new-ship construction over the next 30 years excludes the costs of other activities historically included in the total shipbuilding budget. For example, it excludes funding for the nuclear refueling of aircraft carriers and submarines, mission modules for littoral combat ships, and modernization programs for existing surface combatants. Notably, the 2009 plan also excludes funding to replace the Navy's ballistic missile submarines, which was included in the cost projections the Navy provided in its 2007 and 2008 shipbuilding plans. The 2009 plan states: "The replacement program for the OHIO class Ballistic Missile submarines is a strategic issue that merits immediate attention. Absent additional resources to recapitalize this national strategic capability, the Navy will be unable to concurrently replace the existing OHIO class submarines and the balance of its force structure requirements in accordance with this shipbuilding plan."¹² Using the Navy's corrected data and including CBO's estimates for the costs of 12 SSBNs, as well as the other activities and systems listed above, the Navy's total shipbuilding budget could average about \$25.2 billion per year for the next 30 years, an increase of about 40 percent over comparable estimates in the 2007 and 2008 plans and more than double the average for shipbuilding contained in the budgets of the past six years.

CBO's Estimate of the Costs of the 2009 Shipbuilding Plan

Buying a total of 296 ships over the 2009–2038 period—or an average of about 10 ships per year—would require an average annual shipbuilding budget of \$26.9 billion, according to CBO's estimates:

- Specifically, funding for new-ship construction alone would require \$25.0 billion per year, including the costs for new ballistic missile submarines (see Table 3). (If SSBNs were excluded, the Navy would need to spend an average of \$22.4 billion annually on new-ship construction.) That amount is more than the \$23.2 billion that the Navy expects new-ship construction to cost and more than double the \$11.1 billion per year that the Navy spent on new-ship construction between 2003 and 2008.
- Including the cost of refueling nuclear-powered aircraft carriers and submarines would add annual costs of \$1.2 billion, raising CBO's estimate to \$26.2 billion a year, on average, over the next 30 years (see Figure 3).

12. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 8.

Table 3.**Actual and Projected Average Annual Shipbuilding Costs**

(Billions of 2009 dollars)

	New-Ship Construction			
	Excluding SSBNs	Including SSBNs	Including SSBNs and Nuclear Refuelings	Including SSBNs, LCS Mission Modules, and Surface Combatant Modernization
Navy's Actual Spending, 2003 to 2008	11.1	11.1	12.4	12.6
Costs Under the Navy's 2009 Long-Term Shipbuilding Plan				
Navy's estimate, corrected ^a	20.4	23.2 ^b	24.4 ^b	25.2 ^b
CBO's estimate	22.4	25.0	26.2	26.9
CBO's Estimate of the Cost to Fully Fund the Navy's 313-Ship Fleet ^c	22.5	25.5	26.7	27.4
Memorandum:				
Navy's Estimate of Costs Under the 2007 and 2008 Plans	n.a.	16.1	17.2 ^b	18.0 ^b

Source: Congressional Budget Office based on data from the Department of the Navy.

Note: LCS = littoral combat ship; SSBN = ballistic missile submarine; n.a. = not available.

- a. An error in the Navy's estimate of the costs of new-ship construction caused those costs to be overstated by about 10 percent in the graphic displayed in the Navy's 2009 shipbuilding plan.
- b. The Navy's estimate for new-ship construction plus CBO's estimate for additional costs.
- c. CBO's estimates of the costs to buy all of the attack submarines, guided-missile submarines, ballistic missile submarines, logistics ships, and amphibious ships needed to maintain a 313-ship fleet.

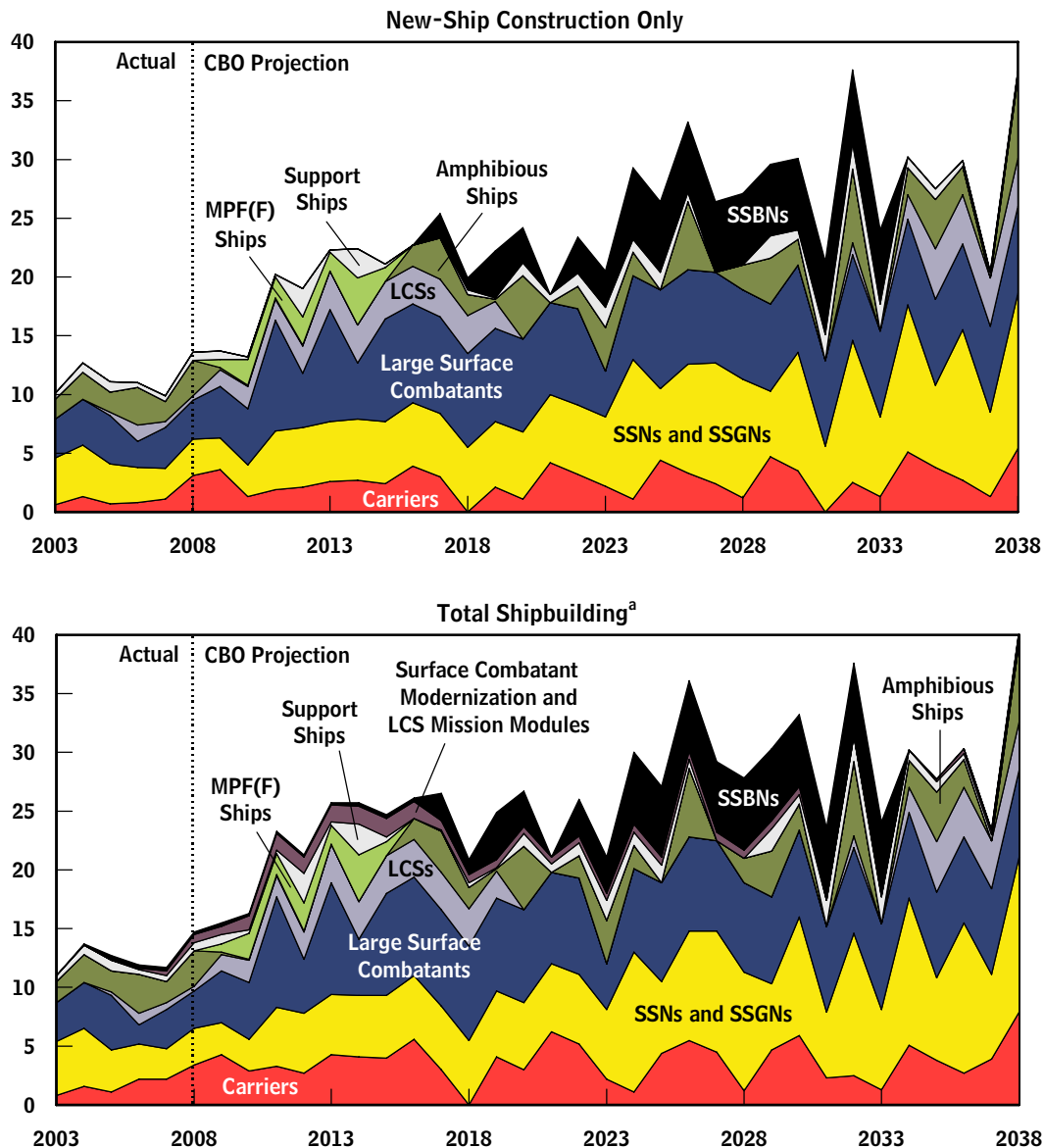
- The final component of the estimated \$26.9 billion incorporates the costs of modernizing existing cruisers and destroyers and of buying the mission modules that are intended to provide much of the combat capability of littoral combat ships. The Navy plans to fund those activities and systems from accounts other than the ones normally associated with ship construction. However, such modernization programs have been funded from shipbuilding accounts in the past; and in other new-ship programs (such as the one for the DDG-1000 Zumwalt class destroyer), combat capability is included in a ship's cost and funded as part of the ship's construction.

In order to conform with the Navy's plan, funding for new-ship construction beyond 2020 would need to average \$24.0 billion a year (excluding SSBNs), CBO estimates. That is about \$2 billion more per year than the Navy projects for new-ship construction costs over the 2021–2038 period.

Figure 3.

Annual Costs Implied by the Navy's 2009 Shipbuilding Plan

(Billions of 2009 dollars)



Source: Congressional Budget Office based on data from the Department of the Navy.

Notes: LCSs = littoral combat ships; MPF(F) = Maritime Prepositioning Force (Future); SSBNs = ballistic missile submarines; SSGNs = guided-missile submarines; and SSNs = attack submarines.

Amounts for 2006 exclude supplemental funding related to Hurricane Katrina.

- a. Includes costs for new-ship construction, refuelings of nuclear-powered ships, programs to modernize existing large surface combatants, and mission modules for littoral combat ships. The modernization of surface combatants and the mission modules for LCSs are expected to be funded from Navy accounts other than those traditionally associated with shipbuilding.

According to CBO's calculations, the Navy's 2009 shipbuilding plan would cost about \$4 billion more per year to carry out than the 2008 plan. Some of that increase is attributable to price escalation of about 3.5 percent from 2008 dollars to 2009 dollars. Some of the increase is attributable to higher ship prices (such as for the LCS), changes in the numbers and types of ships being purchased, and a change in how CBO incorporates higher inflation in the shipbuilding industry into its projection (the latter is discussed in more detail in the next section). The remainder is explained by a change in the Navy's assumptions about several types of ships. Notably, under the 2009 plan, the Navy assumed that it would build larger amphibious ships than CBO had assumed for the 2008 plan and that a larger attack submarine would eventually replace the Virginia class. The change in those assumptions increased the unit costs of those ships in CBO's estimate.

The costs contained in these long-term projections are inherently uncertain. Both the Navy and CBO make many assumptions about the size and capabilities of ships as well as about conditions existing in the shipbuilding industry that in the long-run may not prove valid. As a result, actual costs could differ substantially from current projections.

The Costs of Fully Funding the 313-Ship Fleet

As explained above, under its 2009 shipbuilding plan, the Navy would not build the appropriate number of ships at the right times to meet the service's 313-ship requirement. In particular, it would lead to shortfalls in the following categories of vessels: attack submarines, guided-missile submarines, ballistic missile submarines, logistics ships for the future maritime prepositioning squadron, and amphibious ships. Those shortfalls could be filled by making several changes to the current plan. For example, CBO has estimated the costs of the following possible changes:

- To prevent the attack submarine force from falling below 48, the Navy could purchase two attack submarines in 2010 (instead of one) and then buy three SSNs annually over the six-year period spanning 2017 to 2022. To compensate, fewer attack submarines could be bought in the mid- to late 2020s and 2030s than is called for under the Navy's plan.
- To maintain its force of four guided-missile submarines, the Navy could develop and buy replacements for the Ohio class SSGNs that would be retired from the fleet in the 2020s. CBO assumed that those submarines would be the same size as the Navy's ballistic missile submarine replacements.
- To ensure that the SSBN force was maintained at 14, two additional ballistic missile submarines could be purchased.

- To meet the Navy's requirement for the future maritime prepositioning force, two additional T-AKE logistics ships could be bought in 2010 and 2011.
- To counteract the shortfall in amphibious ships, an additional LPD-17 could be purchased in 2009.

Incorporating those changes into the Navy's plan would raise the required average annual budget to about \$25.5 for new-ship construction, including ballistic missile submarines, and to \$27.4 billion for shipbuilding overall (see Table 3). (Other approaches to alleviating shortfalls in the 313-ship requirement could have different costs.)

Inflation in Shipbuilding

An important component of the Navy's and CBO's cost analyses is the effect of inflation on the cost of constructing naval vessels. The Navy has examined the inflationary component of past cost increases in shipbuilding programs and concluded that the overall figure ("inflater") that the Department of Defense uses to project cost increases for its procurement programs underestimated the inflation that actually occurred in the naval shipbuilding industry over the past decade by about 1.8 percentage points per year, on average. The Navy provided CBO with a composite inflater that reflects the growth in labor and materials costs that the industry has experienced in the past and that the Navy expects to encounter through at least 2013. That inflater is an average of about 1.4 percentage points higher per year, from 2009 through at least 2016, than the price increases that DoD anticipates for its procurement programs overall: about 3.5 percent for shipbuilding versus 2.1 percent for defense procurement programs as a whole. The Navy incorporated that higher rate of inflation in its budget request for 2009, in the associated Future Years Defense Program, and in estimates of the costs of ships for both the near- and far-terms as described in the Navy's 2009 shipbuilding plan. In both the Navy's and CBO's analyses, the higher rate of inflation produces real growth in the future costs of ships. For example, a ship that cost \$2.5 billion to build in 2009 would cost \$3.2 billion (in 2009 dollars) to build in 2025.

In its analysis of the Navy's 2007 and 2008 shipbuilding plans, CBO assumed that cost growth in the shipbuilding industry would continue to be higher than average for many years and then gradually revert to the level of general inflation for DoD procurement programs by 2025. In its analysis of the 2009 plan, CBO assumed that the higher rate for ships would continue throughout the period covered by the analysis, in part because CBO does not have an analytic basis for determining when and how the difference between the shipbuilding inflater and the DoD procurement inflater would disappear. The Navy's cost estimates also incorporate that rate of growth throughout the 2009–2038 period.

Inflation in shipbuilding costs, however, cannot continue to grow indefinitely at a rate faster than that of procurement programs overall (or the economy as a whole). If that were to happen, the price of ships would eventually outstrip the Navy's ability to pay for them, even in very small numbers. In addition, for the purposes of comparison, if in this analysis CBO had used the same assumption it did in its previous analysis—that higher shipbuilding inflation reverts to the average rate anticipated for DoD's procurement programs by 2025—then the total costs for shipbuilding would be \$25.7 billion per year and new construction alone would total an average of \$23.8 billion per year in 2009 dollars, or about 5 percent less than CBO currently estimates.

Individual Ship Programs

To estimate the costs of implementing the 2009 shipbuilding plan, CBO used data provided by the Navy on actual costs for ships now under construction and on historical relationships between the cost and weight of ships (as discussed in more detail below). To apply those relationships to ships for which the Navy has yet to develop even a notional design—such as the prospective replacements for Arleigh Burke class destroyers and the Ohio class ballistic missile submarines—CBO had to make assumptions about the size and capabilities of future ships.

Aircraft Carriers

Under the 2009 shipbuilding plan, the Navy's requirement is for 11 aircraft carriers, which is unchanged from the 2007 and 2008 plans. To maintain a force of that size, the Navy would buy seven CVN-78 Gerald R. Ford class aircraft carriers over the 2009–2038 period. Building them in four- or five-year increments, the Navy would maintain at least 11 carriers through 2038, with the exception of 2013 and 2014, when the force would drop to 10. That decline would occur because under the 2009 plan, the CVN-65—the *Enterprise*—would be retired at the end of its service life, in 2013, and the CVN-78 Gerald R. Ford class nuclear-powered aircraft carrier designed to replace it would not be commissioned until 2015. Construction delays in the CVN-78 program would extend the period during which the Navy had only 10 carriers.

To estimate the cost of the new CVN-78 class aircraft carriers, CBO relied on the Navy's estimate and then increased the cost to account for historical cost risk in procurement programs and for the higher rate of inflation expected in the shipbuilding industry. (A comparison with the cost of the CVN-77 Nimitz class carrier, adjusted for historical cost growth, would have produced a similar estimate.) The first ship of the new CVN-78 class would require substantial funding for nonrecurring detail design, but subsequent ships would need little such funding. CBO estimates that the seven carriers in the Navy's 2009 shipbuilding plan would have an average cost of about \$11.2 billion each (see Table 4). The Navy estimates the average cost of aircraft

Table 4.**Comparison of the Navy's Cost Targets and Cost Estimates, and of CBO's Estimates of the Costs of Major New Ships**

(Billions of 2009 dollars)

	Navy's Average Cost Target per Ship Under the 2007 and 2008 Plans ^a	Average Cost per Ship over the 2009–2038 Period		Total Costs per Class over the 2009–2038 Period	
		Navy's Estimate Under the 2009 Plan, Corrected ^b	CBO's Estimate ^c	Navy's Estimate Under the 2009 Plan, Corrected ^b	CBO's Estimate ^c
CVN-78 Gerald R. Ford Class Aircraft Carriers	10.5	10.3	11.2	72	79
DDG-1000 Zumwalt Class Destroyers	2.4	2.5	3.6	12	22 ^d
CG(X) Cruisers	3.0	3.3	4.2	63	80
DDG(X) Destroyers (Replacement for Arleigh Burke class)	1.6 ^e	1.8	2.6	81	116
Virginia Class Attack Submarines	2.4	2.8	2.8	89	89
Improved Virginia Class (Replacement for Virginia class)	2.4	6.1	6.1	128	128
SSBN(X) Ballistic Missile Submarines (Replacement for Ohio class)	3.4	n.a.	6.4	n.a.	77
Amphibious Ships	1.6	2.9	3.2	58	63

Source: Congressional Budget Office.

Note: n.a. = not available in the Navy's 2009 plan.

- Based on a briefing by the Navy for CBO and the Congressional Research Service on February 10, 2006. Updated to reflect current-year dollars.
- An error in the Navy's estimate of the costs of new-ship construction caused those costs to be overstated by about 10 percent in the graphic displayed in the Navy's 2009 shipbuilding plan.
- CBO's estimates are generally based on historical relationships between cost and weight for individual types of ships; they also incorporate the higher inflation that the naval shipbuilding industry has experienced (compared with inflation in other Department of Defense procurement programs).
- This figure includes \$3.6 billion in additional costs for the two lead ships purchased in 2007. If CBO's estimate for the lead DDG-1000s is realized, the additional costs would appear in the 2009–2013 period.
- In contrast with the Navy's 2007 plan, the 2008 plan added 12 DDG(X)s and removed four large logistics ships; but the 2008 plan indicated that overall shipbuilding costs would not change. CBO assumed that the Navy's resulting per-ship cost target for the DDG(X) would be reduced from \$2.1 billion to \$1.7 billion, reflecting both the increased number of ships to be purchased and the increased funding that could be allocated to purchasing those new destroyers as a result of the reduction in purchases of logistics ships.

carriers under the 2009 plan to be \$10.3 billion, or about the same as its cost target under the 2007 and 2008 plans.¹³

CBO believes that the Navy's estimate of the cost for the first CVN-78 carrier is optimistic, for several reasons. First, in its budget submission to the Congress, the Navy indicated that the lead CVN-78 would cost about \$10.3 billion in 2009 dollars, including about \$2.4 billion for nonrecurring engineering and design costs. The Navy asserts that the actual construction time and cost of the first CVN-78 would be less than those of its predecessor ship, the CVN-77, *George H. W. Bush*.

In contrast, CBO estimates that the CVN-78 would cost about \$11.2 billion, allowing for the historical cost growth that has affected shipbuilding programs at the CVN-78's stage of construction over the past 30 years. If, however, the CVN-78 experienced cost growth similar to that of other lead ships that the Navy has purchased in the past 10 years, costs could be much higher still.¹⁴ Second, Navy officials have told CBO that the confidence level of their estimate for the lead CVN-78 is below 50 percent, implying a more than 50 percent chance that costs for the ship will be higher than the Navy's estimate (or a less than 50 percent chance that they will be lower). Finally, a number of critical technologies that are supposed to be incorporated in the CVN-78 (such as the new electromagnetic catapult system for launching aircraft) remain under development. Difficulties in completing their development could arise and increase costs.

Surface Combatants

Some of the largest differences between the Navy's and CBO's estimates for the costs of individual ships lie with the DDG-1000 program and the first two CG(X)s. Under the 2009 plan, all of the DDG-1000s and most of the CG(X)s are scheduled to be purchased by 2021, which partly explains why CBO's estimates for new-ship construction are higher than the Navy's through 2020. The Navy's purchase of 55 littoral combat ships would be completed before 2020. Starting in 2022, the Navy would begin purchasing replacements for the DDG-51 class destroyer, designated in the plan as DDG(X).

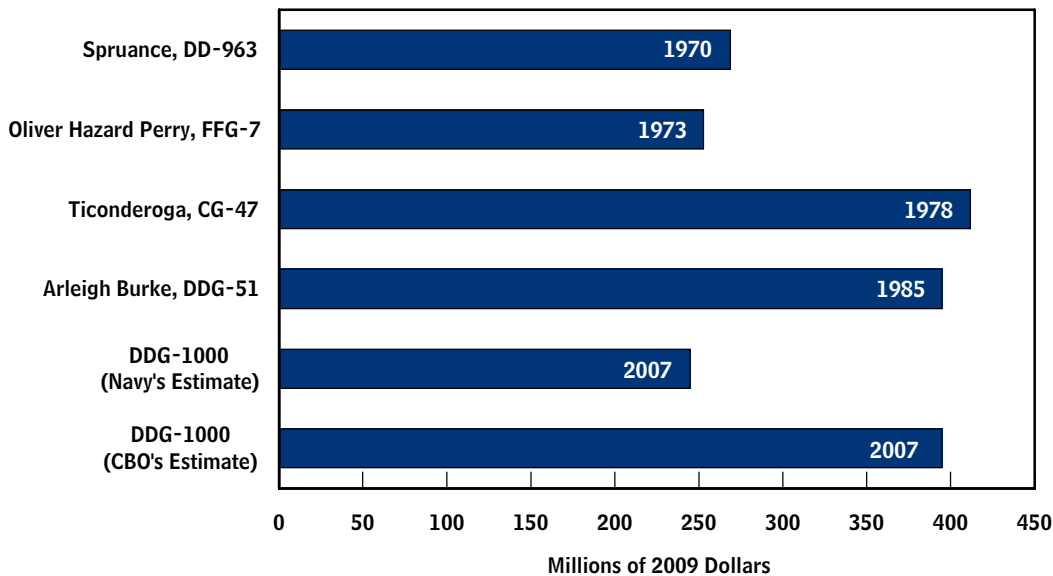
DDG-1000 Guided-Missile Destroyer. The Navy plans to buy one DDG-1000 Zumwalt class destroyer each year from 2009 to 2013, in addition to the two authorized in 2007. The service's 2009 budget suggests that the Navy expects the first two ships to cost \$3.2 billion each and the next five to cost an average of \$2.2 billion each—a cost increase of about \$200 million per ship for the last five ships compared with the cost in the Navy's 2008 budget. CBO, by contrast, estimates that the first two

13. CBO's estimate of the costs of aircraft carriers in the Navy's 2008 shipbuilding plan was almost identical to the Navy's cost target. CBO's higher estimate under the 2009 plan is the result of assuming that higher inflation in the shipbuilding industry will continue through 2038.

14. The costs of the LPD-17, the SSN-774, the SSN-775, and the LCS-1 have increased by about 80 percent, 11 percent, 25 percent, and 100 percent, respectively.

Figure 4.

Cost per Thousand Tons for the Lead Ship of Various Classes of Surface Combatants



Source: Congressional Budget Office based on data from the Department of the Navy.

Notes: The years shown here indicate the year in which each lead ship was authorized.

Costs are per thousand tons of lightship displacement (the weight of the ship itself without its crew, materiel, weapons, or fuel).

DDG-1000s would cost \$5.0 billion apiece and that the next five would cost an average of \$3.6 billion each.

The Navy's estimate for the two lead-ship DDG-1000s prices the ship at about \$250 million (in 2009 dollars) per thousand tons of lightship displacement (the weight of the ship minus its crew, fuel, ammunition, and stores). In comparison, the lead ship of the DDG-51 class destroyer cost about \$390 million per thousand tons, and the lead ship of the Ticonderoga class cruiser cost more than \$400 million per thousand tons (see Figure 4). CBO used the DDG-51 lead-ship cost as its basis for estimating the cost of the lead ship of the DDG-1000 class, adjusting for the size of the ship.

The Navy has asserted that the basis for CBO's estimate may not be valid because the DDG-51 had a number of problems in the early stages of its construction that should not be expected to occur during the construction of the first DDG-1000s. In particular, the design of the lead DDG-51 was disrupted and delayed because a new design tool being used at the time was incomplete and not well understood. It had to be abandoned and the design restarted using more traditional methods. The design of the lead DDG-51 was thus about 20 percent complete when construction began. In

comparison, according to the Navy, the design of the DDG-1000 is progressing far more smoothly; the Navy expects to have the design 85 percent complete when construction begins this summer. In addition, the DDG-51 is a smaller, more densely built ship; therefore, the Navy believes that on a ton-for-ton basis, it has been more difficult to build than the DDG-1000 class is going to be.

Although the Navy may not encounter the same problems constructing the lead DDG-1000s that it did when constructing the lead DDG-51, it is CBO's view that the service is likely to encounter other problems that will increase the costs of the DDG-1000 and delay its construction. As Navy officials have stated, lead ships are often very difficult to build, and many problems typically occur during construction. Problems with the first littoral combat ships (for which costs doubled) and with the lead ship of the LPD-17 class amphibious transport dock (for which costs increased by 80 percent and construction time more than doubled) illustrate the difficulties the Navy has encountered recently in constructing lead ships.¹⁵ Both the LCS and the LPD-17 are much less complex technologically than the DDG-1000 will be. And Navy officials have stated that the Virginia class submarine program was at about the same point in its design that the DDG-1000 will be when construction of those new submarines began. Nevertheless, the cost of the first two ships of the Virginia class exceeded their budget by an average of 17 percent. Moreover, the DDG-1000 program is incorporating 10 major new technologies into the lead ship of the class compared with the technologies used in the previous-generation DDG-51 destroyer. Those technologies include electric drive and a distributed power system, a tumble-home hull (one in which the sides of the ship slope outward to increase stealthiness), an advanced gun system, new radars, and composite materials and stealthy coatings for the deckhouse. In the past, the Navy typically introduced three or four major new technologies into a new class of surface combatant.

Comparing the Navy's estimate for two additional DDG-51s and the Navy's estimate for the seventh DDG-1000 to be purchased in 2013 illustrates the risk for cost growth in the latter program. Last year, the Navy stated that if the Congress authorized and bought two new DDG-51s in 2008—ships that would have the benefit of substantial efficiencies and lessons learned because of the 62 similar ships built previously—the cost would be between \$3.1 billion and \$3.2 billion, or about \$1.6 billion each in 2009 dollars. At the same time, in its fiscal year 2009 budget submission to the Congress, the Navy stated that the cost to build the seventh DDG-1000 in 2013 would be about \$2.4 billion in 2013 dollars. Deflating the cost of the seventh DDG-1000, using the inflation index for shipbuilding that the Navy provided to CBO, brings the Navy's estimate for that ship to about \$1.9 billion in 2009 dollars. The lightship displacement of the DDG-1000 is about 5,000 tons (or more than

15. Problems with the LCS included a change in construction standards, other design changes, and mistakes made by the contractor. The LPD-17 had suffered from an incomplete design before construction began, difficult integration of new technologies on the ship, and higher than expected labor and material costs.

50 percent) greater than the lightship displacement of the DDG-51s under construction today. In effect, the Navy's estimates imply that those 5,000 extra tons, as well as the 10 new technologies being incorporated into the DDG-1000 class, will add only 15 percent, or about \$300 million, to the ship's cost.¹⁶

CG(X) Future Cruiser. The Navy intends to begin buying a new missile defense surface combatant, the CG(X) cruiser, in 2011. CBO's estimates for the first two ships of the class are about double the Navy's estimates. CBO assumed that the CG(X) would use the same hull as the 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. The Navy last year conducted an Analysis of Alternatives (AoA) to determine what capabilities the CG(X) should have. Results of that analysis have not yet been released, but a version of the CG(X) built using the DDG-1000 hull is only one of the options considered in the AoA. The Navy says that it is studying other options that would be larger and more capable than a CG(X) built using the DDG-1000 hull, including ships that use nuclear propulsion (see Box 1). The Navy does not appear to be considering a ship smaller than the DDG-1000 as the basis for the CG(X). Any design that is larger is likely to be substantially more expensive than the DDG-1000. Using the DDG-51 as an analogy, CBO estimates that the lead CG(X) would cost \$5.2 billion. The average cost for each ship in that class would be about \$4.2 billion, assuming that the CG(X) is conventionally powered and uses the DDG-1000 hull. CBO also assumed that, consistent with the DDG-1000 program, 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 design but were intended 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 anti-air 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 the lead Ticonderoga was more than 60 percent higher than the cost of the lead Spruance, notwithstanding their many common hull features and mechanical systems.

16. Recent developments in the DDG-1000 program could change CBO's estimate. Each of the two shipbuilders plans to build about 25 percent of the seven individual ships. The remaining 50 percent of each ship would be built by the home shipyard, wherein one builder would construct four destroyers and the other, three. This "teaming" arrangement, somewhat similar to the teaming arrangement used to build Virginia class attack submarines, would in effect allow half of the content of the seventh ship to benefit from experience developed during the construction of the six previous ships; the other half of the ship's content would benefit from lessons learned during the construction of only three ships. In addition, the Navy has placed both of the lead ships under contract, with fixed-price contracts for the materials that will be used to construct the ships. CBO did not have sufficient data or time to evaluate the effect that these and other developments could have on its estimate but will do so in future analyses and updates of this report.

Box 1.**A Nuclear-Powered Cruiser**

The National Defense Authorization Act for Fiscal Year 2008 directed that future Navy aircraft carriers, submarines, and cruisers should be nuclear powered. Building a future nuclear cruiser, a CGN(X), would probably cost more than the Congressional Budget Office (or the Navy) has currently estimated for a conventionally powered CG(X). A Navy report on the cost-effectiveness of nuclear propulsion estimates that the additional cost to install that capability in a conventionally powered surface combatant would be approximately \$700 million. If a CGN(X) had to be much larger than the DDG-1000, 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 might 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; 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 proved to be the case, the larger, nuclear-powered CGN(X) could cost much more than the DDG-1000.

DDG(X) Future Guided-Missile Destroyer. The Navy's 313-ship plan would also maintain a fleet of 62 DDG-51s. CBO assumed that those ships would be modernized and would serve for about 40 years, consistent with the Navy's plan, which calls for the purchase of the first replacement—a DDG(X)—in 2022. For its analysis, CBO assumed that the new DDG(X) would be somewhat larger than the DDG-51 (which displaces about 9,200 tons at full load) but smaller than the DDG-1000 (which is intended to displace about 14,500 tons at full load). Specifically, CBO assumed that the DDG(X) would have a full-load displacement of about 11,000 tons and would not be able to carry both of the advanced gun systems with which the DDG-1000 is equipped. In CBO's projection, those replacement destroyers would have an average cost of about \$2.6 billion apiece if they were bought at a rate of three per year—the same cost per thousand tons as today's Arleigh Burke destroyers.¹⁷ In

17. Buying more of a given ship in the same year reduces the cost because it allows a shipyard's fixed overhead expenses to be spread among more ships.

Table 5.**Average Retirement Age of Surface Combatant Classes**

Ship Class	Average Retirement Age (Years)	Reason(s) for Retirement
CG-47 (Non-VLS)	20	Budgetary; not as capable as other ships
CG-26	28	Budgetary
CG-16	30	Budgetary
CGN-38	17	Budgetary
CGN-36	24	Budgetary
CGN-35	27	Budgetary
CGN-9	32	Budgetary
DD-963 (VLS)	25	Budgetary; not as capable as other ships
DD-963	25	Budgetary; not as capable as other ships
DD-931	29	End of service life
DDG-993 (Non-VLS)	17	Budgetary; not as capable as other ships
DDG-37	30	End of service life
DDG-2	26	End of service life
FF-1052	17	End of service life; limited capability
FF-1040	22	End of service life; limited capability
FF-1037	25	End of service life; limited capability
FFG-7	18	Budgetary; end of service life
FFG-1	21	End of service life

Source: Congressional Budget Office based on data from the Department of the Navy.

Notes: The reasons cited for retirement are Navy descriptions.

CG = guided-missile cruiser; VLS = vertical launch system; CGN = nuclear-powered guided-missile cruiser; DD = destroyer; DDG = guided-missile destroyer; FF = frigate; FFG = guided-missile frigate.

the 2009 shipbuilding plan, the Navy estimates that the DDG(X)s would cost \$1.8 billion each.¹⁸

Modernizing DDG-51 Destroyers. The 40-year service life assumed for the DDG-51 Arleigh Burke class destroyers in the Navy's 2009 shipbuilding plan is a significant change from the 35-year service life assumed in the 2007 and 2008 shipbuilding plans. Historical evidence suggests that the Navy's assumption that those destroyers can serve effectively for 40 years may be optimistic. The average retirement age of the last 18 classes of cruisers, destroyers, and frigates was below 35 years, and many were retired at 25 years or less (see Table 5). When the DDG-51 class was first built, it was designed to have a service life of 30 years.

18. The cost target for DDG(X)s in the Navy's 2007 plan was \$2.1 billion. However, the Navy added 12 DDG(X)s to the 2008 plan and removed four logistics ships, while stating that the overall costs of the plan were unchanged. CBO therefore assumed that the resulting cost target for the DDG(X) was reduced from \$2.1 billion to \$1.7 billion, reflecting both the increased number of ships to be purchased and the increased funding that could be allocated to purchasing those new destroyers as a result of the reduction in purchases of logistics ships.

Generally, the Navy has considered surface combatants to be obsolete when their installed combat systems are deemed no longer effective to counter the threats they would face in the event of war. The hull and mechanical systems of the ships have usually had some remaining service life, even if additional resources would have been required to keep them in good working order. Currently, the Navy is planning a modernization program that will focus mostly on the DDG-51's hull and mechanical systems, at an average projected cost of about \$100 million per ship. On the basis of historical experience, CBO expects that the combat systems of the DDG-51s may have to be upgraded twice in order for those ships to serve in the fleet for 40 years. The costs for upgrading those combat systems are not included in the Navy's shipbuilding plan. In comparison, the Navy plans to spend more than \$200 million per ship on modernizing the Navy's remaining CG-47 Ticonderoga class cruisers, including their combat systems, so that those ships can serve effectively for at least 35 years. CBO estimates that the per-ship cost of one round of DDG-51 modernizations, including upgrades to the combat systems, would be at least comparable to the costs projected for modernizing the CG-47s, or more than \$200 million apiece.

Littoral Combat Ship. The Navy's 2009 shipbuilding plan envisions building 55 littoral combat ships between 2005 and 2019. Because those ships are assumed to have a service life of 25 years, the Navy would need to begin procuring their replacements in 2032. The LCS differs from the Navy's existing and previous warships in that the program is divided into two components: the sea frame and mission modules. The sea frame (the ship itself) will be built with the ability to switch mission modules (combat systems) depending on which mission the ship is intended to carry out at a given time. Currently, the Navy expects to use three types of mission modules: for counter-mine warfare, antisubmarine warfare, and anti-surface-craft warfare. The Navy expects to buy 64 mission modules for the 55-ship program.

The Navy intends for the LCS to be a relatively affordable ship that will be fairly simple to design and build. Originally, each sea frame was expected to cost about \$260 million (in 2009 dollars, or \$220 million in 2005 dollars). The Navy's 2009 budget would allow the purchase of 18 LCSs during the 2009–2013 period, at an average cost of about \$450 million per sea frame. That is 11 fewer than the 2008 plan envisioned for the same time period. In the summer of 2007, the Navy requested that the cost cap for the fifth and sixth LCSs be raised to \$460 million. Based on the effects of a higher production rate and experience gained between the construction of the first and subsequent ships, that figure suggested that the total construction cost of the first ships would be about \$600 million each. In the 2009 budget, the Navy estimates the cost of LCS-1 at \$631 million and LCS-2 at \$636 million. In recent testimony, the Navy indicated that the costs of LCS-2 will likely grow further but did not indicate by how much.

Historical experience indicates that cost growth in the LCS program is likely. In particular, using the lead ship of the FFG-7 Oliver Hazard Perry class frigate as an analogy, historical cost-to-weight relationships indicate that the Navy's original cost target

for the LCS of \$260 million in 2009 dollars (or \$220 million in 2005 dollars) was optimistic. The first FFG-7 cost about \$670 million in 2009 dollars to build, or about \$250 million per thousand tons, including combat systems. Applying that metric to the LCS program suggests that the lead ships would cost about \$600 million apiece, including the cost of one mission module. Thus, in this case, the use of a historical cost-to-weight relationship produces an estimate that is less than the actual costs of the first LCSs to date but substantially more than the Navy's original estimate.

Based on actual costs the Navy has incurred for the LCS program, CBO estimates that the first two LCSs could cost about \$700 million each, including outfitting and postdelivery and various nonrecurring costs associated with first ships of a class but excluding mission modules. However, as of April 27, 2008, LCS-1 was 87 percent complete and LCS-2 was 72 percent complete. Thus, additional cost growth is possible, and CBO's estimate reflects that cost risk.

Overall, CBO estimates that the LCSs in the Navy's plan would cost about \$550 million each, on average, excluding mission modules. That estimate assumes that the Navy would select one of the two existing designs and make no changes. As the program advanced with a settled design and higher annual rates of production, average ship costs would probably decline. If the Navy decided to make changes to that design, however, the costs of building future ships could be higher than CBO now estimates.

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

Submarines

The attack submarine force continues to be a major source of demand on the Navy's resources. Under the 2009 shipbuilding plan, the Navy would buy two attack submarines a year beginning in 2011. Under the Navy's 2007 and 2008 plans, it would begin buying two submarines a year in 2012. That procurement rate would continue through 2028 and then alternate between one and two submarines a year. The Navy's current plan does not envision continuing to use guided-missile submarines beyond the 2020s, when the existing Ohio class SSGNs are to be retired from service.

Senior Navy leaders have stated—and the 2009 shipbuilding plan assumes—that the cost of Virginia class submarines would have to be reduced by about 15 percent, to

about \$2.4 billion each, before the Navy would be able to buy two per year.¹⁹ The President's 2009 budget indicates a cost of about \$2.9 billion for the Virginia class submarine purchased in fiscal year 2009.

CBO estimates that the Virginia class attack submarines built during the 2009–2038 period would have an average cost of \$2.8 billion apiece. That cost is based on several factors: the prices that the Navy is currently paying for Virginia class submarines, the effects of producing two submarines per year starting in 2012, and the real cost growth affecting naval shipbuilding.

For the replacement to the Virginia class, the first of which would be built starting in 2024, the Navy used the cost-estimating assumption that this ship and the new ballistic missile submarine (discussed below) would have a common hull design that would be about 50 percent larger than that of the existing Virginia class. CBO adopted the same assumption in developing its cost estimate.²⁰ As a result, CBO assumes that the average cost of the Improved Virginia class would be about \$6 billion per ship, or twice the cost per ship of the original Virginia class. That estimate includes the cost growth that is endemic to the shipbuilding industry, which is assumed to continue through 2038. However, other elements of the Navy who are responsible for overseeing the development and acquisition of the Navy's submarines might not agree with the assumption that the follow-on class to the Virginia would be 50 percent larger. They have indicated informally to CBO that although a new ballistic missile submarine might be substantially larger than the Virginia-class SSN, a new attack submarine could be about the same size as the existing Virginia class but with improved technology. Under that assumption, both the Navy's and CBO's costs for the Improved Virginia would be less than is stated here.

The Navy's 2009 plan calls for a force of 14 ballistic missile submarines through 2026, with the force falling to 12 SSBNs by 2030—two fewer than the 2007 and 2008 plans indicated. The Navy intends to buy its first replacement SSBN in 2019 and to purchase one per year starting in 2024. The design, cost, and capabilities of that replacement submarine are among the most significant uncertainties underlying the Navy's and CBO's analyses. The Navy's 2007 and 2008 plans assumed that the first ship of a new class of ballistic missile submarines—an SSBN(X)—would cost \$4.3 billion and that subsequent ships would cost about \$3.3 billion each. The average cost for 14 SSBN(X)s would be about \$3.4 billion. In contrast, the 2009 plan explicitly excludes the SSBN replacement as part of its costs, although it includes 12 of those submarines in its projection of future ship inventories.

19. The Navy's position is that to purchase two submarines per year in 2012, the cost would have to fall to \$2.0 billion each in 2005 dollars (about \$2.4 billion in 2009 dollars).

20. In testimony prepared in March 2008 for the Subcommittee on Seapower and Expeditionary Forces of the House Armed Services Committee, CBO assumed that the Improved Virginia class submarines would be the same size as the existing Virginia class.

Some senior Navy officials who oversee submarine programs have stated that the most cost-effective strategy for designing a new ballistic missile submarine would be to rely heavily on the design of the Virginia class. Much of the bow and stern of a Virginia class submarine, as well as the nuclear reactor, could be incorporated into the new SSBN. New missile-compartment sections would have to be developed, however, and integrated into the submarine's design. The practicality of that option has not yet been explored, and the Navy is only beginning to think about how to design an SSBN(X). No notional design or definitive estimate for the displacement of the SSBN(X) yet exists. Many Navy and industry officials involved with submarine warfare or submarine construction expect that the new ballistic missile submarine would be substantially smaller than the existing Ohio class submarines.

In its projections, CBO assumed that the Navy would buy 12 SSBN(X)s and that those submarines would be about 50 percent larger than the Virginia class submarine and thus about half the size of the Ohio class submarines.²¹ CBO assumed that the SSBN(X) would be designed to carry about eight missile tubes (instead of the 24 carried on existing submarines). On the basis of several factors—the SSBN(X)'s larger size, what the Navy is currently paying for a Virginia class submarine, and cost growth in shipbuilding programs—CBO estimated that the average cost of the SSBN(X) would be about \$6.4 billion. Therefore, CBO's projections include \$77 billion that is excluded from the costs displayed in the Navy's 2009 shipbuilding plan (which excludes the costs of replacement SSBNs).

Amphibious Ships

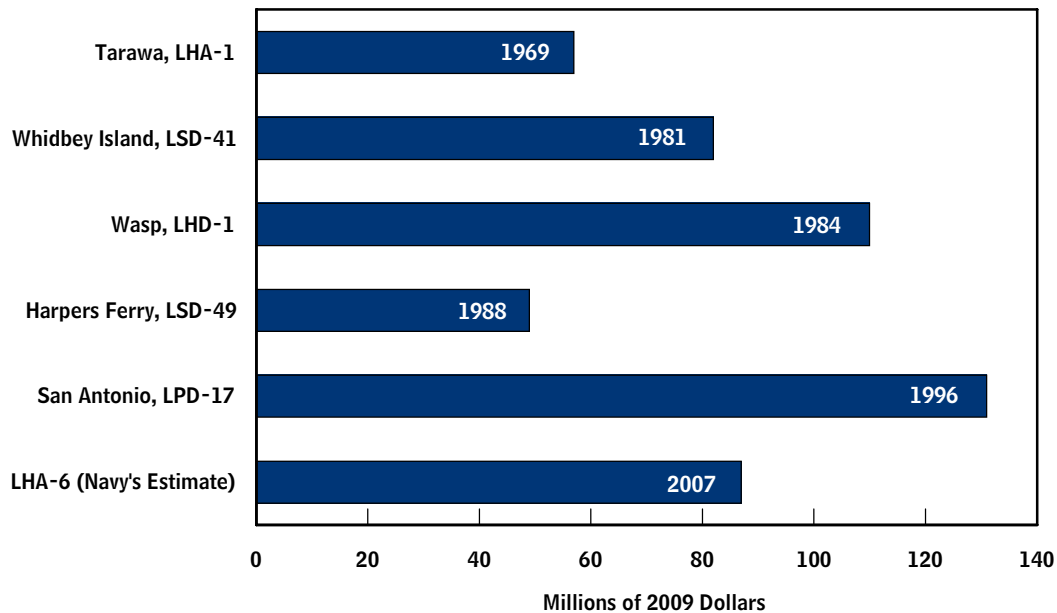
The Navy's 313-ship requirement in its 2009 shipbuilding plan calls for a force of 31 amphibious ships organized around nine expeditionary strike groups. Each group would include one large amphibious assault ship (LHA or LHD class), one amphibious transport dock (LPD), and one dock landing ship (LSD). A footnote in the 2009 plan states, however, that because the Marine Corps requires 33 amphibious ships to transport the assault echelons of two Marine expeditionary brigades, the Navy is reviewing options to increase the number of amphibious ships to 33. To meet the Marine Corps's requirement for 33 ships over the 30-year period, the 2009 plan would not substantially increase the purchase of amphibious ships compared with the 2007 and 2008 plans, but it would increase the service life of two LPD-4s, two LHAs, and all 12 LSDs.

Specifically, the 2009 plan calls for the purchase of an LHA-6 in 2017, in addition to the one being bought in 2007 and versions that would be purchased in 2010 and 2013 for use in the Maritime Prepositioning Force (Future) squadron. The Navy would also buy seven replacements for the Wasp class LHDs in the 2020s and 2030s—designated the LH(X). In addition, 12 replacements for today's LSD-41 and LSD-49 class ships—designated the LSD(X)—which will start to reach the end of

21. In its March 2008 testimony, CBO assumed that the SSBN(X) would be about twice the size of the Virginia class submarine.

Figure 5.

Cost per Thousand Tons for the Lead Ship of Various Classes of Amphibious Ships



Source: Congressional Budget Office based on data from the Department of the Navy.

Notes: The years shown here indicate the year in which each lead ship was authorized.

Costs are per thousand tons of lightship displacement (the weight of the ship itself without its crew, materiel, weapons, or fuel).

The LSD-49 is a variant of the LSD-41, and the LHA-6 is a variant of the LHD-8, the last ship of the LHD-1 class. The principal differences between the LHA-6 and the LHD-8 are that the former will not have a docking well but will have enhanced aviation capabilities.

their service lives in the 2020s, would be purchased starting in 2016, at a rate of one every other year. That program begins two years earlier than was proposed in the 2008 plan, but the 2009 plan slows LSD(X) procurement so that the last four ships of the class would be purchased later than was indicated in the 2008 plan. The Navy's cost target for an amphibious ship in the 2007 and 2008 plans was \$1.6 billion. That target was an average of the costs of the large LHAs and LHDs (which displace about 40,000 to 45,000 tons) and the smaller LSD replacements (which would probably displace about 25,000 tons). Under the 2009 plan, the Navy estimates that the average cost of amphibious ships would be \$2.9 billion each.

CBO assumes that all future amphibious assault ships would be slightly larger than the first LHA-6—a variant of the existing LHD design—which is consistent with the Navy's assumption. According to the Navy, its 2009 plan assumes that future large-deck amphibious ships will resemble the first LHA-6, which the service is purchasing this year at a cost of about \$3.4 billion. Under that assumption, CBO estimates that

the average cost of an amphibious ship—that is, the average cost for the LHA-6s, LHD replacements, and LSD(X)s—would be \$3.2 billion.

The Navy's experience with its LPD-17 San Antonio class amphibious ship serves as a useful illustration of the rising costs of ships from one generation to the next on a per-ton basis. It also illustrates the difficulty in reducing those costs to levels that might meet the Navy's targets. On a per-ton basis, the lead ship of the LPD-17 class is the most expensive amphibious ship ever built, at about \$130 million per thousand tons. Thus, adopting either the LSD-41 or LHD-1 amphibious ships as analogies, historical cost-to-weight relationships would have understated substantially the actual costs of the LPD-17 (see Figure 5). Costs of subsequent ships of the LPD-17 class range from \$1.5 billion to a little less than \$1.7 billion, which are substantially higher than the Navy's original estimates.

The Navy's 2009 plan states that in order to meet the Marine Corps's requirement for 33 amphibious ships, four ships would undergo a program to extend their service life. The costs of those extensions are not indicated in the 2009 plan, however. Likewise, CBO did not include the costs of those extensions in its estimates because little information is available about that effort at this time. Under the 2009 plan, two Austin class LPD-4s will serve for 45 and 47 years, respectively, and two LHA-1 class amphibious assault ships will serve for 43 years. In addition, the decommissioning schedule associated with the Navy's 2009 shipbuilding plan indicates that the LSD-41 and LSD-49 class ships, which are slated to retire in the 2020s, will serve an average of 42 years, up from an average of 38 years in the 2007 and 2008 plans. Those ships may eventually require service-life extension programs as well to allow them to serve more than 40 years in the fleet.

Maritime Prepositioning Ships

In a June 2005 report to the Congress, the Navy outlined the future of the Maritime Prepositioning Force, describing an MPF(F) squadron of 12 ships, most of which would be based on designs of existing amphibious or support ships. The squadron would include two LHA-6s; an LHD; three modified large, medium-speed roll-on/roll-off ships; three modified-design T-AKE support ships; three mobile landing platforms (large flow-on/flow-off ships to carry the squadron's landing craft); and two ships from existing maritime prepositioning squadrons. However, under the 2008 shipbuilding plan, the Navy opted to use the existing T-AKE, rather than a modified design, for the MPF(F) squadron. In the 2009 shipbuilding plan, the Navy has removed two of the three T-AKEs previously associated with the MPF(F) squadron but indicates that those two ships may be restored in its future shipbuilding plans. Consequently, the MPF(F) inventory under the 2009 plan would be short two ships after 2020, when the squadron is expected to be ready for deployment. Further, as was noted earlier, the 2009 plan calls for a delay in the construction of most of the other MPF(F) ships of one to two years until the Navy and Marine Corps resolve issues regarding the concept of operations for the squadron. CBO estimates the cost of the MPF(F) squadron with only one T-AKE at about \$14 billion.

