



CONGRESSIONAL BUDGET OFFICE
U.S. Congress
Washington, DC 20515

Peter R. Orszag, Director

March 23, 2007

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

Dear Mr. Chairman:

In response to your request, the Congressional Budget Office has assessed the long-term resource implications of the Navy's recently reported fiscal year 2008 shipbuilding plan. CBO estimates that the Navy would need to spend an average of \$20.6 billion annually (in 2008 dollars) on new-ship construction over the next 30 years to implement its plan. With refuelings of nuclear-powered aircraft carriers and submarines included, the Navy would need to spend an average of \$21.7 billion annually through 2037. 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 when it would buy them. Different assumptions could produce different estimates.

The enclosure describes the analysis by CBO's National Security Division. 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.

Sincerely,

A handwritten signature in black ink, appearing to read 'Peter R. Orszag'.

Peter R. Orszag

Enclosure

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

Honorable Ike Skelton, Chairman,
House Armed Services Committee

Honorable Duncan Hunter, Ranking Member,
House Armed Services Committee

Resource Implications of the Navy's Fiscal Year 2008 Shipbuilding Plan

March 23, 2007

Overview

In response to a Congressional mandate, the Department of the Navy recently began issuing annual reports that describe its 30-year plans for ship construction. In the report released last year, the Navy presented a plan to expand its battle force fleet from 285 ships at that time to 313 ships over the long run.¹ That plan, which was consistent with the Navy's proposed budget for fiscal year 2007, reflected the department's view of its future naval requirements and the types of ships needed to meet those requirements. In May 2006, the Congressional Budget Office (CBO) issued a study analyzing that plan and estimating its potential costs.²

The Navy has since updated its long-term shipbuilding plan for fiscal year 2008.³ The current plan resembles the previous one in that it envisions a 313-ship fleet, but the timing and size of purchases have changed for several categories of ships. The most important difference is that the total number of ships that the Navy hopes to buy over 30 years has grown from 280 to 293 (see Table 1). That 13-ship increase primarily reflects two factors:

- An acceleration in the building of certain ships, such as the DDG(X), which is intended to replace today's Arleigh Burke class guided missile destroyers; and
- A shift in the time period under consideration (the Navy intends to buy more ships in 2037 than in 2007, so moving from a 2007–2036 planning window to a 2008–2037 window increases the number of vessels purchased over 30 years).

Despite the rise in the number of ships to be purchased, the Navy estimates that the average annual spending needed to carry out its 2008 plan will be the same as for the 2007 plan.

This report updates CBO's earlier analysis to reflect the Navy's new long-term plan for shipbuilding. Unlike the Navy, CBO concludes that the 2008 plan will require greater average annual spending over 30 years for new ships than the 2007 plan did. The increase stems primarily from the growth in ship purchases (because of the acceleration in construction and the shift in the planning period). However, higher projected prices for some types of ships, such as the littoral combat ship (LCS), also play a role in raising the costs of the current plan.

The difference between CBO's and the Navy's estimates for the updated plan are attributable to two factors. First (as noted in previous CBO reports), CBO generally estimates that new ships will cost more to build than the Navy anticipates. Second, in updating its analysis for the 2008 plan, CBO revisited its cost-per-ship estimates and,

-
1. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY2007* (February 2006).
 2. Congressional Budget Office, *Options for the Navy's Future Fleet* (May 2006).
 3. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY2008* (February 2007).

Table 1.

Comparison of the Navy's 2007 and 2008 Long-Term Shipbuilding Plans

	2007 Plan (2007 to 2036)	2008 Plan (2008 to 2037)
Number of Ships Purchased Over 30 Years		
Aircraft Carriers	7	7
Large Surface Combatants	53	66
Littoral Combat Ships	78	85 ^a
Attack Submarines	51	51
Ballistic Missile Submarines	14	14
Amphibious Ships	22	20
MPF(F) Ships	11	11
Support Ships	44	39
Total	280	293
Total 30-Year Costs for New-Ship Construction (Billions of 2008 dollars)		
Navy's Estimate	462	462
CBO's Estimate	585	618

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

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

a. CBO assumed that the two littoral combat ships canceled in 2007 (as well as the ones that the Navy is now planning to forgo in 2008 and 2009) would be purchased in 2017, at the end of that ship program.

in several cases, raised them because of new information. In updating its plan, by contrast, the Navy adopted a largely top-down approach to estimating ship costs—it assumed that average annual spending for ship construction would be the same as in last year's plan. Since the number of ships in the plan has increased, that approach implicitly assumes that future costs per ship will be lower than the Navy has stated previously. As a result, the difference between CBO's and the Navy's estimates of the costs of the 30-year plan has widened since last year.

The Navy's 2008 Shipbuilding Plan

On February 2, 2007, the Secretary of the Navy submitted a report to the Congress on the Navy's fiscal year 2008 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 6 ships in 2008 (see Figure 1) and a total of 63 ships between 2008 and 2013 (the period covered by the Department of Defense's 2008 Future Years Defense Program). From 2014 to 2037, the Navy would buy another 230 vessels under its long-term plan—for a total of 293 ships, or an average of 9.8 per year, over 30 years.

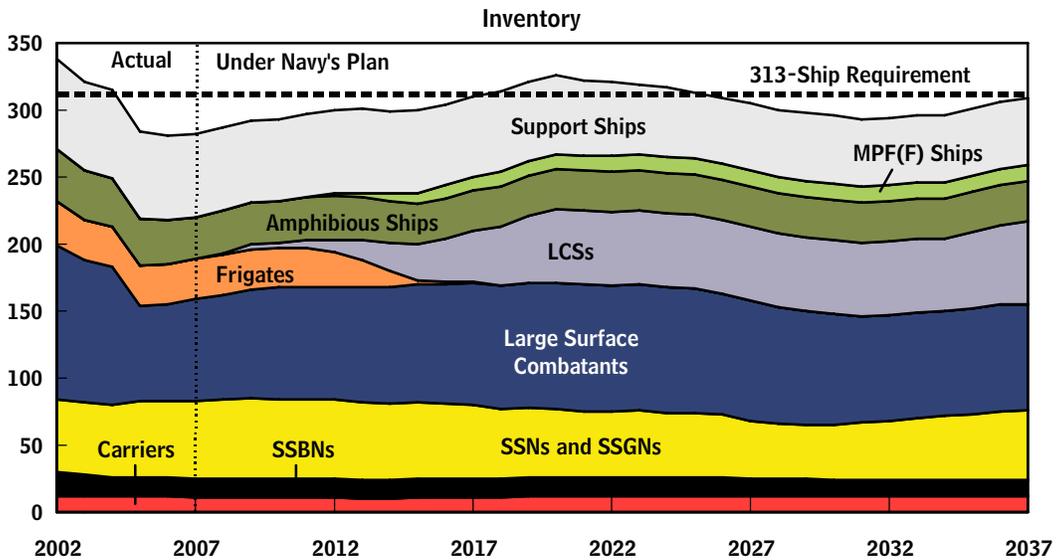
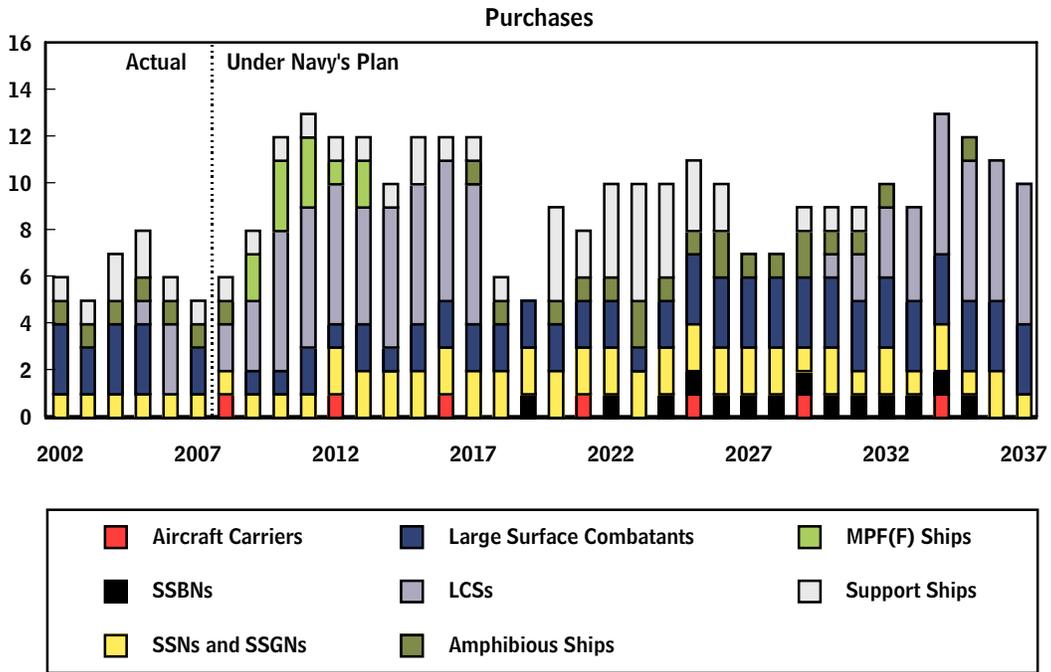
CBO adjusted the number of ships purchased under the Navy's plan to reflect the recent decision to alter the procurement schedule for littoral combat ships. The Navy now intends to forgo buying two LCSs in 2007 (in order to pay for cost overruns on the first four LCSs), to purchase two LCSs in 2008 instead of the planned three, and to buy three LCSs in 2009 rather than the six in the current shipbuilding plan. CBO assumed that the six ships removed from the Navy's short-term procurement plans would be purchased in 2017, at the end of the LCS program.

If implemented as described, however, the Navy's current plan would not keep the fleet at or above the 313-ship goal over the long term. The number of battle force ships would increase initially, from today's level of about 276 to a peak of 326 in 2020. By 2031, however, the fleet would decline to 293 ships, before rising at the end of the 30-year period to 309 ships. In particular, relative to the goals for various components of the 313-ship fleet, the Navy would experience shortfalls in attack submarines (40 in 2028 and 2029 versus a stated requirement of 48), guided missile submarines (none after 2028 versus a stated requirement of 4), and guided missile destroyers (60 in 2037 versus a stated requirement of 69). The shortfalls would result from not buying enough ships at the right times to replace Los Angeles class attack submarines and Arleigh Burke class destroyers as they were retired in the 2020s and 2030s (see Figure 2). The Navy's plan is also short one LPD-17 amphibious transport dock.

In addition, the number of ballistic missile submarines (SSBNs) in the Navy's inventory would fall below the stated requirement of 14 beginning in 2027. That shortfall

Figure 1.

Annual Ship Purchases and Inventory Implied by the Navy's 2008 Shipbuilding Plan



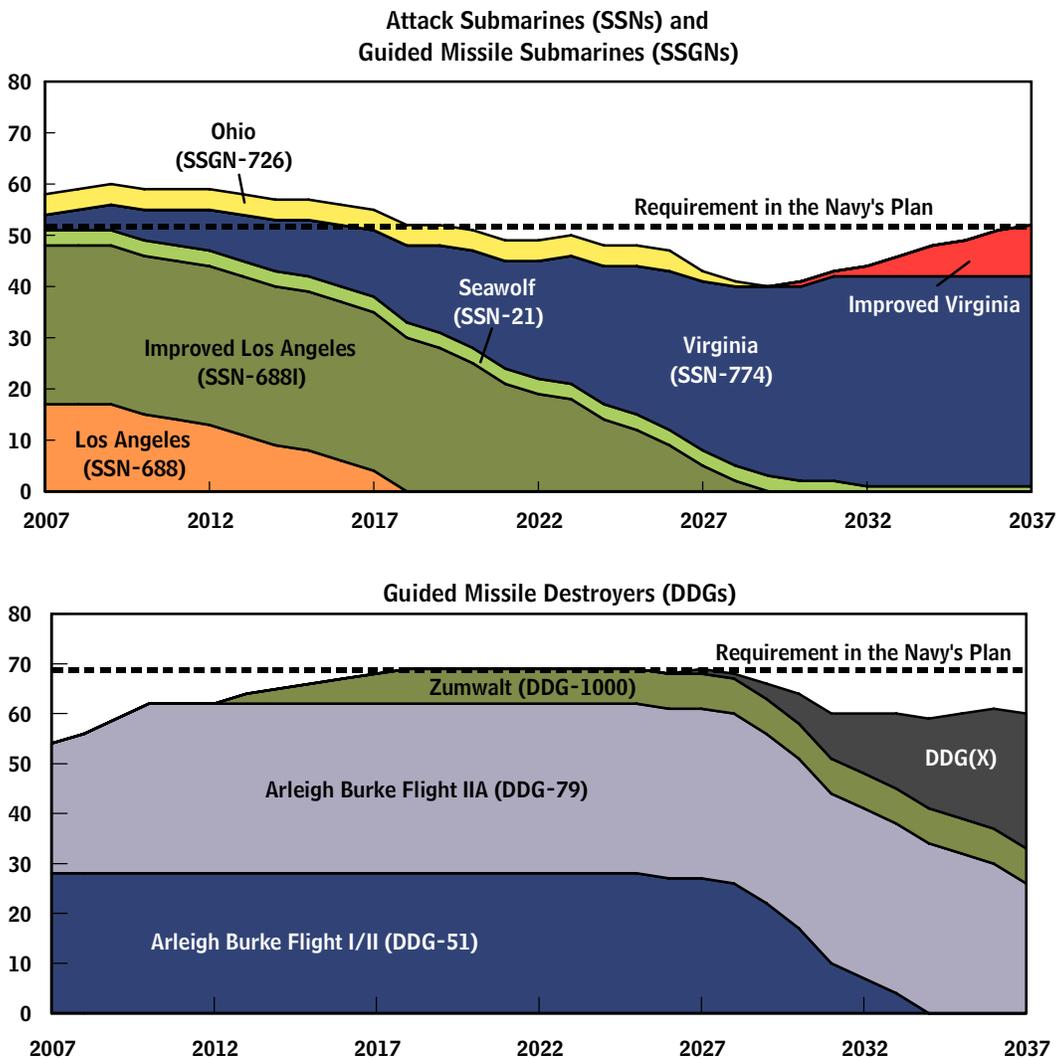
Source: Congressional Budget Office based on data from the Navy.

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

CBO adjusted the number of ships purchased under the Navy's 2008 plan to reflect the recent decision to forgo buying two LCSs in 2007, to purchase two LCSs in 2008 instead of three, and to buy three LCSs in 2009 rather than six. CBO assumed that the six ships removed from procurement plans for those years would be bought in 2017, at the end of the LCS program.

Figure 2.

Submarine and Destroyer Inventories Under the Navy's 2008 Shipbuilding Plan



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

would not stem from buying an insufficient number of submarines to replace retiring SSBNs but rather from a procurement schedule that would not be fast enough to deliver new submarines to the fleet before the old ones were retired. By 2041, however, the Navy would again have 14 SSBNs in its inventory.

The 2008 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 has been tested.”⁴ That statement leaves open the possibility that either the 30-year plan will need to incorporate replacements for those submarines in the future or that the Navy will conclude that the SSGNs are not useful enough to be worth replacing, in which case they would presumably be dropped from the official fleet requirements.

Differences Between the 2008 and 2007 Plans

The long-term shipbuilding plan that the Navy submitted this year substantially resembles the one submitted in February 2006. The procurement schedules and quantities for aircraft carriers, attack submarines, ballistic missile submarines, guided missile cruisers, and future maritime prepositioning ships remain virtually unchanged. For other categories of ships, however, the Navy has made significant changes from the previous plan.

- The procurement quantity for the new guided missile destroyer, the DDG(X), has been increased from two per year to three per year starting in the mid-2020s. That increase reduces the Navy’s pending shortfall of DDGs to 10 ships in 2034 (and 12 ships in 2042 if the procurement rate of three per year continues beyond 2037).⁵
- Although the total number of amphibious assault ships (LHAs and LHDs) to be purchased over 30 years has not changed, the Navy has made the procurement schedule more regular at one ship every three years (except for a single instance in which the gap between ships would be four years). By comparison, the 2007 plan had an 11-year gap—from 2013 to 2024—when no LHAs or LHDs would have been built. The new plan provides a more stable construction schedule for the private shipyard that builds amphibious assault ships.
- Four large combat logistics ships that would have been purchased in the late 2020s have been eliminated in the 2008 plan. Those ships were intended to replace four AOE-6 class logistics ships that, in the 2007 plan, would have been retired as their replacements were commissioned. The current plan does not envision retiring the AOE-6 class any time before 2037, meaning that those ships would be more than 40 years old—the notional life span for the class—at the end of the current planning period.

Overall, the difference of 13 ships between the 2008 and 2007 plans can be accounted for by larger planned ship purchases as well as by the shift in the time period that the two plans cover. For the 29 years that are common to both plans (2008 to 2036), the

4. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2008*, p. 6.

5. Under the 2007 plan, the Navy would have fallen short of its requirement for guided missile destroyers by 15 in 2036, and the shortfall would have grown to 27 by 2045 if DDGs were bought at the then-planned rate of two per year beyond the period of that plan. See Congressional Budget Office, *Options for the Navy’s Future Fleet*, pp. 26–28.

Navy added 12 destroyers and removed 4 large combat logistics ships. In addition, the 2008 plan dropped the year 2007, when the Navy had planned to buy 7 ships, and added the year 2037, when it intends to purchase 10 ships. Finally, CBO included in the 2008 plan the two LCSs that were canceled in 2007.

The Navy's Planned Spending for Ship Construction

Despite the changes outlined above, the Navy's estimate of the costs of constructing the ships in the 2008 plan is the same as its estimate for the 2007 plan: an average of about \$15.4 billion per year in 2008 dollars, or \$13.4 billion per year in 2005 dollars (see Table 2).⁶ Those costs, known as new-ship construction costs, exclude the expense of refueling reactors on nuclear-powered aircraft carriers and submarines. In addition, the Navy's estimate omits costs for modernizing large surface combatants (cruisers and destroyers) and purchasing mission modules for littoral combat ships, both of which the Navy plans to fund from other procurement accounts. With those related costs included, the Navy's estimate of the average annual funding needed to implement the current plan would rise to \$17.3 billion in 2008 dollars—45 percent more than the Navy received for those categories of spending in its 2007 appropriation and about 20 percent more than requested in the President's budget for 2008.⁷

In developing its shipbuilding plan, the Navy assumed that its total obligational authority—the budgetary top line—would increase at the same rate of inflation as Department of Defense (DoD) programs overall, about 2 percent a year. In other words, the Navy assumed no real (above-inflation) growth in its budget for the next 30 years.

Since 1990, the Navy has devoted about 8.5 percent of its total budget to ship construction. Under the 2008 plan, it would devote more than 12 percent of its budget to shipbuilding, on average, over the next 30 years. To accommodate the larger budgetary share for ship construction, the Navy made four assumptions:

- That spending on operations and maintenance in the service's accounts would not grow faster than the overall rate of inflation;
- That spending on research and development—which hit a historical high of about \$20 billion in 2006—would fall by \$4 billion or \$5 billion and remain at that annual level through the next 30 years;

6. Unless otherwise indicated, the costs in this report are given in billions of 2008 dollars of budget authority. However, because the Navy's cost estimates for its original 313-ship plan were presented in 2005 dollars, CBO sometimes also provides 2005 figures for comparison.

7. The Navy intends to fund 40 percent of the construction of its newest aircraft carrier in 2008 and 60 percent in 2009. Historically, funding for ship construction has been much higher than average in years in which carriers have been purchased.

Table 2.**Average Annual Shipbuilding Costs**

(Billions of 2008 dollars)

	New-Ship Construction	New-Ship Construction and Nuclear Refuelings	New-Ship Construction, Nuclear Refuelings, LCS Mission Modules, and Surface Combatant Modernization
Navy's Actual Spending, 2002 to 2007	9.6	11.4	11.5
Costs Under the Navy's 2008 Long-Term Shipbuilding Plan			
Navy's estimate	15.4	16.5 ^a	17.3 ^a
CBO's estimate	20.6	21.7	22.5
Costs to Meet the Navy's 313-Ship Requirement over the Long Term (CBO's estimate)	21.9	22.9	23.8
Memorandum:			
Navy's Estimate of Costs Under the 2008 Plan in 2005 Dollars ^b	13.4	14.3 ^a	15.0 ^a

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

Note: LCS = littoral combat ship.

- a. The Navy's estimate for new-ship construction plus CBO's estimate for the additional costs.
b. The Navy originally presented the costs of its long-term shipbuilding plan in 2005 dollars.

- That 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
- That ship programs would experience no cost growth in the short run and would meet strict cost goals in the long run.

Although most of the near-term costs for ship programs shown in the Navy's plan are based on estimates for existing ship designs, the cost targets for ships to be bought after 2013 generally do not reflect either existing or notional designs.⁸ To develop cost targets for future ships, the Navy used a top-down approach. It allocated the total amount of money it plans to 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 shares

8. Exceptions to that generalization include the CG(X) future cruiser, which would be bought starting in 2011 but has not yet been designed, and the Virginia class attack submarine and LHA-6 amphibious warfare ship, which are under construction now and would be purchased in the long term as well.

of Navy spending. The historical share for a particular category was then divided by the number of ships the Navy wants to buy in that category to calculate the cost goal for each future ship. In some cases, meeting those goals would require the Navy to reduce the costs of major classes of ships already in production (such as the Virginia class attack submarine and the LHA-6 amphibious warfare ship); in other cases, those targets would allow little or no growth in the costs of new classes of ships relative to the costs of the ships they would replace. The Navy realizes that its plan may be inconsistent with its cost goals. The plan report states: “As more accurate cost estimates are determined in future ship development (for ships such as CG(X), SSBN(X), etc.), the Navy may need to adjust the average annual investment objective or revisit warfighting requirements as appropriate.”⁹

Inflation in Shipbuilding

An important component of the Navy’s and CBO’s cost analyses is the role of inflation in the construction of naval vessels. The Navy has examined the inflationary component of past cost increases in shipbuilding programs and concluded that the overall figure (“inflator”) that DoD uses to project cost increases for its procurement programs has underestimated the inflation that has 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 inflator that reflects the growth in labor and materials costs that the industry has experienced in the past and that the Navy expects it to experience through at least 2013. That inflator is an average of about 1.4 percentage points higher per year—from 2008 through at least 2015—than the price increases expected for DoD 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 level of inflation in its budget request for 2008 and the associated Future Years Defense Program. In both the Navy’s and CBO’s analyses, the higher level of inflation produces real growth in the future costs of ships. For example, a ship that costs \$2.5 billion to build in 2008 will cost \$2.9 billion (in 2008 dollars) to build in 2020.

In its analysis of the Navy’s previous long-term plan, CBO assumed that cost growth in the shipbuilding industry would continue to be higher than average for many years and then would gradually revert to the level of general inflation for DoD procurement programs by 2025. CBO made the same assumption in analyzing the Navy’s current plan.

CBO’s Estimate of the Costs of the 2008 Shipbuilding Plan

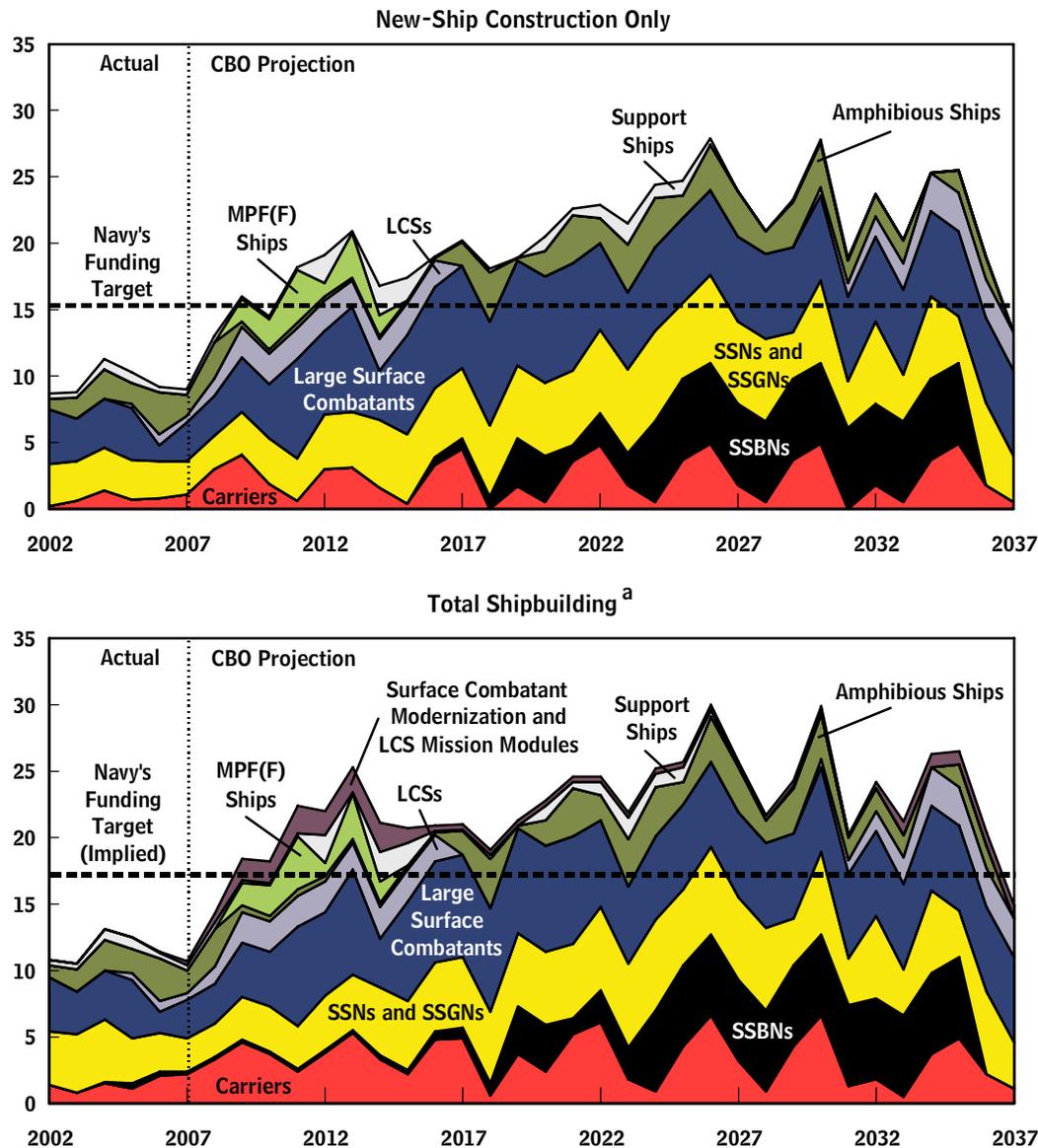
Buying a total of 293 ships over the 2008–2037 period—or an average of about 9.8 ships per year—would require an average annual shipbuilding budget of \$20.6 billion for new construction alone, CBO estimates. That amount is about one-third more than the Navy’s \$15.4 billion estimate (see Figure 3) and more than

9. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY2008*, p. 8.

Figure 3.

Annual Costs Implied by the Navy's 2008 Shipbuilding Plan

(Billions of 2008 dollars)



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

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

Amounts for 2006 exclude supplemental funding related to Hurricane Katrina.

- a. Total shipbuilding costs include 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.

double the \$9.6 billion per year that the Navy spent on new-ship construction between 2002 and 2007. Including the costs of refueling nuclear-powered aircraft carriers and submarines would raise CBO's estimate to \$21.7 billion a year, on average, over the next 30 years (see Table 2).

Those figures exclude costs to modernize existing cruisers and destroyers and to buy the mission modules that are intended to provide much of the combat capability of littoral combat ships; as noted above, the Navy plans to fund those items 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 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. Paying all of the expenses of new-ship construction, nuclear refuelings, modernization of surface combatants, and mission modules for LCSs would require average funding of \$22.5 billion annually, CBO estimates.¹⁰

According to CBO's calculations, the Navy's 2008 shipbuilding plan would cost about \$1.1 billion more per year to carry out than the 2007 plan. Of that amount, \$0.4 million results from the difference between 2007 dollars and 2008 dollars. (CBO estimated that new-ship construction under the 2007 plan would require average annual funding of \$19.5 billion in 2007 dollars, which is \$19.9 billion in 2008 dollars.) The remainder of the increase is attributable to higher ship prices (such as for the LCS) and the overall increase in the number of ships envisioned in the 2008 plan—notably, 12 additional DDG(X) replacements for Arleigh Burke class destroyers over the 2025–2036 period.

The Costs of Fully Funding the 313-Ship Fleet

As explained above, the Navy's new 30-year shipbuilding plan would not build enough ships at the right times to meet the service's 313-ship requirement. In particular, it would fall short for guided missile destroyers, attack submarines, guided missile submarines, ballistic missile submarines, and amphibious ships. Those shortfalls could be filled by making several changes to the current plan.

- To maintain a force of 69 guided missile destroyers, the Navy could start constructing replacements for the Arleigh Burke class DDG-51s a few years earlier than in its plan—buying the first ship in 2020 rather than 2022 and increasing the construction rate to three ships per year by 2022.
- To prevent the attack submarine (SSN) force from falling below 48, the Navy could purchase two attack submarines in 2010 and 2011 (instead of one each year) and buy three SSNs annually during the six years from 2015 to 2020. Fewer attack

10. The Navy has not stated how many mission modules it plans to buy for each littoral combat ship; CBO assumed that those purchases would average two per ship.

submarines could then be bought in the mid- to late 2020s and 2030s than under the Navy's plan.

- To maintain its force of four guided missile submarines, the Navy would have to develop and buy replacements for the Ohio class SSGNs when they retired from the fleet in the 2020s.
- No additional ballistic missile submarines would need to be purchased to prevent that force from falling below 14, but the construction schedule would have to be adjusted to buy some SSBNs two years earlier than the Navy intends.
- The shortfall in amphibious ships could be filled by purchasing an additional LPD-17 in 2009.

Incorporating those changes into the Navy's plan would raise the required average annual budget to about \$21.9 billion for new-ship construction and \$23.8 billion for shipbuilding overall. (Other approaches to filling the shortfalls from the 313-ship requirement would have different costs.)

Individual Ship Programs

To estimate the costs of the 2008 shipbuilding plan, CBO used Navy data on actual costs for ships now under construction and historical relationships between the cost and weight of ships. To apply those relationships to ships for which the Navy has yet to develop even a notional design—such as the prospective replacements for the 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 Navy's plan for a 313-ship fleet, the number of aircraft carriers (CVNs) would decline from 12 to 11. That reduction comes from retiring the *John F. Kennedy* in 2007. To maintain that size force, the Navy's plan would buy seven CVN-78 Gerald R. Ford class aircraft carriers over the 2008–2037 period at a target cost of about \$10.1 billion apiece (see Table 3).¹¹

To estimate the cost of those new aircraft carriers, CBO relied on the cost of the Navy's most recent carrier, the CVN-77, and adjusted that amount to account for historical levels of cost growth and for the higher level of inflation expected in the shipbuilding industry. The first two ships of the new CVN-78 class would require substantial funding for nonrecurring detail design, but subsequent ships would not need any money for that purpose. CBO estimates that the seven carriers in the Navy's 2008 shipbuilding plan would have an average cost of about \$10.1 billion each, the same as the Navy's target.

11. The program to build that new class of nuclear-powered aircraft carriers was formerly called the CVN-21 (for 21st century) program.

Table 3.

Comparison of the Navy's Goals and CBO's Estimates of the Costs of Major New Ships

(Billions of 2008 dollars)

Program	Average per-Ship Cost over the 2008-2037 Period ^a	
	Navy's Cost Target ^b	CBO's Estimate ^c
CVN-78 Gerald R. Ford Class Aircraft Carrier	10.1	10.1
DDG-1000 Zumwalt Class Destroyer	2.3	3.9
CG(X) Cruiser	2.9	4.0
DDG(X) Destroyer (Replacement for Arleigh Burke class)	1.6 ^d	2.2
Virginia Class Attack Submarine	2.3	2.7
SSBN(X) Ballistic Missile Submarine (Replacement for Ohio class)	3.3	6.3
Amphibious Ships	1.5	2.3

Source: Congressional Budget Office.

- a. The total amount of money spent on a ship program from 2008 to 2037 divided by the total number of ships bought in that program—except in the case of the DDG-1000 destroyer, in which the average cost per ship reflects the costs of all seven ships in that program.
- b. Based on a briefing by the Navy for CBO and the Congressional Research Service, February 10, 2006.
- c. 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 that in other Department of Defense procurement programs).
- d. The Navy's 2008 plan added 12 DDG(X)s and removed 4 large logistics ships compared with the 2007 plan, but it indicated that overall shipbuilding costs would not change. Thus, CBO assumed that the Navy's per-ship cost target for the DDG(X) was lowered to reflect those changes. (CBO also assumed that the funding not allocated to the logistics ships would be spent on the new destroyers.)

Finally, in estimating costs for the aircraft carrier program, CBO assumed that all of the current Nimitz class carriers would be operated for at least 50 years, with a three-year period for nuclear refueling at about 23 years of age.

Surface Combatants

The Navy's current plan would buy one DDG-1000 Zumwalt class destroyer each year from 2009 to 2013, in addition to the two authorized in 2007. The service's 2008 budget suggests that the Navy expects the first two ships to cost \$3.0 billion each and the next five to cost an average of \$2.0 billion apiece—for an average

per-ship cost for the class of \$2.3 billion.¹² CBO, by contrast, estimates that the first two DDG-1000s would cost \$4.8 billion in 2008 dollars and that the next five ships would cost an average of \$3.5 billion each. The average per-ship cost of the class would be \$3.9 billion. In addition, the Navy intends to begin buying a new missile-defense surface combatant, the CG(X) cruiser, in 2011. CBO assumed that a CG(X) would use the same hull, and cost about the same, as a DDG-1000.¹³ (CBO's estimates for the DDG-1000 and other large surface combatants are based on relationships between the cost and weight of past ships, such as the DDG-51 Arleigh Burke class destroyers and CG-47 Ticonderoga class cruisers.)

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 35 years, consistent with the Navy's plan, which would purchase the first replacement—a DDG(X)—in 2022.¹⁴ 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 could not carry both of the advanced gun systems of the DDG-1000. In CBO's projection, those replacement destroyers would have an average cost of about \$2.2 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.¹⁵ The Navy's implicit cost target for DDG replacements is lower: \$1.6 billion each.¹⁶

Finally, the current shipbuilding plan envisions building 55 littoral combat ships between 2005 and 2017. Because those ships are assumed to have a service life of 25 years, the Navy would need to begin procuring their replacements in 2030. The LCS differs from the Navy's usual 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

-
12. The first two DDG-1000s were partially funded in 2007 and earlier years; the rest of the Navy's estimated cost for those ships (about half) would be funded in 2008.
 13. The Navy is currently studying what the new cruiser might look like. A larger or smaller design than one based on a DDG-1000 hull, with appropriate implications for cost, are possible outcomes of that analysis.
 14. Generally, the Navy retires large surface combatants after 30 years or less even if their notional service lives are longer. If the DDG-51s lasted only 30 years, replacements would need to start being purchased earlier than 2022.
 15. 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.
 16. 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 only 4 logistics ships, while stating that the overall costs of the plan were unchanged. CBO therefore assumed that the cost target for the DDG(X) had declined, reflecting the larger number of ships to be purchased. CBO also assumed that the money saved from removing the logistics ships would be allocated to the DDG(X) program.

to use three types of mission modules: for countermine warfare, antisubmarine warfare, and anti-surface-craft warfare. However, it has not yet determined how many mission modules it plans to buy for each sea frame.

The LCS was originally expected to cost about \$250 million per sea frame in 2008 dollars (or \$220 million in 2005 dollars). But the Navy recently stated that the program is suffering from cost growth beyond that reported in the President's budget for 2007. The Navy has testified that the sea frame for LCS-1, the first littoral combat ship, will cost between \$350 million and \$375 million. According to some press reports, however, that cost could well exceed \$400 million. Before the latest changes to the LCS program, the Navy's 2008 budget envisioned buying 32 LCSs during the 2008–2013 period at an average cost of a little less than \$300 million each. But that figure does not reflect the recent cost growth that the first four LCSs have experienced. The Navy does not have an official estimate for the LCS program that incorporates that recent cost growth. With that growth included, CBO assumed that the LCSs in the Navy's plan would cost about \$390 million each, on average, excluding mission modules. According to information in the Navy's budget, those modules are expected to cost about \$80 million apiece. As more information becomes available about the status of the first four ships of the LCS program, CBO's assumptions about the program's costs could change.¹⁷

The Navy intends for the LCS to be an affordable ship that will be relatively simple to design and build. 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 CG(X).

Submarines

The attack submarine force continues to be a major source of demand on the Navy's resources. Under the current plan, the Navy would buy two attack submarines a year beginning in 2012 (including Improved Virginia class submarines starting around 2024). That procurement rate would continue through 2028 and then alternate between one and two submarines a year. The Navy's plan does not envision continuing to use guided missile submarines beyond the 2020s, when the existing Ohio class SSGNs are likely to be retired from service.

Senior Navy leaders have stated—and the 2008 shipbuilding plan assumes—that the cost of Virginia class submarines would have to be reduced by about 15 percent, to less than \$2.3 billion each, before the Navy would be able to buy two per year.¹⁸ However, the President's 2008 budget requests an appropriation of about \$2.7 billion

17. If the cost-to-weight ratio of the lead Oliver Hazard Perry class frigate was used as a guide, LCS-1 would be expected to cost about \$470 million, including one mission module. LCS-2 is also a lead ship (in that it is being built by different contractors), but it is being constructed with an aluminum hull, so the steel-hulled frigate may be less useful as an analogy for that ship.

18. The Navy's position is that to purchase two submarines per year in 2012, their cost would have to fall to \$2.0 billion each in 2005 dollars, which is about \$2.3 billion in 2008 dollars.

for the next Virginia class submarine. Approximately 30 percent of that amount (or about \$800 million) is for equipment furnished by the government, with the remainder to be spent by the shipyard building the vessel. If the necessary savings are intended to come from the shipyard, its expenses will have to be reduced by more than 20 percent to meet the Navy's cost goal for Virginia class submarines.

CBO estimates that the Virginia class attack submarines built during the 2008–2037 period would have an average cost of \$2.7 billion apiece, on the basis of the prices that the Navy is currently paying for Virginia class submarines, the effects of producing two subs per year starting in 2012, and the real cost growth affecting naval shipbuilding. In addition, CBO assumes that the Improved Virginia class would cost about 20 percent more to build than the original Virginia class did, largely because of the historical cost growth in the shipbuilding industry.

In addition to the attack submarine force, the 2008 plan calls for a force of 14 ballistic missile submarines through 2037. Consequently, the Navy intends to buy its first replacement SSBN in 2019 and purchase one per year starting in 2024 (three years earlier than under the 2007 plan). The design, cost, and capabilities of that replacement submarine are one of the most significant uncertainties in the Navy's and CBO's analyses. The Navy's plan assumes that the first ship of a new class of ballistic missile submarines—an SSBN(X)—would cost \$4.1 billion and that subsequent ships would cost about \$3.2 billion each. The average cost for 14 SSBN(X)s would be about \$3.3 billion.

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 Virginia class design. 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 displacement estimate exists. Most participants in the process and observers agree that the new ballistic missile submarine would probably be substantially smaller than the existing Ohio class submarines.

Adopting an approach consistent with that thinking, CBO assumed that the Navy would buy 14 SSBN(X)s and that those submarines would be smaller than Ohio class submarines. CBO assumed that the SSBN(X) would be designed to carry 16 missile tubes (instead of 24 on existing submarines) and would displace around 15,000 tons submerged—making it roughly twice the size of a Virginia but nearly 4,000 tons smaller than an Ohio. On the basis of what the Navy is currently paying for a Virginia class submarine, CBO estimated that the average cost of the SSBN(X) would be about \$6.3 billion. A smaller design with only 12 or 8 missile tubes could cost \$700 million or \$1.4 billion less, respectively.

Amphibious and Maritime Prepositioning Ships

The Navy's 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). The current plan would end the LPD-17 class at nine ships—one short of the goal of 10—and maintain nine LHAs or LHDs by buying replacements for them about every three years.¹⁹ Specifically, it would purchase an LHA-6 in 2017 (in addition to the one being bought in 2007 and the MPF(F) versions of that ship that would be purchased in 2010 and 2013) as well as six replacements for the Wasp class LHDs in the 2020s and 2030s. In addition, 12 replacements for today's LSD-41 and LSD-49 class ships, which will start to reach the end of their service lives in about 15 years, would be purchased in the long term.²⁰ The Navy's cost target for an amphibious ship is \$1.5 billion. That target averages the costs of the large LHAs and LHDs (which displace around 40,000 to 45,000 tons) and the smaller LSD replacements (which would probably displace 20,000 to 25,000 tons).

CBO assumes that all future amphibious assault ships will not be substantially larger than the first LHA-6, which is a variant of the existing LHD design. According to the Navy, its plan assumes that future large-deck amphibious ships will look much like the first LHA-6, which it is purchasing this year. Under that assumption, CBO estimates the average cost of an amphibious ship—that is, the average cost for the LHA-6s, LHD replacements, and LSD(X)s—at \$2.3 billion.

In a June 2005 report to the Congress, the Navy outlined the future of the maritime prepositioning force, describing an MPF(F) squadron composed 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, the Navy's current shipbuilding plan appears to forgo a modified T-AKE design. Instead, the Navy would build the same versions that are now under construction, thus reducing their cost by about \$200 million per ship relative to the June 2005 estimates. The Navy also intends to use an existing LHD in the MPF(F) squadron. With those changes, the Navy plans to buy one such squadron and estimates its total cost at about \$12 billion. CBO's estimate of the cost of that squadron is about \$14 billion, reflecting its higher cost estimates for various ships in the squadron, such as the LHA-6s and T-AKEs.

19. In the Navy's stated requirements, the tenth LPD-17 would be part of the forward-based expeditionary strike group in Japan, which normally is composed of four amphibious ships.

20. According to the Navy, the three LSDs beyond the nine needed for the expeditionary strike groups would be used for antiterrorism missions.