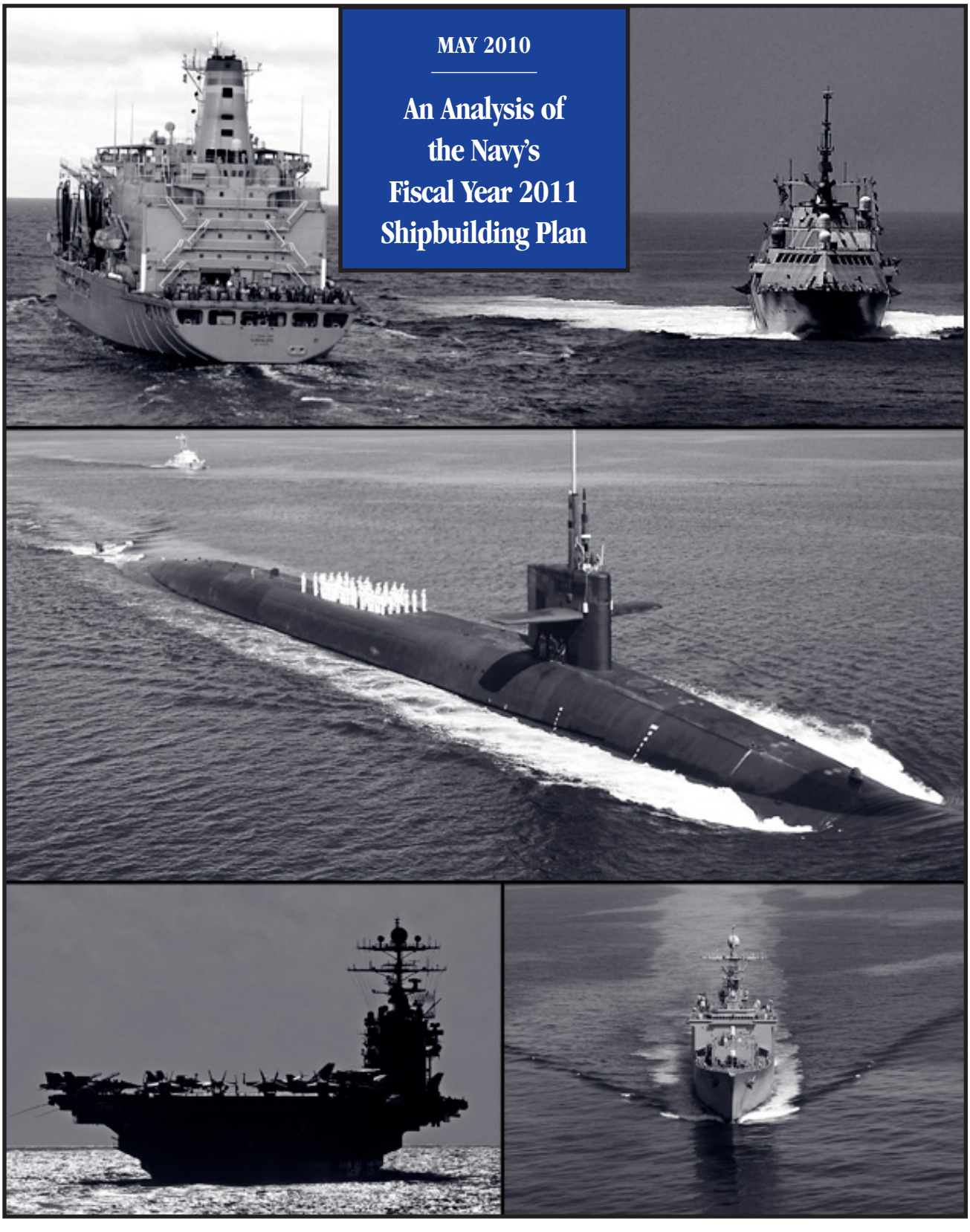
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MAY 2010

An Analysis of the Navy's Fiscal Year 2011 Shipbuilding Plan

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An Analysis of the Navy's Fiscal Year 2011 Shipbuilding Plan

May 2010

The Congress of the United States ■ Congressional Budget Office

Notes

Unless otherwise indicated, all dollar amounts in this study are in 2010 dollars, and all years are federal fiscal years (which run from October to September).

Numbers in the text and tables may not add up to totals because of rounding.

The cover shows the following U.S. Navy ships (clockwise from upper right): A littoral combat ship (LCS-1), photo by Mass Communication Specialist 2nd Class Daniel Barker; an Ohio class ballistic missile submarine (SSBN-735), photo by Photographer's Mate 3rd Class Chris Otsen; an amphibious dock landing ship (LSD-51), photo by Mass Communication Specialist 2nd Class Michael Russell; a Nimitz class aircraft carrier (CVN-73), photo by Photographer's Mate Airman Michael D. Blackwell II; and a fleet replenishment oiler (T-AO-200), photo by Mass Communication Specialist 3rd Class Steven Maksinchuk.

CBO

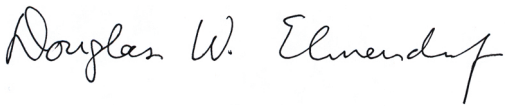
Preface

The Navy is required by law to submit a report to the Congress each year that projects the service's shipbuilding requirements, procurement plans, inventories, and costs over the coming 30 years. Since 2006, the Congressional Budget Office (CBO) has been performing an independent analysis of the Navy's latest shipbuilding plan at the request of the Subcommittee on Seapower and Expeditionary Forces of the House Armed Services Committee. This CBO report, the latest in that series, summarizes the ship requirements and purchases described in the Navy's 2011 plan and assesses their implications for the Navy's funding needs and ship inventories through 2040.

The Navy currently envisions buying a total of 276 ships over 30 years at an average annual cost of about $16 billion (in 2010 dollars) for new construction alone or roughly $18 billion for total shipbuilding (which includes new-ship construction, refueling of nuclear-powered aircraft carriers, and other costs related to shipbuilding). By comparison, CBO estimates the costs of the Navy's plan at an average of $19 billion per year for new construction or $21 billion per year for total shipbuilding. In keeping with CBO's mandate to provide impartial analysis, this study makes no recommendations.

Eric J. Labs of CBO's National Security Division prepared the study under the general supervision of Matthew Goldberg. Raymond Hall of CBO's Budget Analysis Division produced the cost estimates under the general supervision of Sarah Jennings. Christopher Murphy and Kurt Schnabel provided helpful comments on the report, as did Ronald O'Rourke of the Congressional Research Service. (The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.)

Christian Howlett edited the study, with assistance from Leah Mazade, and Christine Bogusz proofread it. Jeanine Rees prepared the report for publication, and Maureen Costantino designed the cover. Lenny Skutnik printed the initial copies, Linda Schimmel coordinated the print distribution, and Simone Thomas prepared the electronic version for CBO's Web site (www.cbo.gov).



Douglas W. Elmendorf
Director

May 2010

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Summary

At the direction of the Congress, the Department of the Navy issues annual reports that describe its plans for ship construction over the coming 30 years. The latest report—issued in February and covering fiscal years 2011 to 2040—contains some significant changes in the Navy's long-term goals for shipbuilding.[1] The new plan appears to increase the required size of the fleet compared with earlier plans, while reducing the number of ships to be purchased—and thus the costs for ship construction—over the next three decades. Despite those reductions, the total costs of carrying out the 2011 plan would be much higher than the funding levels that the Navy has received in recent years, according to analysis by the Congressional Budget Office (CBO). Specifically:

- Language in the 2011 shipbuilding plan and in related briefings by the Navy implies that the service's requirement for battle force ships (aircraft carriers, submarines, surface combatants, amphibious ships, and some logistics and support ships) now totals 322 or 323—up from 313 in the Navy's three previous long-term plans.[2] The battle force fleet currently numbers 286 ships. (Summary Box 1 describes the major ships in the Navy's fleet.)

- The 2011 plan calls for buying a total of 276 ships over the 2011–2040 period: 198 combat ships and 78 logistics and support ships (see Summary Table 1). That construction plan is insufficient to achieve a 322- or 323-ship fleet.

- In comparison, the previous shipbuilding plan (for 2009) envisioned buying 40 more combat ships and 20 fewer support ships over 30 years.[3] Under that plan, the Navy would have purchased 238 combat ships and 58 logistics and support ships between 2009 and 2038, for a total of 296.[4]

- If the Navy receives the same amount of funding for ship construction in the next 30 years as it has over the past three decades—an average of about $15 billion a year in 2010 dollars—it will not be able to afford all of the purchases in the 2011 plan.[5]

1. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011* (February 2010), www.militarytimes.com/static/projects/pages/2011shipbuilding.pdf.

2. The alternative totals result from the Navy's current requirement—10 or 11 ships—for aircraft carriers. The timing of its purchases to fulfill that requirement would enable the Navy to have a force of at least 11 carriers most of the time through 2040, except in 2013 and 2014, when the number would drop to 10.

3. The Navy did not release a long-term shipbuilding plan for fiscal year 2010.

4. Of the nine Maritime Prepositioning Force (Future), or MPF(F), ships included in the 2009 plan, CBO categorized two of them (aviation ships) as combat ships and the rest as logistics and support ships. In the 2011 plan, purchases of multiple landing platform ships are included in the category of support ships, whereas in the 2009 plan, a much larger and more expensive version of the multiple landing platform ship was included in the MPF(F) category.

5. For a broader discussion of historical cost trends in Navy shipbuilding, see the statement of Eric J. Labs, Senior Analyst for Naval Forces and Weapons, Congressional Budget Office, before the Subcommittee on Seapower and Expeditionary Forces, House Committee on Armed Services, *The Long-Term Outlook for the U.S. Navy's Fleet* (January 20, 2010).

Summary Table 1.

Comparison of the Navy's Long-Term Shipbuilding Plans for Fiscal Years 2009 and 2011

	2009 Plan (2009–2038)	2011 Plan (2011–2040)
	Number of Ships Purchased Over 30 Years	
Aircraft Carriers	7	6
Ballistic Missile Submarines	12	12
Attack Submarines	53	44
Large Surface Combatants	69	50
Littoral Combat Ships	75	66
Amphibious Ships	20	20
MPF(F) Ships	9	n.a.
Combat Logistics and Support Ships	51	78
Total	**296**	**276**
	Costs (Billions of 2010 dollars)	
Total Cost of New-Ship Construction over 30 Years[a]		
Navy's estimate	718 [b]	476
CBO's estimate	775 [b]	569
Average Annual Cost of New-Ship Construction[a]		
Navy's estimate	23.9	15.9
CBO's estimate	25.8	19.0
Average Price per Ship		
Navy's estimate	2.4	1.7
CBO's estimate	2.6	2.1

Sources: Congressional Budget Office; Department of the Navy.

Note: MPF(F) = Maritime Prepositioning Force (Future); n.a. = not applicable.

a. New-ship construction costs exclude the costs of refueling existing nuclear-powered aircraft carriers as well as outfitting and postdelivery costs (which include the purchase of many smaller tools and pieces of equipment needed to operate a ship but not necessarily provided by the manufacturing shipyard as part of ship construction).

b. These estimates include CBO's 2009 projections of the costs of ballistic missile submarines. The Navy's estimate also reflects corrected data that the service released after publishing the 2009 shipbuilding plan.

- The Navy estimates that buying the new ships in the 2011 plan will cost an average of about $16 billion per year, or a total of $476 billion over 30 years (about 33 percent less than its estimate for the 2009 plan).[6] Those figures are solely for construction of new ships, the only type of costs reported in the Navy's shipbuilding plans. However, other activities that are typically funded from the Navy's budget accounts for ship construction—such as refueling nuclear-powered aircraft carriers and outfitting new ships with various small pieces of equipment after the ships have been built or delivered—will add about $2 billion to the Navy's average annual shipbuilding costs under the 2011 plan, in CBO's estimation.

- Using its own models and assumptions, CBO estimates that the cost for new-ship construction under the 2011 plan will average about $19 billion per year, or a total of $569 billion through 2040.[7] Including the expense of refueling aircraft carriers as well as outfitting and postdelivery costs raises that average to about $21 billion per year, CBO estimates. (Those figures are about 25 percent lower than CBO's estimates of the Navy's 2009 plan.)

- CBO's estimates of the costs of the 2011 shipbuilding plan are about 18 percent higher than the Navy's estimates overall. That figure masks considerable variation over time, however: CBO's estimates are 4 percent higher than the Navy's for the first 10 years of the plan, 13 percent higher for the following decade, and 37 percent higher for the final 10 years of the plan (see Summary Figure 1). Those differences result partly from different estimating methods and different assumptions about the design and capabilities of future ships. The estimates also diverge because CBO accounted for the fact that costs of labor and materials have traditionally grown much faster in the shipbuilding industry than in the economy as a whole, whereas the Navy does not appear to have done so. That difference becomes more pronounced over time.

6. CBO calculated that 33 percent figure by adding its 2009 estimate of the cost of new ballistic missile submarines to the Navy's 2009 estimate of new-ship construction. If the cost of those submarines was not included in the calculation, the Navy's estimate for ship construction under its 2011 plan would be 25 percent lower than the cost of new ships under the 2009 plan.

7. Generally, CBO estimates the price of future naval vessels on the basis of the relationship between cost and weight of analogous ships. The estimated cost per ship is then adjusted for factors such as the number of ships of the same type being built at a given shipyard, production efficiencies that occur as more ships of the same class are produced, and the fact that prices of labor and materials in the naval shipbuilding industry tend to rise faster than prices in the economy as a whole.

Summary Box 1.

The Roles of Major Types of Ships in the Navy's Fleet



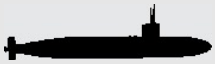
Nimitz Class
Aircraft Carrier

The Navy's 11 **aircraft carriers** are the heart of the battle force fleet. Each carries an air wing of about 60 aircraft, which can attack hundreds of targets per day for up to a month before needing to be rested. Carriers are by far the largest ships in the fleet, with a weight (displacement) of about 100,000 tons. Ten of the 11 current carriers belong to the Nimitz class.



Ohio Class Ballistic
Missile Submarine

Strategic **ballistic missile submarines** carry the major part of the U.S. nuclear deterrent, up to 24 Trident missiles with four to eight nuclear warheads apiece. The Navy has 14 Ohio class ballistic missile submarines in the strategic role and has converted four more to a conventional guided missile (SSGN) configuration, each of which displaces about 19,000 tons submerged. Those SSGNs carry up to 154 Tomahawk missiles as well as special-operations forces.



Los Angeles Class
Attack Submarine

Attack submarines are the Navy's premier undersea warfare and antisubmarine weapon. Since the end of the Cold War, however, they have mainly performed covert intelligence-gathering missions. They have also been used to launch Tomahawk missiles at inland targets in the early stages of conflicts. The Navy has 53 attack submarines, 49 of which belong to the Los Angeles class. At 7,000 tons, they are less than half the size of ballistic missile submarines.



Arleigh Burke Class
Destroyer

Large surface combatants—which include cruisers and destroyers—are the workhorses of the fleet. They defend the Navy's aircraft carriers and amphibious ships against other surface ships, aircraft, and submarines. They also perform many day-to-day missions, such as patrolling sea lanes, providing overseas presence, and conducting exercises with allies. In addition, they are capable of striking land targets with Tomahawk missiles. Different types of surface combatants have displacements ranging from 9,000 to 14,000 tons.



Freedom Class
Littoral Combat Ship

Small surface combatants are composed of frigates and, in the future, littoral combat ships. Frigates today are used to perform many of the same day-to-day missions as large surface combatants. Littoral combat ships are intended to counter mines, small boats, and diesel electric submarines in the world's coastal regions. More routinely, they will also participate in patrolling sea lanes, providing overseas presence, and conducting exercises with allies. These ships range in size from 3,000 to 4,000 tons.



Wasp Class Amphibious
Assault Ship

The Navy's two classes of **amphibious assault ships** (also known as helicopter carriers) are the second largest ships in the fleet at 40,000 tons. They form the centerpiece of amphibious ready groups and can each carry about half the troops and equipment of a Marine expeditionary unit. They also carry as many as 30 helicopters and six fixed-wing Harrier jump jets, or up to 20 Harriers.



Austin Class Amphibious
Transport Dock

The Navy has four other classes of amphibious warfare ships, and such ships are divided into two types: **amphibious transport docks** and **dock landing ships.** Two of those ships together provide the remaining transport capacity for a Marine expeditionary unit in an amphibious ready group. They range in size from 16,000 to 25,000 tons.



Supply Class Fast Combat
Support Ship

The many **logistics and support ships** in the Navy's fleet provide the means to resupply, repair, salvage, or tow combat ships. The most prominent of those vessels are fast combat support ships, which operate with carrier strike groups to resupply them with fuel, dry cargo (such as food), and ammunition. These ships can be as small as 2,000 tons for an ocean-going tug or as large as 50,000 tons for a fully loaded fast combat support ship.

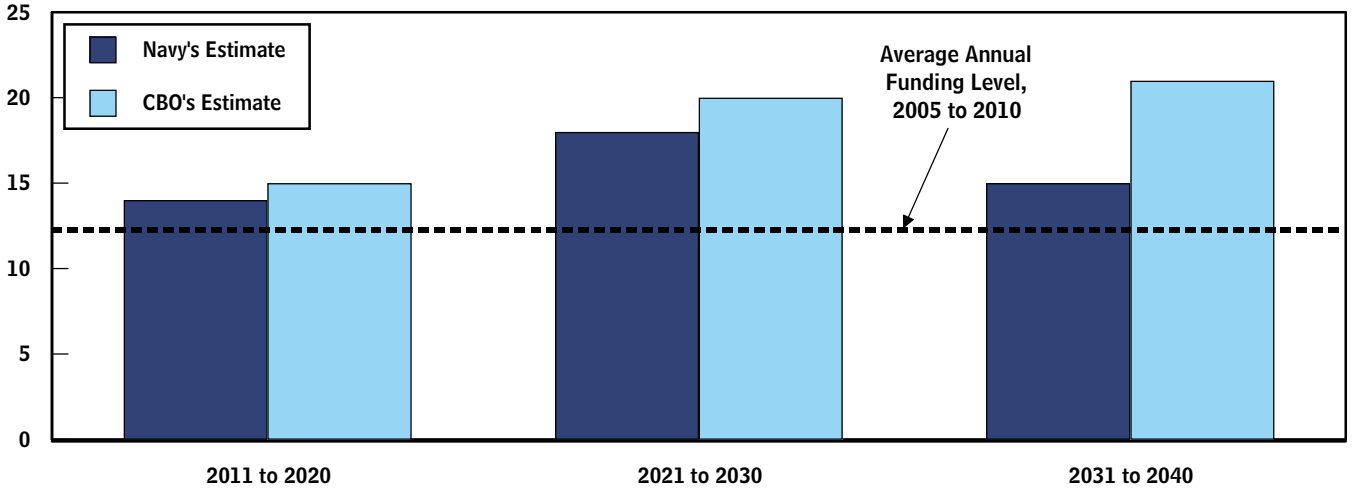
Source: Congressional Budget Office.

Note: Ship silhouettes are not to scale.

Summary Figure 1.

Average Annual Cost of New-Ship Construction Under the Navy's 2011 Plan

(Billions of 2010 dollars)



Sources: Congressional Budget Office; Department of the Navy.

Note: New-ship construction costs exclude the costs of refueling existing nuclear-powered aircraft carriers as well as outfitting and post-delivery costs (which include the purchase of many smaller tools and pieces of equipment needed to operate a ship but not necessarily provided by the manufacturing shipyard as part of ship construction).

An Analysis of the Navy's Fiscal Year 2011 Shipbuilding Plan

In February 2006, the Navy presented a long-term shipbuilding plan that called for expanding the battle force fleet from the then-current size of 285 ships to 313 ships by 2020.[1] A few months later, the Congressional Budget Office (CBO) issued a study analyzing that plan and estimating its potential costs. Since then, the Navy has released several updates to its 313-ship plan, the most recent being the plans for 2009 and 2011.[2] (The Navy did not provide an update for 2010.) Those two plans differ sharply with respect to the Navy's total inventory goal—in military parlance, its requirement—for battle force ships, the number and types of ships the Navy would purchase over 30 years, and the amount of money needed to implement the plans.

As it has for each of the Navy's long-term shipbuilding plans in recent years, CBO has examined the 2011 plan in detail and produced estimates of the costs of the proposed ship purchases using its own estimating methods and assumptions. CBO has also analyzed how those ship purchases would affect the Navy's inventories of various types of ships over the next three decades.

Changes in Ship Requirements Under the 2011 Plan

The report that the Deputy Secretary of Defense submitted to the Congress on February 1, 2010, described the 313-ship fleet as the "baseline" for the Navy's 2011 goals for ship construction over the next 30 years. However, the report went on to describe changes to several categories of ships that would ultimately alter the requirement for battle force ships:

- The number of aircraft carriers required to support the Navy's operations was described as 10 to 11, compared with 11 in the previous plan (see Table 1).
- Plans for building 19 CG(X) future cruisers were canceled, but the requirement for destroyers was raised from 69 to at least 88.
- The Navy's four guided missile submarines, which are due to reach the end of their service lives starting in 2026, would not be replaced under the current plan (which was also the case under earlier plans).
- The requirement for ballistic missile submarines appears likely to fall from 14 to 12, consistent with the recommendation in the Department of Defense's (DoD's) recent Nuclear Posture Review.[3]
- The requirement for amphibious ships was increased from 31 to 33.
- The sea-basing ships of the Future Maritime Prepositioning Force, or MPF(F)—which were intended to help the Navy support and supply onshore Marine operations entirely from the sea—were eliminated from the plan. However, the Navy intends to buy a

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, submarines, surface combatants, amphibious ships, and some logistics and support ships.

2. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009* (February 2008) and *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011* (February 2010).

3. Those submarines, which carry Trident ballistic missiles, are the sea-based leg of the U.S. strategic triad for delivering nuclear weapons. (The other two legs are land-based intercontinental missiles and manned strategic bombers.)

Table 1.

The Navy's Evolving Force-Structure Requirements

	Requirements for a 313-Ship Fleet in the Navy's 2009 Plan	Requirements Implied in the Navy's 2011 Plan
Aircraft Carriers	11	10–11
Submarines		
Attack	48	48
Guided missile	4	0
Ballistic missile	14	12
Large Surface Combatants		
Cruisers	19	0
Destroyers	69	88 [a]
Littoral Combat Ships	55	55
Amphibious Ships	31	33
MPF(F) Ships	12	0
Combat Logistics Ships	30	30
Support Ships		
Joint high-speed vessels	3	23
Other[b]	17	23 [c]
Total	**313**	**322–323** [a]

Source: Congressional Budget Office.

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

a. The minimum implied requirement. If the requirement for destroyers ended up being higher than 88, the total requirement for the fleet could exceed 322 to 323 ships.

b. Includes command ships, logistics ships, salvage ships, ocean tugs, surveillance ships, and tenders.

c. Includes three logistics ships and three scaled-down versions of the multiple landing platform ship to augment existing maritime prepositioning squadrons.

few other ships to enhance existing maritime prepositioning squadrons.

- Current command ships, which provide command-and-control capabilities for fleet commanders, will have their service lives extended but will not be replaced when they retire in 2029.

- The planned fleet of joint high-speed vessels (JHSVs), which are intended to transport troops and equipment quickly within a theater of operations, was expanded from 3 to 23 ships.[4]

Those changes—some of which resulted from decisions made as part of DoD's recent Quadrennial Defense Review—would effectively increase the fleet requirement from 313 ships to 322 or 323 ships.

The 2011 shipbuilding report also stated that the Navy plans to conduct a new force-structure analysis to officially determine what the future ship requirement will be. (The most recent force-structure analysis was conducted in 2005, and its results led to the 313-ship requirement.) This CBO study does not evaluate the force-structure requirements identified by the Navy. Rather, it assesses the costs of the Navy's shipbuilding plan, its effects on the force structure, and the extent to which that plan would satisfy those requirements.

Ship Purchases and Inventories Under the 2011 Plan

The Navy intends to buy nine ships in 2011 (see Figure 1) and a total of 50 ships between 2011 and 2015 (the period covered by DoD's current Future Years Defense Program, or FYDP).[5] Thereafter, under the 2011 shipbuilding plan, the Navy would buy another 226 vessels through 2040—for a total of 276 ships over 30 years, or an average of 9.2 per year. The pace of shipbuilding would be faster than that in the near term: The Navy plans to purchase an average of 10.2 ships annually between 2011 and 2020, with production of littoral combat ships increasing to four per year and production of joint high-speed vessels rising to two per year.[6]

If implemented as described above, the 2011 plan would enable the Navy to reach its earlier 313-ship goal by 2020. However, the fleet would remain at or above that number for only seven years. After that, as older ships were retired faster than new ones were brought into service, the fleet would fall to a low of 288 ships in 2032 before increasing to 301 ships by 2040. Thus, the current plan would never achieve its implied goal of 322 or 323 ships.[7]

4. A force of 23 JHSVs was implied by the ship purchases in the 2011 plan, and that number was explicitly mentioned in slides that the Navy used to brief Members of Congress and their staffs, the Congressional Budget Office, and the Congressional Research Service.

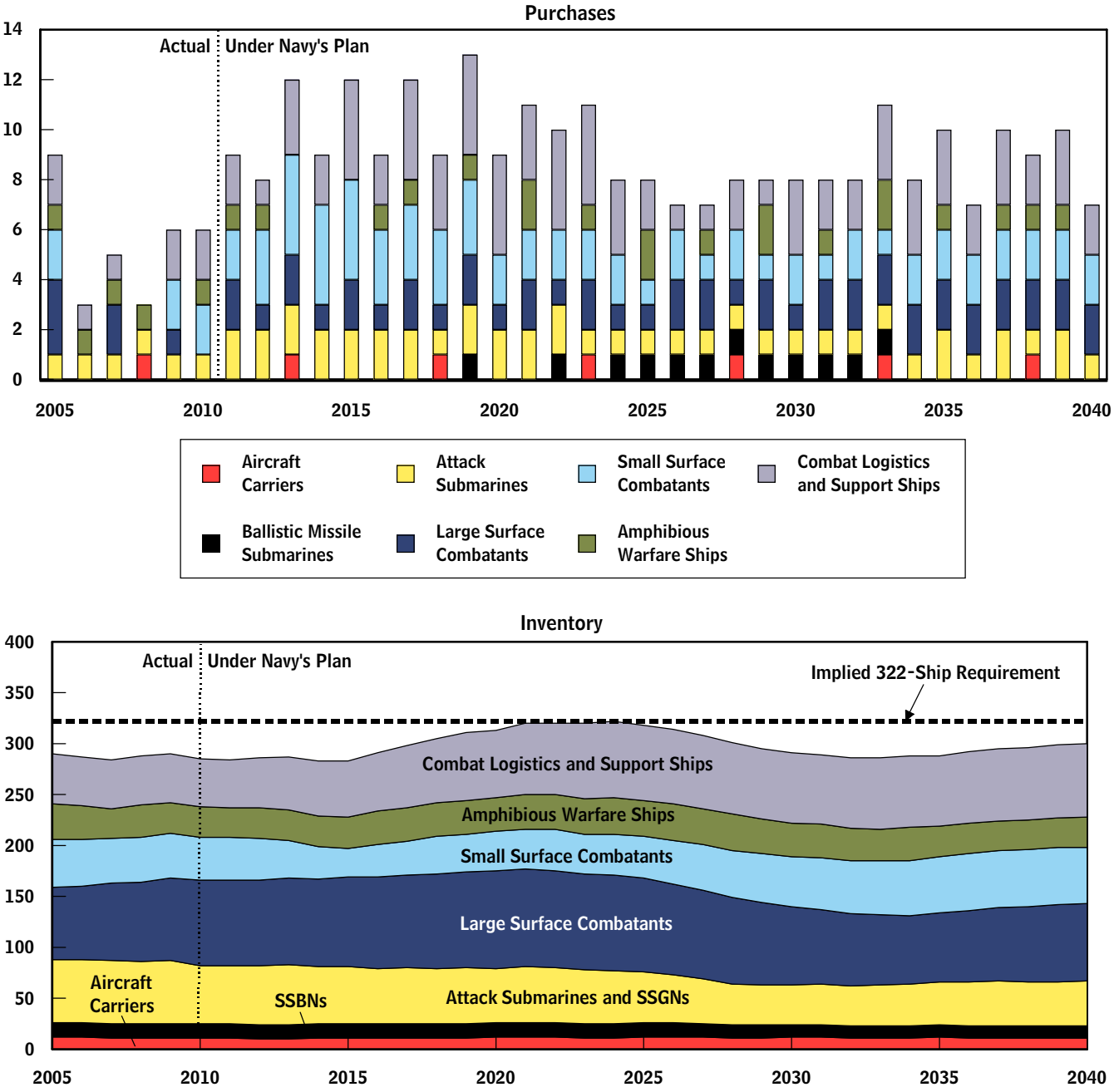
5. The FYDP is a five- or six-year funding plan that DoD updates annually.

6. Littoral combat ships are small surface combatants designed to operate in coastal waters.

7. If the expected service life of ships in the fleet is 35 years, the Navy needs to purchase an average of 9.2 ships per year to maintain a 322- or 323-ship fleet. Over the past 18 years, however, the Navy has acquired ships at the rate of 6.4 per year, which would result in a fleet of 224 ships at the end of 35 years. Thus, after 18 years, the Navy is now 51 ships short of being able to sustain a 322- or 323-ship fleet.

Figure 1.

Annual Ship Purchases and Inventories Under the Navy's 2011 Plan



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

Notes: The category of small surface combatants includes mine countermeasures ships.

SSBNs = ballistic missile submarines; SSGNs = guided missile submarines.

Altogether, the Navy would buy 20 fewer ships over 30 years under the 2011 plan than it would have bought under the previous plan.[8] In addition to the decline in total purchases, the composition of ship purchases—particularly the number of combat ships versus logistics and support vessels—has changed substantially with the latest plan.

Combat Ships

The Navy now envisions buying 198 combat ships—aircraft carriers, submarines, large and small surface combatants, and amphibious ships—between 2011 and 2040. That total represents a reduction of 40 ships, or 17 percent, from the 2009 plan.[9] Those purchases would leave the Navy short of its requirements for attack submarines, large surface combatants (cruisers and destroyers), and amphibious ships for parts of the 2011–2040 period. In addition, those shortfalls would be greater than under the 2009 plan.

With aircraft carriers, by contrast, the Navy would meet or exceed its new implied requirement of 10 or 11 ships throughout the 2011–2040 period. With respect to small surface combatants, the Navy plans to replace its frigates and mine countermeasures ships with 55 littoral combat ships, although it will not reach that number until 2035.

Attack Submarines. Under the 2011 plan, the Navy would purchase 44 attack submarines through 2040, which would not be enough to keep that force at or above the stated requirement of 48 after 2024 (see Figure 2). The number of attack submarines would reach a low of 39 in 2030 and then increase to about 45 for the last five years of the plan. The reason for the decline is that in 2015, the Navy expects to begin retiring Los Angeles class attack submarines (SSN-688s)—which were generally built at rates of three or four per year during the 1970s and 1980s—as they reach the end of their service lives. It would then replace them with Virginia class attack submarines (SSN-774s) and their successors at rates of one or two per year.

In comparison, the Navy's previous plan would have bought 9 more attack submarines (a total of 53) over 30 years. At its smallest, the force of attack submarines under that plan would have numbered 41 between 2028 and 2030. After that, the force would have grown, exceeding the 48-submarine requirement in 2034 and beyond.

Large Surface Combatants. The Navy has decided not to develop the CG(X) future cruiser, which was supposed to replace existing cruisers that are due to be retired in the 2020s. Instead, the current shipbuilding plan calls for buying 50 destroyers, most of them based on the existing Arleigh Burke class destroyers (DDG-51s). Those purchases would allow the Navy's inventory of large surface combatants to meet the implied requirement of at least 88 ships between 2015 and 2026. After that, however, the inventory of large surface combatants would fall to a low of 67 in 2034 before increasing to the mid-70s by 2040. As with the attack submarine force, the decline in the number of large surface combatants would occur because the Navy would begin retiring Ticonderoga class cruisers (CG-47s) in the early 2020s and DDG-51s in the late 2020s at a faster pace than their replacements would be commissioned.

That plan for large surface combatants represents a major departure from the Navy's 2009 plan. Under that earlier proposal, the Navy would have purchased 69 cruisers and destroyers over 30 years, which would have kept the service at or above the 88-ship requirement after 2015. In addition, the Navy has changed some of its assumptions about the service lives of large surface combatants. The 2009 plan assumed that all Arleigh Burke class destroyers would have a service life of 40 years, whereas the current plan assumes that only destroyers commissioned after 2000 will be in service that long.[10]

Amphibious Ships. The current long-term plan calls for buying 20 amphibious ships through 2040, which would

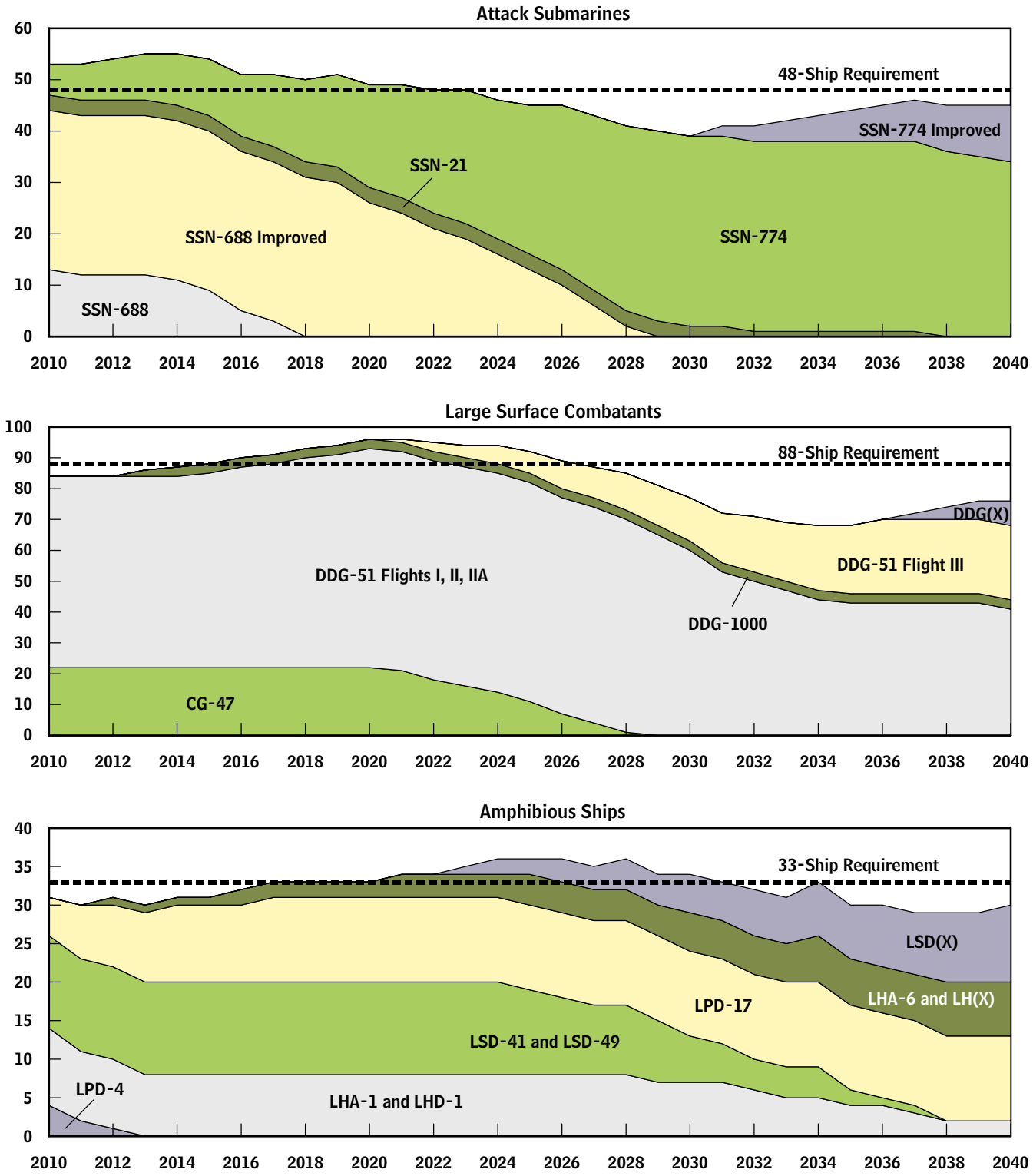
8. The change in the time frame covered by the two plans—2009 to 2038 versus 2011 to 2040—accounts for a difference of only two ships. The 2009 plan called for buying 15 ships in 2009 and 2010, whereas the 2011 plan includes the purchase of 17 ships in 2039 and 2040.

9. In characterizing the 2009 plan, CBO classified the plan's two MPF(F) aviation platforms as combat ships and the rest of the MPF(F) squadron as support ships.

10. The Navy built the Arleigh Burke class destroyers to last 35 years. However, the average retirement age of the past 13 classes of cruisers and destroyers has been well below that, and many ships (including, in recent years, Spruance class destroyers and some Ticonderoga class cruisers) have been retired after 25 years of service or less. See the statement of Eric J. Labs, Senior Analyst for Naval Forces and Weapons, Congressional Budget Office, before the Subcommittee on Seapower and Expeditionary Forces, House Committee on Armed Services, *The Navy's Surface Combatant Programs* (July 31, 2008).

Figure 2.

Inventories Versus Requirements for Selected Categories of Ships Under the Navy's 2011 Plan



Source: Congressional Budget Office.

Note: SSN = attack submarine; DDG = guided missile destroyer; CG = guided missile cruiser; LSD = dock landing ship; LHA, LHD, and LH(X) = amphibious assault ships; LPD = amphibious transport dock.

increase the amphibious force from 31 ships today to the new requirement of 33 by 2016. The force would stay at that size or greater through 2031 and then decline to 29 or 30 ships after 2034.

Under the 2009 plan, the Navy would also have purchased 20 amphibious ships over three decades, but it assumed that many existing ships would stay in service longer than 40 years. As a result, the 2009 plan would have kept the amphibious force at 32 or 33 ships for virtually the entire 30-year period from 2009 to 2038.

One of the changes in plans is the cancellation of nine of the 12 ships envisioned for the Maritime Prepositioning Force (Future) squadron. In their place, the Navy now plans to buy three support ships (in addition to three others bought in recent years) to augment existing maritime prepositioning squadrons (which store cargo at sea for use by Marine Corps and Navy units in various theaters). The three new ships are multiple landing platforms, which are intended to be similar to—but less capable than—the ones envisioned for the MPF(F) squadron.

Logistics and Support Ships

The Navy's 2011 plan envisions buying 78 logistics and support ships in the next three decades—20 more than in the 2009 plan, or an increase of about one-third. Those planned purchases include 19 new oilers (which provide fuel and other supplies to ships at sea) and 41 joint high-speed vessels (relatively small, fast ships with a large cargo area that are designed for intratheater transport). According to the Navy, the JHSVs are in great demand by regional combatant commanders. They may also be useful for other missions, such as engagement with friendly nations (through visits, training, and joint exercises) and some kinds of maritime security operations. The 2011 plan implies a new requirement for JHSVs of 23, compared with only 3 previously. (Purchases under that plan would exceed the new requirement because the JHSVs are expected to have a service life of only 20 years, meaning that the Navy would need to begin buying replacements in 2030.)

Once the initial JHSVs were built, the Navy would meet its implied requirements for most types of logistics and support ships through the end of the 30-year period. The exception would be for combat logistics ships: T-AKE dry cargo ships, T-AO oilers, and AOE fast combat support ships. Those vessels operate with, or directly resupply, combat ships that are on deployment. The 2011 plan includes a requirement for 30 combat logistics ships, but the force would fall below that number after 2022, declining to as few as 24 ships in 2031 before increasing to 28 by 2040.

Under the 2009 plan, by comparison, the Navy would have purchased 58 support ships over 30 years, including 15 oilers and only 14 JHSVs (7 initial ships and 7 replacements). Unlike with the current plan, however, the Navy would have kept its force of combat logistics ships at or above the required size of 30 continuously beginning in 2015.

Ship Costs Under the 2011 Plan

In the new shipbuilding report, the Navy states that carrying out those planned purchases would cost an average of $15.9 billion per year through 2040—33 percent less than the $23.9 billion average under its 2009 plan (see the top panel of Figure 3).[11] For estimating purposes, the Navy divided the time frame of the 2011 plan into three periods: near term (2011 to 2020), midterm (2021 to 2030), and far term (2031 to 2040). Using its own cost assumptions about Navy ships, which are explained in detail later in this study, CBO estimated the costs of the 2011 plan. Overall, CBO's estimates are about 18 percent higher than the Navy's, but the differences are smaller for the near term and much larger for the far term (see the bottom panel of Figure 3).

The Navy's Estimates

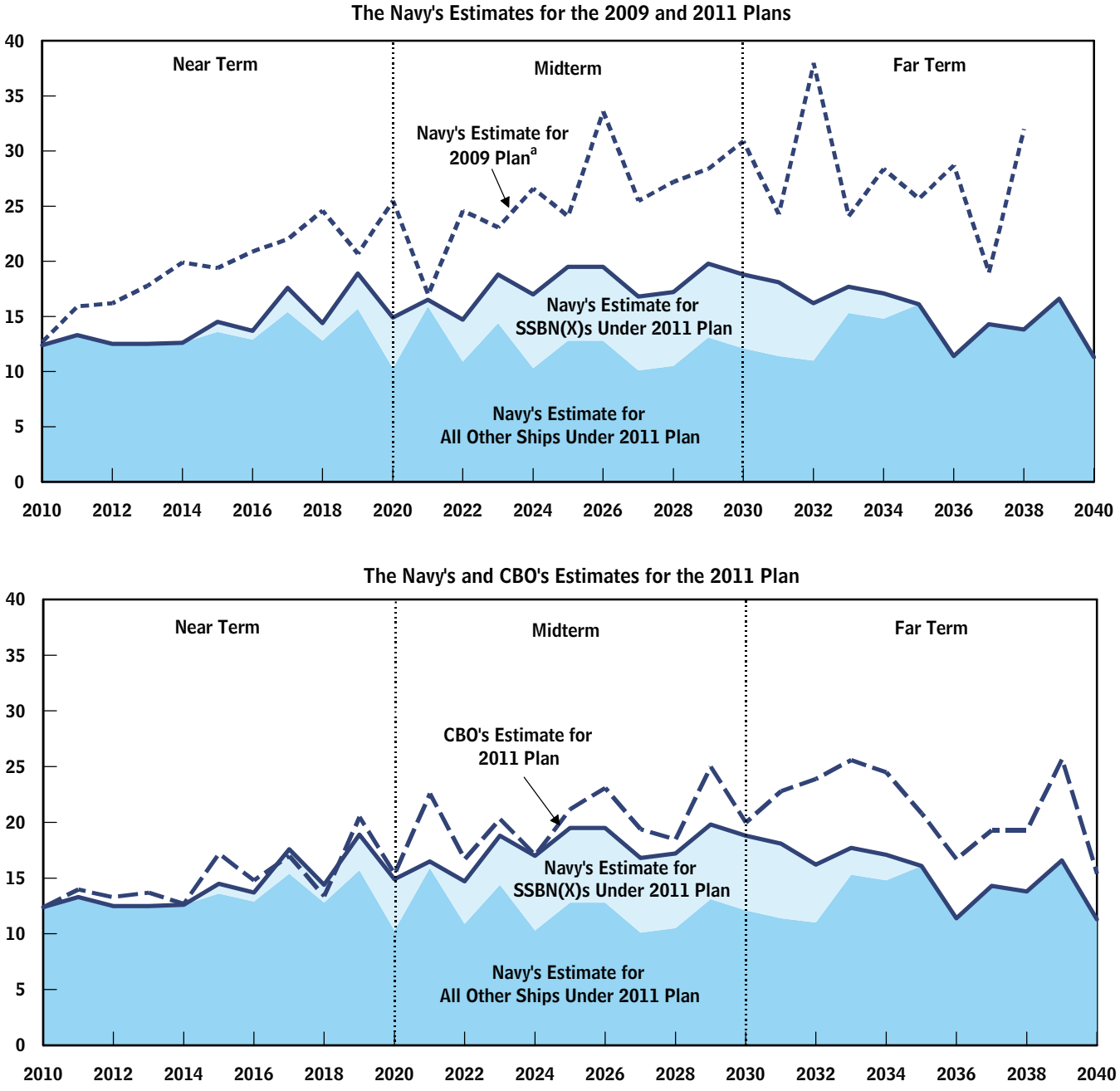
The 2011 shipbuilding report offers a frank discussion of the difficulties in estimating the types of capabilities that ships might need to have—and thus their costs—over the three estimating periods. The Navy says that it will need an average of $14.5 billion per year in the near term to build new ships and that "given known ship capability and quantity requirements, the cost estimates are judged to be accurate in this period" (see Table 2). In the midterm period, replacing the Navy's current Ohio class ballistic missile submarines drives up the average cost of new

11. Like most other dollar figures in this study, those numbers are in 2010 dollars. The Navy reported the costs of the 2009 plan in 2007 dollars and excluded funding for the next generation of ballistic missile submarines. CBO added its 2009 estimate for those submarines to the Navy's number and inflated the total to 2010 dollars.

Figure 3.

Estimates of Annual Spending for New-Ship Construction Under the Navy's 2009 and 2011 Plans

(Billions of 2010 dollars)



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

Notes: The estimates shown here cover only construction of new ships; they exclude the costs of refueling existing nuclear-powered aircraft carriers as well as outfitting and postdelivery costs (which include the purchase of many smaller tools and pieces of equipment needed to operate a ship but not necessarily provided by the manufacturing shipyard as part of ship construction).

SSBN(X)s = next-generation ballistic missile submarines.

a. Unlike the 2011 plan, the 2009 plan did not include the cost of building new ballistic missile submarines. To make the Navy's estimates for the two plans comparable, CBO added its 2009 estimate of the cost of the SSBN(X)s to the Navy's estimate for the 2009 plan.

construction to $17.9 billion per year. However, the Navy says that "the accuracy of the cost estimates diminishes for the force structure estimates in this timeframe." In the far term, the Navy's estimated costs fall to an average of $15.3 billion, although "the cost estimates are notional due to the uncertainty of business conditions affecting the shipbuilding industry."[12]

The Navy's 2009 shipbuilding plan excluded the cost of replacing Ohio class ballistic missile submarines. That decision was criticized by Members of Congress and outside analysts. The current plan includes that cost—an estimated $86 billion, according to the Navy—which is one of the biggest differences between the two plans. (The Navy's 2007 and 2008 plans included funding to replace those submarines, but the average cost per submarine was about half the Navy's current estimate.)[13]

As in the three previous shipbuilding plans, the Navy's latest cost estimates exclude other items that the service would need to fund from its budget accounts for ship construction:[14]

- Refueling of nuclear-powered aircraft carriers, whose reactors are replaced midway through the ships' service life; and
- Outfitting and postdelivery costs, which cover various activities and small items, such as tools and equipment, that a ship needs to become operational but that are not provided by the manufacturing shipyard.[15] Over the past 15 years, outfitting and postdelivery costs have equaled about 3.2 percent of the Navy's total budget for new construction and for refueling of submarines and aircraft carriers.

Including the costs of refueling carriers would increase the Navy's budget estimate for the 2011 plan to an average of $17.2 billion a year through 2040, CBO estimates.[16] Adding outfitting and postdelivery costs would raise that amount to $17.8 billion per year. Those figures are higher than the average funding that the Navy has received in the past three decades—about $15 billion per year for all items in its shipbuilding accounts.

CBO's Estimates

The full cost of the 2011 shipbuilding plan, in CBO's estimation, would average $20.9 billion over the 2011–2040 period—about 18 percent more than the Navy's estimate of $17.8 billion. CBO's numbers are only about 4 percent higher than the Navy's for the first 10 years of the plan but nearly 37 percent higher for the last 10 years of the plan. Looking at the 30-year period as a whole and adding up the various cost components, CBO estimated the following:

- Costs for new-ship construction alone would average $19.0 billion per year, 20 percent greater than the Navy's figure of $15.9 billion.
- New-ship construction plus refueling of nuclear-powered aircraft carriers would cost an average of $20.3 billion per year.
- Outfitting and postdelivery would add annual costs of about $600 million (see Figure 4), raising CBO's estimate to an average of $20.9 billion per year through 2040.

For the near term, CBO's and the Navy's cost estimates are similar because most of the ships that the Navy plans to buy are already under construction, and their costs are reasonably well known. Looking farther ahead, CBO and the Navy made different assumptions about the size and capabilities of future ships that led to different cost

12. The statements quoted in this paragraph come from Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011,* pp. 9–10.

13. See Congressional Budget Office, "Resource Implications of the Navy's Fiscal Year 2009 Shipbuilding Plan," attachment to a letter to the Honorable Gene Taylor (June 9, 2008), p. 28.

14. The Navy funds shipbuilding through two accounts: Ship Construction, Navy (commonly called the SCN account) and the National Defense Sealift Fund, which, among other things, includes funding for procurement of some types of logistics ships.

15. Outfitting costs exclude the costs of fuel, food, and ammunition.

16. That number represents the Navy's estimate for new construction plus CBO's estimate for refueling aircraft carriers. (It also includes CBO's estimate of the costs to extend the service lives of existing air-cushion landing craft—known as LCACs—and to buy their replacements; together, those costs average about $200 million per year.) In 2010, the Navy transferred funding for refueling nuclear-powered submarines to a procurement account (Other Procurement, Navy, or OPN) that is not used to purchase ships. Thus, CBO did not include the refueling costs for submarines in its shipbuilding estimates.

Table 2.

Average Annual Shipbuilding Costs Under the Navy's 2011 Plan, by Decade

	Near Term (2011–2020)	Midterm (2021–2030)	Far Term (2031–2040)	Total (2011–2040)
		Navy's Estimates (Billions of 2010 dollars)		
New-Ship Construction	14.5	17.9	15.3	15.9
New-Ship Construction plus Refueling of Nuclear-Powered Aircraft Carriers[a]	15.9	19.1	16.6	17.2
New-Ship Construction, Refueling of Nuclear-Powered Aircraft Carriers, and Outfitting and Postdelivery Costs[a]	16.4	19.7	17.2	17.8
		CBO's Estimates (Billions of 2010 dollars)		
New-Ship Construction	15.2	20.4	21.4	19.0
New-Ship Construction plus Refueling of Nuclear-Powered Aircraft Carriers	16.6	21.6	22.7	20.3
New-Ship Construction, Refueling of Nuclear-Powered Aircraft Carriers, and Outfitting and Postdelivery Costs	17.1	22.3	23.4	20.9
Memorandum:				
Additional Costs of Mission Packages for Littoral Combat Ships	0.3	0.3	0.2	0.3
		Percentage Difference Between CBO's and the Navy's Estimates		
New-Ship Construction	5	14	40	20
New-Ship Construction plus Refueling of Nuclear-Powered Aircraft Carriers	4	13	37	18
New-Ship Construction, Refueling of Nuclear-Powered Aircraft Carriers, and Outfitting and Postdelivery Costs	4	13	37	18

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

Notes: Actual costs for the Navy's shipbuilding accounts over the past 30 years averaged $14.8 billion per year for all items. More recently, between 2005 and 2010, costs for new-ship construction averaged $12.0 billion per year; new-ship construction and nuclear refuelings averaged $12.5 billion; and new-ship construction, nuclear refuelings, and outfitting and postdelivery averaged $12.9 billion per year.

Outfitting and postdelivery costs include the purchase of many smaller tools and pieces of equipment needed to operate a ship but not necessarily provided by the manufacturing shipyard as part of ship construction.

a. These numbers represent the Navy's estimate for new-ship construction plus CBO's estimates for additional costs (including an average of about $0.2 billion per year to extend the service lives of existing air-cushion landing craft, known as LCACs, and buy new ones as well).

estimates. In addition, CBO incorporated the fact that costs for labor and materials have traditionally grown much faster in the shipbuilding industry than in the economy as a whole, whereas the Navy does not appear to have accounted for the higher growth rates (see Box 1 on page 12). That difference is much more pronounced in the last decade of the plan, after 20 or more years of compounded inflation, than in the early years.

Changes from the 2009 Plan

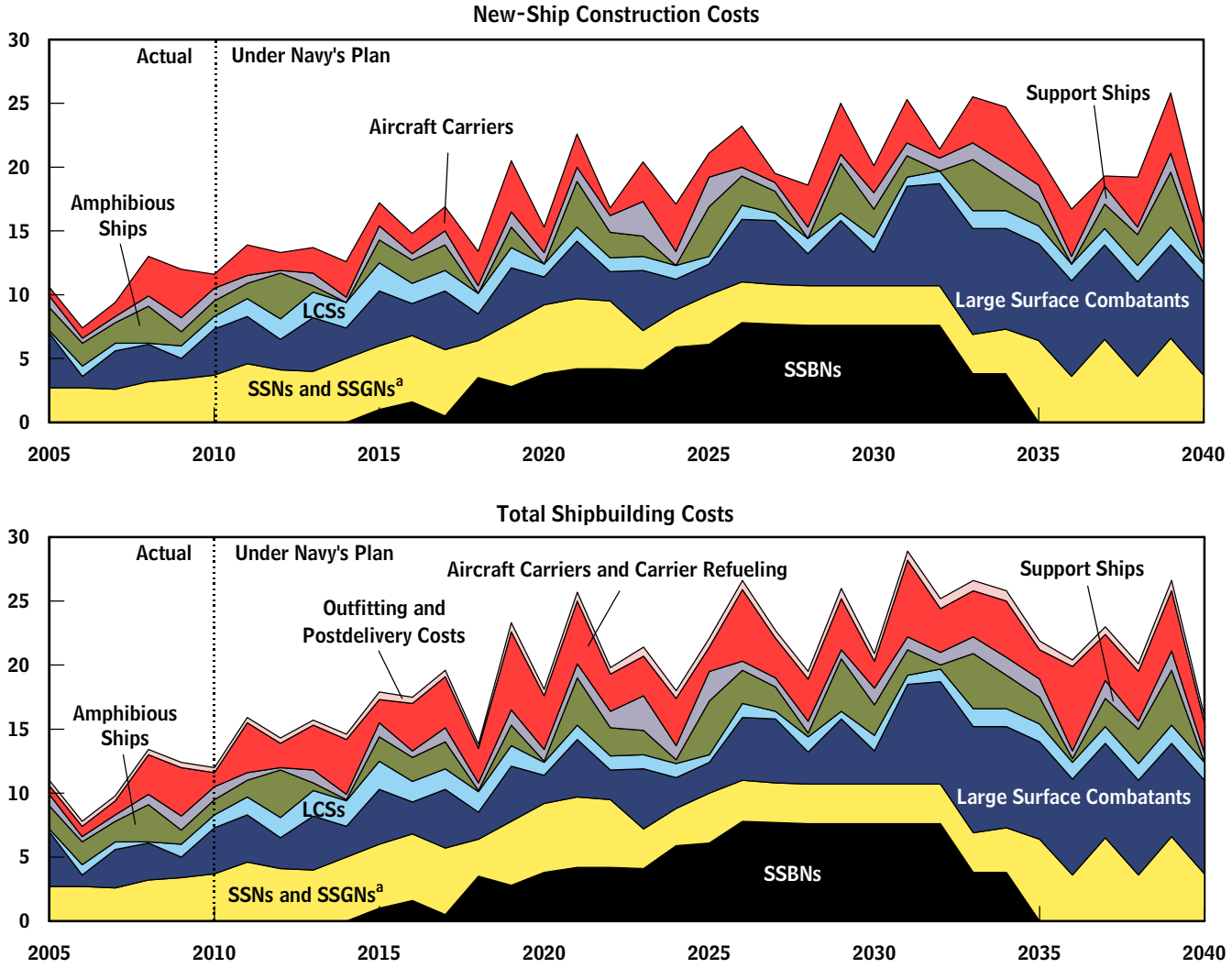
Despite its cost, the 2011 shipbuilding plan is substantially less expensive than the Navy's previous plan, which would have required average funding of $27.8 billion a year (in 2010 dollars), CBO estimates. The reduction of $6.9 billion per year—or about 25 percent—in the full cost of the current plan stems mainly from three factors:

- *Changes in the items included in CBO's estimates*—For its estimate of the costs of the 2011 plan, CBO excluded several activities or items that it had included in its estimate of the previous plan: specifically, modernization of existing cruisers and destroyers, refueling of nuclear-powered submarines, and mission modules for littoral combat ships. The Navy pays for those things from budget accounts other than the two shipbuilding accounts, and CBO excluded them to bring its current estimate more in line with the expected

Figure 4.

CBO's Estimate of Annual Costs Implied by the Navy's 2011 Plan

(Billions of 2010 dollars)



Source: Congressional Budget Office.

Notes: New-ship construction costs exclude the costs of refueling existing nuclear-powered aircraft carriers as well as outfitting and post-delivery costs (which include the purchase of many smaller tools and pieces of equipment needed to operate a ship but not necessarily provided by the manufacturing shipyard as part of ship construction). Total shipbuilding costs include those amounts.

SSNs = attack submarines; SSGNs = guided missile submarines; SSBNs = ballistic missile submarines; LCSs = littoral combat ships.

a. Costs for SSGNs refer only to the 2005–2010 period.

contents of the shipbuilding accounts.[17] Removing those costs is responsible for about $800 million of the difference in CBO's estimates of the average annual costs of the 2009 and 2011 plans.

- *Changes in the number and types of ships that the Navy plans to buy*—The 2011 plan envisions purchasing 20 fewer ships over 30 years than the 2009 plan did (276 instead of 296). In addition, compared with the previous plan, more of the new ships would be support ships, which cost an average of about $400 million apiece, and fewer would be combat ships, which cost an average of about $3 billion each. Those changes account for about half of the remaining $6 billion difference in the average annual costs of the two plans.

- *Effects on the per-ship cost of various classes*—Since 2009, the Navy has altered a number of its assumptions about the size and capabilities of ships in some of its key programs. Most notably, the current plan assumes that the submarines intended to replace today's Virginia class submarines will be about the same size as their predecessors, whereas the 2009 plan assumed that they would be about 50 percent larger. Likewise, the 2011 plan now assumes that the LH(X) and LSD(X)—replacements for existing amphibious assault ships and dock landing ships, respectively—will be smaller than the 2009 plan had assumed. In addition, the cancellation of the CG(X) cruiser program and the planned procurement of more DDG-51 destroyers mean that the Navy will buy smaller, less expensive surface combatants under the 2011 plan than under the 2009 plan and those ships will have more predictable construction costs—because the manufacturing shipyards have already built 62 destroyers similar to the new versions of the DDG-51. Together, those changes (which are discussed in more detail later) and several smaller changes in assumptions account for the other half of the remaining $6 billion difference in the average yearly costs of the two plans.

17. Even so, CBO's estimate does not correspond exactly to what is included in those accounts; for example, CBO excluded the costs of service craft (such as tugboats, barges, and floating dry docks) as well as other small items that are purchased through the shipbuilding accounts. In all, the excluded items have represented less than 1 percent of the Navy's shipbuilding budget in the past few years.

Outlook for Individual Ship Programs

To estimate the costs of implementing the 2011 plan, CBO calculated the cost of each of the 276 ships that the Navy intends to purchase through 2040. For ships under construction, the estimates were based in part on data from the Navy on actual costs; for ships yet to be built, they were based on relationships between the cost and weight of past ships. (Specifically, CBO used the cost per thousand tons of lightship displacement—the weight of the ship itself without its crew, materiel, weapons, or fuel.) CBO then adjusted its estimates to incorporate the effects of "rate" (the reduction in average overhead costs that occurs when a shipyard builds more than one of the same type of ship at a time) and "learning" (the efficiencies that shipyards gain as they produce additional units of a given type of ship). To apply the effects of rate and learning to ships for which the Navy has yet to develop even a notional design, CBO had to make assumptions about the size and capabilities of future ships.

Aircraft Carriers

The 2011 shipbuilding plan slightly reduced the Navy's requirement for aircraft carriers: from 11, which was the standard under the 2009 plan, to a force of 10 to 11. The Navy intends to buy six CVN-78 Gerald R. Ford class aircraft carriers over the 2011–2040 period. Building one carrier every five years (commonly referred to as "five-year centers") would enable the Navy to have a force of at least 11 carriers most of the time through 2040. The exceptions would be in 2013 and 2014, when the number of carriers would drop to 10. That temporary decline would occur because the *U.S.S. Enterprise* (CVN-65) is scheduled to be retired in 2013—after 52 years of service—but the next new carrier, the *U.S.S. Gerald R. Ford* (CVN-78), would not be commissioned until 2015. Any delays in building the new CVN-78 class would extend the period during which the Navy had only 10 carriers.

The Navy's projected cost of the lead ship of the CVN-78 class grew by 10 percent between the President's 2008 and 2011 budget requests. The Navy now expects the lead ship's cost to be about $11.7 billion (about what CBO estimated in its analysis of the Navy's 2009 plan). Yet further increases appear likely. The CVN-78 is only about 10 percent complete, and cost growth in shipbuilding programs typically occurs when a ship is more than half finished—particularly in the later stages of construction, when all of a ship's systems must be installed and integrated.

Box 1.

Inflation in Shipbuilding

An important factor affecting the Navy's and the Congressional Budget Office's (CBO's) estimates is assumptions about future increases in the cost of building naval ships. The Department of Defense (DoD) has an overall estimate of future inflation (known as an inflator) that it uses to project increases in the costs of its procurement programs. However, according to the Navy, DoD's inflator is lower than the actual inflation that occurred in the naval shipbuilding industry in the past decade. The Navy provided CBO with a shipbuilding index that reflects the growth in the costs of labor and materials that the industry has experienced in the past. The service developed that index using a weighted composite of annual percentage changes in the costs of labor and materials specific to shipbuilding, based on shipyards' data about labor costs in the past, advance pricing agreements, vendor surveys, and projections of the cost of materials from the Bureau of Labor Statistics.

From 2011 through at least 2017, the Navy's index is projected to grow at an average annual rate of 3.3 percent. By comparison, the gross domestic product (GDP) price index, which measures the prices of final goods and services in the economy, will grow at an average annual rate of 1.4 percent, in CBO's estimation. The difference between the two rates implies that annual inflation will be 1.9 percentage points higher for shipbuilding programs during that period than for the economy as a whole, which is greater than the historical average gap of 1.4 percent since 1980 (see the figure to the right).[1]

The Navy incorporated that higher rate of shipbuilding inflation into its budget request for 2011 and into the associated Future Years Defense Program. In projecting its constant-dollar estimates for the 2011 shipbuilding plan, however, the Navy did not assume that the higher inflation rate would drive the costs of future shipbuilding programs. Instead, it assumed that, in constant dollars, a ship that cost $2.5 billion to build in 2011 would cost the same to build in 2020 or 2030. The estimates in its 2009 plan, by contrast, did factor in higher shipbuilding inflation, which at that time the Navy projected to be about 3.5 percent per year. As a result, many of the Navy's current estimates of unit (per-ship) costs are lower than its estimates under the 2009 plan for the same ships.

1. That comparison represents a change from CBO's report on the Navy's 2009 plan (Congressional Budget Office, "Resource Implications of the Navy's Fiscal Year 2009 Shipbuilding Plan," attachment to a letter to the Honorable Gene Taylor, June 9, 2008), which compared shipbuilding inflation with inflation in DoD's procurement programs in general. Using the GDP price index as the basis for comparison is consistent with CBO's analyses in other economic sectors and better reflects the cost to the taxpayer of higher inflation in naval shipbuilding.

Continued

To estimate the cost of the lead ship of the CVN-78 class, CBO used the actual costs of the previous carrier—the CVN-77—and then adjusted them for higher costs for government-furnished equipment and for more than $3 billion in costs for nonrecurring engineering and detail design (the plans, drawings, and other one-time items associated with the first ship of a new class). As a result, CBO estimates that the lead CVN-78 will cost about $12.5 billion once it is completed. Subsequent ships of the class will not require as much funding for one-time items; however, on the basis of higher projected inflation in shipbuilding costs, CBO estimates the average cost of the six carriers in the 2011 plan at $12.4 billion, whereas the Navy estimates their average cost at $10.6 billion (see Table 3).

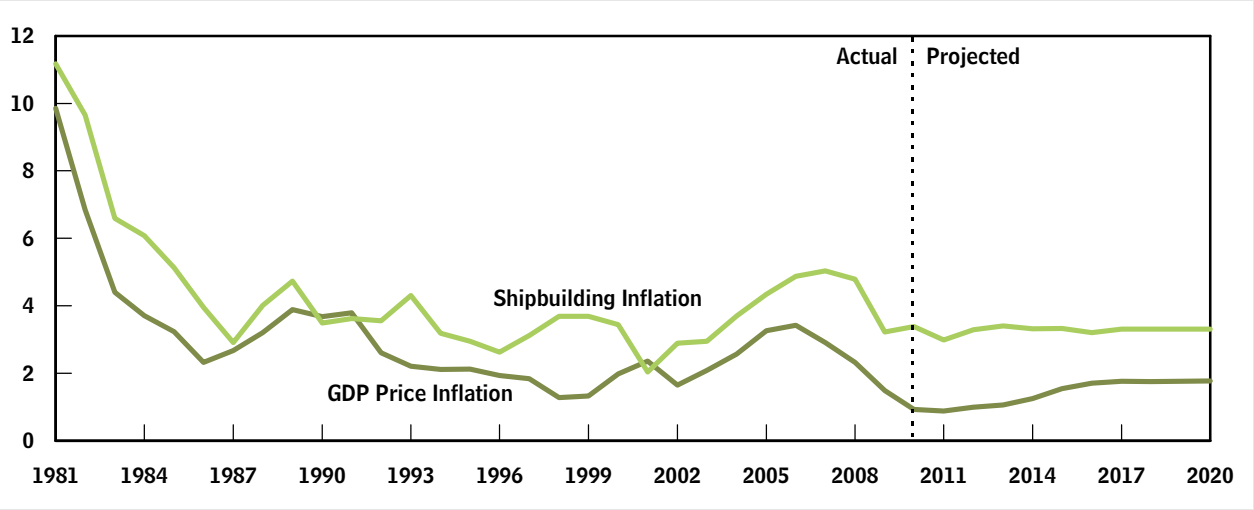
There are several reasons to believe that the final cost of the CVN-78 could be even higher than CBO's estimate. First, most lead ships built in the past 20 years have experienced cost growth of more than 40 percent. (CBO's estimate for the lead CVN-78 already accounts for some of that historical cost growth.) Second, Navy officials

Box 1. **Continued**

Inflation in Shipbuilding

Annual Rates of Shipbuilding Inflation and GDP Price Inflation

(Percent)



Sources: Congressional Budget Office; Department of the Navy.

Note: GDP = gross domestic product.

In its estimates, CBO assumed that a higher inflation rate for shipbuilding would continue for the next 30 years—partly because price growth in the shipbuilding industry has exceeded general inflation for most of the past three decades and partly because CBO lacked an analytic basis for determining when and how the difference between the two growth rates would disappear. Specifically, CBO assumed that shipbuilding inflation would outpace inflation as measured by the GDP price index by 1.9 percentage points between 2011 and 2017 and by 1.5 percentage points thereafter. Thus, CBO estimated that a ship costing $2.5 billion to build in 2011 would cost $3.6 billion (in 2010 dollars) to build in 2030. However, shipbuilding costs cannot continue indefinitely to grow faster than the costs of goods and services in 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.

have told CBO that there is a 60 percent probability that the final cost of the CVN-78 will exceed the service's estimate, compared with a 40 percent probability that the final cost will be less than that estimate. Third, a number of critical technologies that are supposed to be incorporated into the ship, such as a new electromagnetic catapult system for launching aircraft, remain under development. Difficulties in completing their development could arise and increase costs, which would affect the costs for subsequent ships of the class.

Submarines

Under the 2011 shipbuilding plan, submarines would overtake surface combatants as the largest source of demand for the Navy's resources over the next 30 years (see Table 4). The Navy currently operates 14 Ohio class ballistic missile submarines (SSBNs), four Ohio class guided missile submarines (SSGNs) modified from the SSBN version, and 53 attack submarines (SSNs) of several classes. Over the next three decades, the Navy plans to buy 12 new SSBNs, starting in 2019; increase production of Virginia class attack submarines from one to

Table 3.

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

(Billions of 2010 dollars)

	Number of Ships Purchased Under the 2011 Plan	Average Cost per Ship over the 2011–2040 Period		Total Costs per Class over the 2011–2040 Period		Memorandum: Navy's Estimate of Average Cost per Ship Under the 2009 Plan
		Navy's Estimate	CBO's Estimate	Navy's Estimate	CBO's Estimate	
CVN-78 Gerald R. Ford Class Aircraft Carriers	6	10.6	12.4 [a]	63	77 [a]	10.6
SSBN(X) Ballistic Missile Submarines (Replacements for Ohio class)	12	7.2	8.2	86	99	*
Virginia Class Attack Submarines	25	2.5	2.5	62	63	2.9
Improved Virginia Class Attack Submarines (Replacements for Virginia class)	19	2.9	3.3	56	63	6.7
DDG-51 Arleigh Burke Class Destroyers						
Flight IIA	8	1.6	1.8	13	14	n.a.
Flight III	24	2.0	2.4	48	57	n.a.
CG(X) Cruisers	n.a.	n.a.	n.a.	n.a.	n.a.	3.4
DDG(X) Destroyers (Replacements for Arleigh Burke class)	18	2.4	4.0	44	71	1.8
Littoral Combat Ships	49	0.6 [b]	0.6 [b]	29	27	0.6
LCS(X)s (Replacements for littoral combat ships)	17	0.6	0.7	10	12	0.8
LSD(X) Amphibious Dock Landing Ships	12 [c]	1.3	1.7	15	21	2.5
LHA-6/LH(X) Amphibious Assault Ships	7	3.4	4.2	24	29	4.5

Sources: Congressional Budget Office; Department of the Navy.

Note: n.a. = not applicable; * = the Navy's 2009 plan included purchases but not costs.

a. In CBO's estimates for aircraft carriers, the total costs per class include remaining funds for the CVN-78 as well as advance procurement funding for the carrier that the Navy plans to buy in 2043, but the average cost per ship excludes that funding.

b. The Navy's estimate of the average cost of a littoral combat ship is slightly less than $600 million. CBO's estimate of the average cost of such a ship is $550 million for ships built during the 2011–2040 period and $560 million per ship for the entire class.

c. Also included under the Navy's plan is the purchase of one LPD-17 amphibious transport dock in 2012.

Table 4.

Shipbuilding Costs, by Major Category, 1981 to 2040

	Historical				CBO's Estimate Under the Navy's 2011 Plan			
	1981–1990	1991–2000	2001–2010	1981–2010	2011–2020	2021–2030	2031–2040	2011–2040
	Average Annual Costs (Billions of 2010 dollars)							
Aircraft Carriers	2.8	1.4	2.7	2.3	3.7	3.6	4.2	3.8
Submarines	7.0	2.4	3.8	4.4	6.2	10.2	6.8	7.7
Surface Combatants	7.6	4.9	4.0	5.5	5.1	4.7	9.2	6.3
Amphibious Ships	1.4	1.3	1.8	1.5	1.4	2.4	2.1	2.0
Support Ships	2.0	0.6	0.7	1.1	0.8	1.3	1.1	1.1
Total	**20.9**	**10.5**	**12.9**	**14.8**	**17.1**	**22.3**	**23.4**	**20.9**
	Percentage of Average Annual Costs							
Aircraft Carriers	13	13	21	15	22	16	18	18
Submarines	34	23	30	30	36	46	29	37
Surface Combatants	36	46	31	37	30	21	39	30
Amphibious Ships	7	12	14	10	8	11	9	9
Support Ships	10	6	5	8	5	6	5	5
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Congressional Budget Office.

Note: The costs shown here cover construction of new ships, refueling of nuclear-powered aircraft carriers, and outfitting and postdelivery (which include the purchase of many smaller tools and pieces of equipment needed to operate a ship but not necessarily provided by the manufacturing shipyard as part of ship construction).

two per year, beginning in 2011; and redesign and improve on the Virginia class, with production of the new version to start in 2025. The Navy does not plan to replace its four SSGNs when they retire in the mid- to late 2020s.

SSBN(X) Future Fleet Ballistic Missile Submarine. The design, cost, and capabilities of the SSBN(X), the submarine slated to replace the Ohio class, are among the most significant uncertainties in the Navy's and CBO's analyses of future shipbuilding. The Navy's 2007 and 2008 plans assumed that the first SSBN(X) would cost $4.5 billion (in 2010 dollars) and that subsequent ships in the class would cost about $3.4 billion apiece.[18] The 2009 plan explicitly excluded the costs of the SSBN(X) class, although it included 12 of those submarines in its projected inventories. The 2011 plan, in contrast, includes the costs of the SSBN(X) class—with an estimate that highlights the great expense of replacing current ballistic missile submarines and the effect that effort could have on other shipbuilding programs.

Specifically, the Navy now estimates that the lead SSBN(X) will cost about $9 billion and that building 12 of the new submarines will cost $86 billion, or an average of about $7.2 billion apiece. The Navy's 2011 report states that those estimates are "consistent with the escalated cost of the OHIO class SSBN."[19] However, escalating (that is, inflating) the actual costs of the Ohio class submarines would produce an average cost of only about $3.1 billion per submarine in 2010 dollars. Navy officials subsequently clarified that the service's estimate is based on the cost to build Ohio class submarines in today's industry conditions and with today's technology. Under the 2011 plan, however, the first SSBN(X) would be authorized in 2019 (although advance procurement money would be needed starting in 2015 for items with long lead times). The second submarine would be

18. For more about how the Navy arrived at those estimates, see Congressional Budget Office, "Resource Implications of the Navy's Fiscal Year 2008 Shipbuilding Plan," attachment to a letter to the Honorable Gene Taylor (March 23, 2007), pp. 8–9.

19. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, p. 20.

purchased in 2022, followed by one per year from 2024 to 2033.

In most of its recent naval analyses, CBO assumed that the SSBN(X) would be smaller and would carry fewer weapons than existing ballistic missile submarines—specifically, that it would have 16 missile tubes instead of the 24 on today's SSBNs and would displace around 15,000 tons submerged, compared with 18,750 tons for an existing Ohio class submarine.[20] But in a recent briefing to CBO and the Congressional Research Service, the Navy stated that an SSBN(X) would probably be about the same size and have roughly the same displacement as an Ohio class submarine, even though it might have only 16 or 20 missile tubes. Over time, technological advancements tend to add weight to a submarine design (compared with the same submarine produced 30 years earlier). If the Ohio class was being built today with the same capability to launch ballistic missiles, it would actually be much larger than 18,750 tons. Thus, a new SSBN with fewer than 24 missile tubes would probably still be equivalent in displacement to an Ohio class submarine. For those reasons, in its analysis, CBO adopted the Navy's assumption about the size of the SSBN(X).[21]

CBO estimates that the lead SSBN(X) will cost about $13 billion if it is purchased in 2019. Estimating the cost of that submarine is particularly difficult because it is not clear how much the Navy will need to spend on nonrecurring engineering and detail design. The Navy spent about $2 billion on those items—out of a total of more than $5 billion—for the lead Virginia class attack submarine, which is about 60 percent smaller than the first Ohio class submarine. CBO assumed that the cost of nonrecurring items would be proportional to the weight of the new submarine, so it estimated more than $4 billion for those items. (The Navy appears to have assumed that nonrecurring items for the lead SSBN(X) would cost about $2 billion.)

The historical track record for the lead ship of new classes of submarines in the 1970s and 1980s implies little difference on a per-ton basis between a lead attack submarine (SSN) and a lead SSBN (see Figure 5). If that pattern continued, the per-ton cost of the SSBN(X) would be about the same as that of the first Virginia class SSN.

Overall, 12 SSBN(X)s would cost a total of about $99 billion in CBO's estimation, or an average of $8.2 billion each. Another $10 billion to $15 billion would be needed for research and development, for a total program cost of more than $110 billion. Those estimates appear to differ from the Navy's mainly because the Navy priced the SSBN(X) as though it were being built today, whereas CBO incorporated the effects that higher shipbuilding inflation would have on submarines built 10 to 20 years from now.

Attack Submarines. Under the 2011 plan, the Navy would buy two attack submarines per year beginning in 2011 (up from one per year over the past decade). That procurement rate would continue in almost every year through 2022 and then change to one SSN annually in most years until 2040. With such a procurement schedule, the attack submarine force would remain at or above the Navy's required size of 48 through 2023 but then fall to 39 to 46 submarines thereafter.

Senior Navy leaders have stated—and the 2011 plan assumes—that Virginia class SSNs would have to cost $2.5 billion or less for the Navy to be able to afford two per year.[22] The President's 2011 budget indicates a cost of about $2.4 billion. The Navy and CBO both estimate that the average cost for all of the Virginia class submarines purchased between 2011 and 2024 will be about $2.5 billion. Both of those estimates are lower than the estimates made under the 2009 shipbuilding plan. CBO reduced its estimate partly because of the myriad small cost-cutting strategies that the Navy has successfully incorporated into the Virginia class program in recent years.

20. Displacement figures for submarines refer to Condition A displacement, which is roughly analogous to lightship displacement (the weight of the ship itself without its crew, materiel, weapons, or fuel) for surface ships.

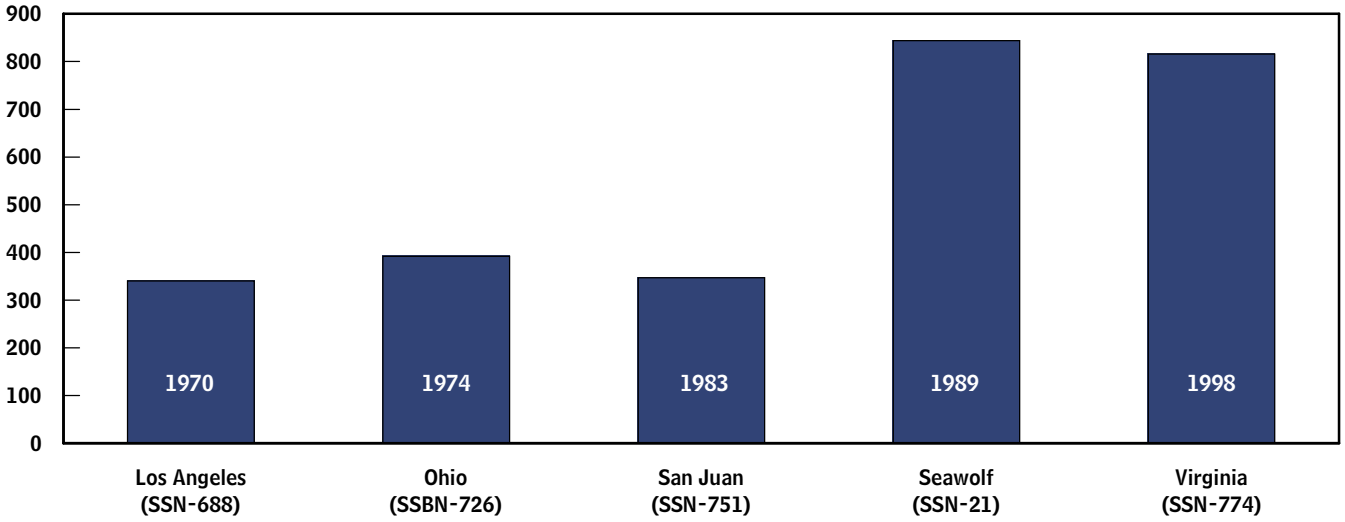
21. For more information, see Ronald O'Rourke, *Navy SSBN(X) Ballistic Missile Submarine Program: Background and Issues for Congress,* Report for Congress R41129 (Congressional Research Service, May 3, 2010); and the statement of Eric J. Labs, Senior Analyst for Naval Forces and Weapons, Congressional Budget Office, before the Subcommittee on Seapower and Expeditionary Forces, House Committee on Armed Services, *The Long-Term Outlook for the U.S. Navy's Fleet* (January 20, 2010).

22. Specifically, the Navy says that to purchase two Virginia class submarines a year, their cost would have to decline to $2.0 billion each in 2005 dollars, which is equivalent to about $2.5 billion in 2010 dollars.

Figure 5.

Cost per Thousand Tons for the Lead Ship of Various Classes of Submarines

(Millions of 2010 dollars)



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 submarine (the first of each class to be built) was authorized.

Costs are per thousand tons of Condition A displacement (the weight of the submarine itself without its crew, materiel, weapons, or fuel), which is roughly analogous to lightship displacement for surface ships.

For the improved Virginia class, the first of which would be built starting in 2025, the Navy abandoned its previous cost-estimating assumption that this ship and the SSBN(X) would share a common hull design that would be about 50 percent larger than that of an existing Virginia class submarine. In the 2011 plan, the Navy apparently assumed that the improved Virginia would be a further evolution of the original Virginia class, which itself regularly receives technological upgrades to its systems and capabilities. Similarly, CBO assumed that the replacement for the Virginia class would incorporate some significant technological improvements that would, in essence, define the improved Virginia as a new class but would not constitute an entirely new design. On the basis of that assumption, CBO estimated that the average cost of the improved Virginia would be about $3.3 billion, or 14 percent more than the Navy's estimate of $2.9 billion.

Large Surface Combatants

The Navy has made significant changes to its procurement goals for cruisers and destroyers since the 2009 plan was issued. The DDG-1000 destroyer program has been cut to 3 ships from 7 under the 2009 plan and from as many as 24 under earlier plans. Plans for the CG(X) future cruiser have been canceled outright. In place of those programs, the Navy is planning to restart production of DDG-51 destroyers, with the first ship funded in the 2010 budget and eight more planned for 2011 to 2015. Beginning in 2016, new DDG-51s would have an upgraded design—a configuration known as Flight III. And in 2032, the Navy would start purchasing the DDG(X), an as-yet-undesigned destroyer intended to replace the DDG-51 class. Those programs, if implemented as planned, would allow the Navy to meet its implied requirement for 88 or more large surface combatants through 2027, although the force would fall below that number thereafter.

DDG-51 Flight IIA. The Navy's existing DDG-51 destroyers were built in three configurations. The first 28 ships, designated Flight I or II, did not include a hangar for embarking helicopters (which play important roles in countering enemy submarines, mines, and small-boat attacks). The next 34 ships were designated Flight IIA, which included a hangar and thus the ability to carry two

helicopters or several ship-launched unmanned aerial vehicles.[23]

Under the Navy's 2011 plan, the new DDG-51s purchased through 2015 would use the Flight IIA configuration but also incorporate the latest ballistic missile defense capabilities.[24] Those ships would have an average cost of a little less than $1.8 billion in CBO's estimation—about $150 million more than the Navy's per-ship estimate. CBO's higher figure stems partly from the expectation that restarting a production line that last received an order in 2005 will cost more than the Navy anticipates.

DDG-51 Flight III. The Navy's strategy to meet combatant commanders' demand for the increased capabilities of ballistic missile defense ships—as well as to replace Ticonderoga class cruisers when they retire in the 2020s—is to modify the DDG-51 destroyer substantially, creating a Flight III configuration. That configuration would incorporate the new Air and Missile Defense Radar (AMDR), now under development, which is larger and more powerful than the radars on earlier DDG-51s. Adding the AMDR would require increasing the amount of power and cooling available on a Flight III ship in order to operate the radar effectively.[25] Those changes, and associated increases in the ship's displacement, would make a DDG-51 Flight III at least $500 million, or about 30 percent, more expensive than a new Flight IIA, by CBO's estimate.[26]

However, there appears to be some question as to whether the hull of the DDG-51 will be able to accommodate the changes envisioned for Flight III. In particular, if the AMDR proved too large to fit inside the deckhouse (the main superstructure above the hull) of a DDG-51 without raising the ship's center of gravity and destabilizing it, the Navy would need to lengthen the ship, further increasing its displacement and cost substantially.

Overall, the Navy plans to buy 24 DDG-51 Flight III ships between 2016 and 2031. If the Navy does not need to lengthen the DDG-51's hull, those Flight IIIs will cost an average of $2.4 billion, CBO estimates, compared with the Navy's estimate of $2.0 billion.

DDG(X) Future Guided Missile Destroyer. Like the Navy's 2009 shipbuilding plan, the current plan includes a future class of destroyers—the DDG(X)—intended to eventually replace the DDG-51s when they retire in the 2030s.[27] However, the 2011 plan has pushed back the start of the DDG(X) program from 2022 to 2032, which means it would be a successor to the DDG-51 Flight III program. Some Navy officials have suggested that the DDG(X) could be based on the hull and design of the DDG-51 class but incorporate technological improvements appropriate to the late 2020s and early 2030s. The Navy's cost estimate for the DDG(X) averages $2.4 billion—20 percent more than for the DDG-51 Flight III—a figure that would not allow for a new design or much increase in size.

CBO, in contrast, assumed that the DDG(X) would have a largely new design and would be about 10 percent larger than a DDG-51 Flight III. By 2032, when the first DDG(X) would be authorized under the current plan, the initial DDG-51 design would be about 50 years old. The Navy has made, and will continue to make, improvements to the DDG-51 class, as the plans for Flight III illustrate. Nevertheless, CBO considers it unlikely that a ship design that originated in the late 1970s and early 1980s will prove robust enough to accommodate changes designed to counter threats at sea until the 2070s and 2080s (when the DDG(X)s would be reaching the end of their notional 35-year service life). As an example, the Navy has limited ability to improve the stealthiness of the

23. For a detailed discussion of the differences between the DDG-51 flights, see Norman Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet* (Washington, D.C.: Naval Institute Press, 2005), pp. 147–152.

24. The Navy has announced that all existing DDG-51s will eventually be equipped with improved ballistic missile defenses; up to 16 of those upgrades will have been funded by the end of 2010. For more about the Navy's plans for the DDG-51 program, see Ronald O'Rourke, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress,* Report for Congress RL32109 (Congressional Research Service, April 8, 2010).

25. See Ronald O'Rourke, *Navy Aegis Ballistic Missile Defense Program: Background and Issues for Congress,* Report for Congress RL33745 (Congressional Research Service, April 26, 2010).

26. As a point of comparison, the Navy's first Flight IIA ship, the DDG-79, which incorporated such changes as a helicopter hangar and a larger displacement, cost about 20 percent more than the DDG-78. The transition from the Flight IIA to Flight III ships is expected to involve much more extensive changes than the transition from the Flight I/II to Flight IIA ships.

27. That retirement date is based on CBO's and the Navy's assumption that all Flight IIA DDG-51s will be modernized midway through their service life and will operate for 40 years.

DDG-51 class if it does not redesign the hull—and if it does, it will, in effect, have designed an entirely new ship.

Under those assumptions, CBO projects the average cost of the DDG(X) at $4.0 billion. That figure is about two-thirds greater than both the Navy's current estimate and CBO's previous estimate (under the 2009 plan). The difference between CBO's estimates of the cost of the future destroyer under the 2011 and 2009 plans is largely attributable to two factors. First, because the current plan would delay the DDG(X) program for 10 years, those ships would be purchased in a period when the higher average inflation in naval shipbuilding would have a greater cumulative effect. Second, under that plan, the Navy would procure only two DDG(X)s per year, one each from two different shipyards, meaning that a shipyard's full annual overhead costs for the destroyer would not be spread among multiple ships, so there would be no benefit from a rate effect. (Under the 2009 plan, the Navy would have purchased DDG(X)s at a rate of three per year using two shipyards, so each shipyard would have built an average of more than one ship per year, allowing for a rate effect.)

Littoral Combat Ships

The 2011 plan envisions that the Navy will build a force of 55 littoral combat ships (LCSs) between 2005 and 2031. Because those ships are assumed to have a service life of 25 years, the Navy will need to begin procuring their replacements in 2032. The LCS differs from past and present U.S. warships in that its production program is divided into two components—the sea frame (the ship itself) and mission packages (the main combat systems). The sea frame is being built with the ability to switch mission packages depending on what mission the ship is intended to carry out at a given time. Currently, the Navy expects to use three types of mission packages: for countering mines, submarines, or surface ships. It also expects that the LCS will be able to perform maritime security operations while equipped with any of those mission packages. In all, the service plans to buy 64 mission packages for the 55-ship program.[28]

The Navy wants the LCS to be a relatively affordable ship that will be fairly easy to design and build. However, the program has experienced significant cost growth since its inception. Originally, each sea frame was expected to cost about $270 million in 2010 dollars (or $220 million in 2005 dollars). So far, two LCSs have been built, each by a different contractor using a different design. LCS-1, a semiplaning steel monohull, cost $570 million to build (not including $33 million invested by the contractor); LCS-2, an all-aluminum trimaran (basically, a three-hulled ship), cost $626 million. With outfitting and post-delivery costs added in, as well as some nonrecurring costs to complete the designs (which normally are not considered part of a ship's construction cost), the price tags of those ships rise to about $690 million and $750 million, respectively.

In 2009, when the Navy was authorized to buy two more LCSs, it ordered one of each design. After that, however, it revamped its acquisition strategy in an attempt to counter the cost growth and turmoil in the LCS program. Earlier, the Navy had planned to continue building both designs and have the two contractors compete to see which one would produce the larger number of its type of ship. In the summer and fall of 2009, the Navy changed course and decided instead to select one design for the 15 LCSs it expects to order between 2010 and 2014. The contractor whose design is chosen will get to build 10 ships—2 per year—between 2010 and 2014. In 2012, the Navy will accept bids on 5 more ships of the same design (1 authorized in 2012 and 2 each in 2013 and 2014) from any other shipbuilder except the one constructing the first group of 10 LCSs. The Navy hopes that strategy will lead to a competitive environment for LCS purchases in 2015 and beyond, thus lowering costs.

In the 2011 FYDP and shipbuilding plan, the Navy estimated the average cost of the LCS at about $600 million per ship. That figure is well above the Congressionally mandated cost cap for the LCS program ($480 million per ship, adjusted for inflation).[29] However, in a briefing to CBO and the Congressional Research Service, Navy officials said that with the new acquisition strategy, they fully expect the first group of 10 new ships to cost an average of less than $600 million apiece.

28. Department of the Navy, *Report to Congress: Littoral Combat Ship Mission Packages* (May 2009).

29. The National Defense Authorization Act for Fiscal Year 2010 (Public Law 111-84), which set the LCS cost cap to begin in 2011, gave the Secretary of the Navy authority to waive compliance with the cap if doing so was considered in "the best interest of the United States," if the ship was "affordable, within the context of the annual naval vessel construction plan," or in certain other circumstances.

CBO estimates the average per-ship cost of the 49 LCSs in the plan at $550 million, not counting outfitting and postdelivery costs. That figure is slightly smaller than CBO's previous estimates.[30] The reduction is based on the Navy's new acquisition strategy and on additional information about the construction costs of the first two LCSs. CBO expects that some of the ships in the first group of 10 LCSs will come in under the Congressional cost cap (because the cap is adjusted for inflation each year and excludes outfitting and postdelivery costs).

Besides the change in acquisition strategies that the Navy announced last year, the 2011 shipbuilding plan substantially slows the planned procurement rate for LCSs. Under the 2009 plan, the Navy would have bought 55 LCSs by 2019, and all of them would have been in service by 2023. To achieve that, the Navy would have purchased the ships at a rate of 6 per year through most of the current decade. Under the 2011 plan, by contrast, the Navy would purchase up to 4 LCSs a year between 2013 and 2015, 3 per year thereafter, and then 1 or 2 per year starting in 2020. As a result, the service would not achieve a force of 55 LCSs until 2035—12 years later than under the 2009 plan.

The Navy would also buy fewer next-generation littoral combat ships—called LCS(X)s—under the 2011 plan because it would not need to replace the original ships as quickly as it would have with the faster procurement rate of the 2009 plan. The Navy's current cost estimate for the LCS(X) is $600 million, the same as for the LCS, implying that the new class would have no improvements over the old one. CBO assumed, however, that the LCS(X) would have improvements compared with the LCS and thus estimated the average cost of the LCS(X) at about $700 million.

Amphibious Ships

In the 2011 shipbuilding report, the Navy implies that the new requirement for its amphibious force will be 33 ships, up from 31 previously.[31] The proposed force would consist of 11 LHA or LHD amphibious assault ships, 11 LPD amphibious transport docks, and 11 LSD dock landing ships. In pursuit of that force, the 2011 plan calls for buying 3 LHA-6s (in 2011, 2016, and 2021) as well as 4 LH(X)s (in the 2020s and 2030s) to replace LHD-1 class amphibious assault ships. The plan also envisions buying 1 more LPD-17 class amphibious transport dock (in 2012) and 12 LSD(X) dock landing ships (one every other year between 2017 and 2039) to replace existing LSD-41s and LSD-49s. With that procurement schedule, however, the total number of amphibious ships would be below the implied 33-ship requirement from 2011 to 2015 and again from 2032 to 2040.

The 2011 plan would also cancel the Navy's proposed Maritime Prepositioning Force (Future) program. Instead, the service would acquire some of the capabilities associated with the MPF(F) and incorporate them into the three existing maritime prepositioning squadrons. The resulting formations would be hybrid squadrons: They would not have all of the capabilities of the MPF(F) that the Navy and Marine Corps have been calling for over the past decade, but they would have more flexibility to selectively unload certain kinds of equipment from the existing prepositioning squadrons.

The Navy's cost estimates for amphibious ships have changed significantly since the 2009 plan. The most important underlying reason is that in that plan, the Navy assumed that the LSD(X) future dock landing ship would be based on the hull of the LPD-17, which costs about $1.8 billion today and displaces about 25,000 tons. In the 2011 plan, the Navy assumed that the LSD(X)s would instead be about the same size as existing LSDs—that is, have a displacement of about 16,000 tons. Consequently, the Navy's estimate for the LSD(X) fell from $2.5 billion per ship to $1.3 billion per ship. (The Navy's apparent change in its treatment of inflation for the 2011

30. CBO estimated, in "Resource Implications of the Navy's Fiscal Year 2009 Shipbuilding Plan" and *Options for Combining the Navy's and the Coast Guard's Small Combatant Programs* (July 2009), that LCSs would cost an average of $570 million per ship (or $550 million in 2009 dollars). That estimate included some outfitting and postdelivery costs.

31. Specifically, the report says that 33 is the minimum number of amphibious ships needed for the "Assault Echelon in a 2 Marine Expeditionary Brigade forcible-entry operation"; see Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2011*, p. 15. The increase in the requirement for amphibious ships was not unexpected: The Navy's 2009 plan had suggested that the requirement would be changed to 33 in the future.

plan and the assumption that a ship built in the future would cost the same amount as a ship built today probably played a role as well; a 32 percent reduction in weight alone does not explain a 48 percent reduction in cost.) CBO likewise assumed that the LSD(X) would be smaller than previously expected, but it estimated the ship's average cost at $1.7 billion, 29 percent less than its estimate under the 2009 plan.

The Navy has also changed its cost estimates for LHA-6 and LH(X) class amphibious assault ships from $4.5 billion in the 2009 plan to $3.4 billion now, a decrease of 25 percent. The Navy currently assumes that the LH(X)s will be the same size as the LHA-6s, whereas the LH(X)s envisioned in the 2009 plan were slightly larger. As was the case with the LSD(X)s, the change in how the Navy treats shipbuilding inflation probably also had an effect on costs. However, it seems unlikely that both causes could account for the full $1.1 billion reduction in per-ship costs.

CBO's estimate for amphibious assault ships is higher than the Navy's: an average of $4.2 billion per ship, about 10 percent less than its estimate under the 2009 plan. CBO assumed that the LHA-6s and LH(X)s would be the same size as the first LHA-6, which was authorized in 2007 and is currently under construction. CBO also assumed that the last LHA-6 and the LH(X)s would include well decks, necessitating some redesign to the LHA-6 class and thus additional costs. (Well decks are large floodable areas in the sterns of most amphibious ships that allow amphibious vehicles and craft to be launched directly from the ships.) The cost of that redesign is included in CBO's estimate for the LHA-6 to be purchased in 2021. In briefings to CBO, however, some Marine Corps officials have said they would like to see a well deck installed in the 2017 ship as well.