Congressional Budget Office

Testimony

Costs of Building a 355-Ship Navy

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Notes

Unless otherwise indicated, all dollar amounts in this testimony are expressed in constant 2017 dollars and all years are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end.

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

Chairman Wicker, Senator Hirono, and Members of the Subcommittee, thank you for the opportunity to testify on the Navy's goal of building a 355-ship fleet, as outlined in its 2016 force structure assessment. My submitted statement today reprises the Congressional Budget Office's report titled *Costs of Building a 355-Ship Navy*, which was released on April 24, 2017.[1]

Summary

In December 2016, the Navy released a new force structure assessment (FSA) that called for a fleet of 355 ships—substantially larger than the current fleet of 275 ships and also larger than the Navy's previously stated goal of 308 ships.[2] In response to a request from the Subcommittee on Seapower and Projection Forces of the House Committee on Armed Services, the Congressional Budget Office has estimated the costs of achieving the Navy's objective within 15, 20, 25, or 30 years. As part of its analysis of those alternatives, the agency assessed the implications of building and operating a 355-ship fleet, including the number of ship purchases that would be necessary, prospective inventory levels, personnel requirements, and effects on the shipbuilding industry.

To enlarge the Navy to 355 ships would require a substantial investment of both money and time. CBO estimates that the earliest the Navy could achieve its goal of a 355-ship fleet would be in 2035, or in about 18 years, provided that it received sufficient funding. However, the cost to build and operate a 355-ship fleet would average $102 billion per year (in 2017 dollars) through 2047, CBO estimates, or more than one-third greater than the amount appropriated for fiscal year 2016 for today's 275-ship fleet. On average under CBO's alternatives, shipbuilding costs would be at their highest point over the next 10 years, while operating costs would be highest between 2037 and 2047, once the fleet numbered 355 ships.

Shipbuilding Costs

CBO estimates that, over the next 30 years, meeting the 355-ship objective would cost the Navy an average of about $26.6 billion (in 2017 dollars) annually for ship construction, which is more than 60 percent above the average amount the Congress has appropriated for that purpose over the past 30 years and 40 percent more than the amount appropriated for 2016. By comparison, CBO estimates that the Navy's 2017 shipbuilding plan—which is based in part on the 308-ship goal outlined in the service's 2014 FSA—would cost an average of $21.2 billion per year to implement over the next 30 years. However, the Navy's 2017 shipbuilding plan would fall short of the 308-ship force goal in 22 of the next 30 years.[3]

To establish a 355-ship fleet, the Navy would need to purchase around 329 new ships over 30 years, compared with the 254 ships that would be purchased under the Navy's 2017 shipbuilding plan (see Table 1).[4] In particular, over the next five years, the Navy would purchase about 12 ships per year under CBO's alternatives compared with about 8 per year under the Navy's 2017 plan.[5] Over the next 30 years, buying additional fixed-wing aircraft and helicopters to outfit the additional 63 ships would require $15 billion more than the Navy would spend on aircraft under its existing plan. Those costs do not reflect the additional weapons or unmanned systems that the Navy would need to purchase to arm the new ships or

1. See Congressional Budget Office, *Costs of Building a 355-Ship Navy* (April 2017), www.cbo.gov/publication/52632.

2. See Department of the Navy, Executive Summary, *2016 Navy Force Structure Assessment (FSA)* (December 15, 2016), http://tinyurl.com/zgdk5o7. The 2016 FSA does not describe the annual ship purchases or costs needed to reach 355 ships. Such information presumably would be forthcoming when the Navy releases its next long-term shipbuilding plan. For further discussion, see Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress,* Report for Congress RL32665 (Congressional Research Service, February 2, 2017).

   The Navy's previously stated goal of 308 ships was described in a 2014 update to its 2012 force structure assessment, which CBO refers to in this testimony as the 2014 FSA.

3. See Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2017 Shipbuilding Plan* (February 2017), www.cbo.gov/publication/52324. That report estimated that the Navy's 2017 shipbuilding plan would cost $20.7 billion per year in 2016 dollars. Adjusting that figure for inflation yields a cost of $21.2 billion in 2017 dollars. See also Department of the Navy, *Report to Congress: Force Structure Assessment* (February 2015).

4. See Department of the Navy, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2017* (July 2016), https://news.usni.org/2016/07/12/20627.

5. According to recent press reports, an internal Navy memorandum lays out an accelerated shipbuilding plan that would purchase an average of about 12 ships per year over the next five years. See Lee Hudson, "Proposed Navy Shipbuilding Plan Adds 23 Ships in Five Years," *Inside the Navy* (April 10, 2017), http://tinyurl.com/nxkvpwc. The accelerated shipbuilding plan most closely resembles CBO's 20-year buildup over the first five years.

Table 1.

Implications of Building a 355-Ship Fleet Under CBO's Four Alternatives Compared With the Navy's 2017 Shipbuilding Plan

	355-Ship Fleet[a]	The Navy's 2017 Shipbuilding Plan[b]
	Purchases	
Combat Ships		
Aircraft carriers	10	6
Ballistic missile submarines	12	12
Attack submarines	60 to 63	44
Large surface combatants	90 to 91	66
Small surface combatants[c]	68	58
Amphibious warfare ships	30	23
Subtotal	271 to 273	209
Combat Logistics and Support Ships	57	45
Total	328 to 330	254
	Costs (Billions of 2017 dollars)	
Total Shipbuilding Cost Over 30 Years	794 to 801	637
Average Annual Cost	26.5 to 26.7	21.2
New-Ship Construction	766 to 773	580
Average Cost per Ship[d]	2.3	2.3
Increase in Annual Operation and Support Costs by 2047 Compared With Today's Fleet	About 38	About 23
	Personnel	
Increase in Sailors Assigned to Ships Compared With Today's Fleet	About 19,000[e]	About 6,000[f]
Increase in Total Military and Civilian Personnel Compared With Today's Fleet	About 48,000[e]	About 14,000[f]
	Year All Force Goals for a 355-Ship Fleet Are Met Under CBO's Alternatives	
15-Year Buildup	2035[g]	n.a.
20-Year Buildup	2037	n.a.
25-Year Buildup	2042	n.a.
30-Year Buildup	2047	n.a.

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

n.a. = not applicable.

a. The ranges in this column reflect differences among CBO's paths to building a 355-ship fleet in four time frames—15, 20, 25, and 30 years.

b. The Navy's 2017 shipbuilding plan is based in part on a 308-ship force goal, which was described in a 2014 update to the 2012 force structure assessment. The 2017 plan, however, falls short of the 308-ship force goal in 22 of the 30 years covered by the plan.

c. Under the 2017 plan, the Navy would have 40 small surface combatants in service after 2029. However, because each of those ships is expected to be in service for 25 years, the Navy would begin buying replacements in 2030.

d. Average ship costs are calculated using new-ship construction amounts only.

e. The additional personnel is based on the number of sailors when the fleet would reach 355 ships.

f. The additional personnel is based on the number of sailors when the fleet would reach 308 ships.

g. With the exception of attack submarines, the fleet reaches all force goals in 2032.

the cost of improvements to the shipyards that would be needed to build ships at higher rates. (The effects on the shipbuilding industry of establishing a larger Navy are discussed in more detail below.)

Operating Costs

In addition to the costs of building 329 new ships, a larger fleet would cost more to operate: More ships would require more sailors; recruiting and training those sailors would require more civilian and military positions onshore; additional ships would lead to larger maintenance budgets; and those extra ships and crews would consume more fuel and supplies, during both training exercises and deployments. According to CBO's analysis, by 2047, the annual cost in 2017 dollars of operating the Navy's 355-ship fleet—regardless of whether the buildup took 15 or 30 years—would be about $38 billion (or 67 percent) more than the $56 billion the fleet of 275 ships costs annually to operate today. CBO's projection of the steep increase in operating costs by 2047 results both from having a larger fleet and from the expectation that operation and support costs would grow faster than general inflation in the economy. Under the smaller buildup proposed in the Navy's 2017 shipbuilding plan, annual costs would also rise by 2047, by about $23 billion.

Total Costs

CBO estimates that the cost to build, crew, and operate a 355-ship fleet would average $102 billion per year through 2047. That amount would be 13 percent more than the $90 billion needed to build and operate the fleet envisioned in the Navy's 2017 shipbuilding plan.

Effects of Reaching 355 Ships More Quickly

CBO analyzed four alternatives that would expand the fleet to 355 ships over different time frames: 15, 20, 25, and 30 years. Under each alternative, construction of the additional ships would begin in 2018. The major difference among those alternatives is the timing of when the fleet would reach 355 ships and, thus, when the money to build, crew, and operate those fleets would need to be appropriated. Exactly when the fleet reached the 355-ship goal would not have a significant effect on total 30-year costs in real (inflation-adjusted) terms. For example, buying more ships earlier in the 15-year time frame would mean that those ships would be slightly less expensive to build (because ships would be constructed at more efficient rates and the real cost growth in the shipbuilding industry would be lower than in later years); but establishing a larger fleet earlier would lead to higher operating costs.[6] In addition, in comparison with the 30-year buildup, shipbuilding budgets would need to be significantly higher in the 2020s for the 15-year alternative. Finally, building the fleet more quickly would pose much greater, but not insurmountable, challenges for the shipbuilding industry.

How Does the Navy's New 355-Ship Goal Compare With Earlier Plans?

In general, the 2016 FSA maintains what the Navy calls a balanced fleet. It does not substantially change the relative proportion of the different major components of the battle force: aircraft carriers, submarines, surface combatants, amphibious ships, and combat logistics and support ships. That composition has varied little since 1990 (see Figure 1). The major difference between the Navy's 355-ship goal and its prior 308-ship goal is one of scale. The new goal represents an increase of 15 percent over the Navy's previous FSA and an increase of nearly 30 percent over the current fleet of 275 ships. The composition of the 355-ship fleet would be roughly the same as today's fleet, which proportionately has slightly fewer surface combatants and more combat logistics and support ships than are called for in the 2016 FSA. Compared with an across-the-board percentage increase relative to the 2014 FSA, the new goal would increase the number of attack submarines slightly and reduce the number of small surface combatants. Because the goal for ballistic missile submarines is determined in part by a separate process that analyzes the requirements for all U.S. strategic nuclear forces, the number of ballistic missile submarines was unchanged in the 2016 FSA, effectively reducing their percentage of the fleet relative to the 2014 FSA and today's fleet.

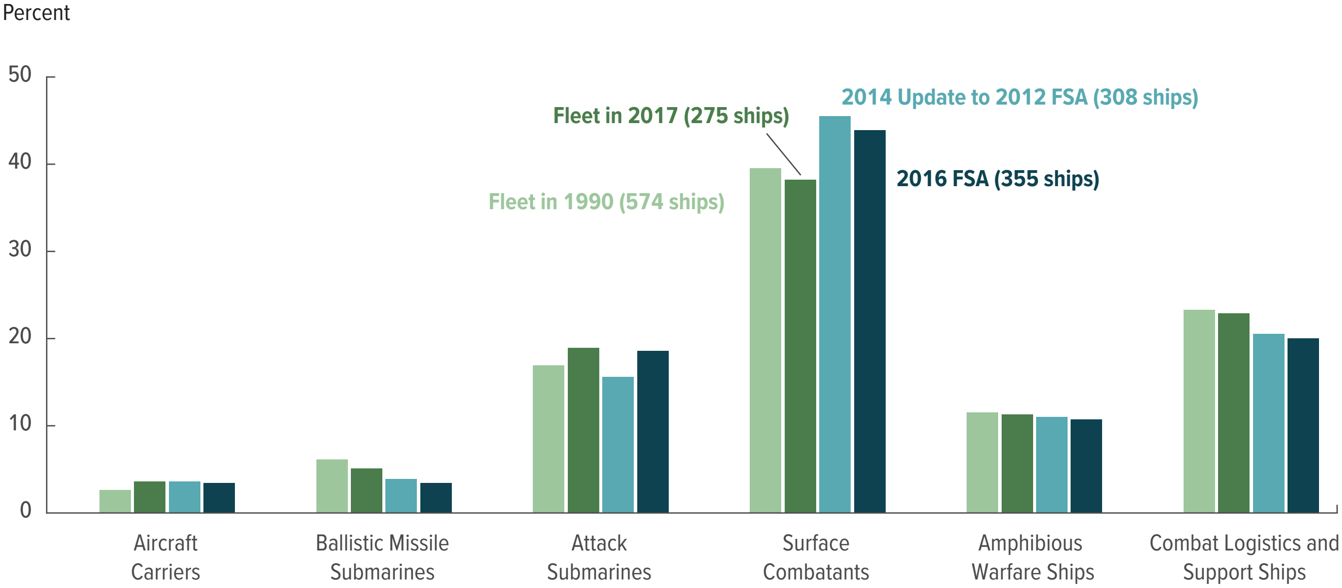
How Quickly Might the Navy Reach Its New 355-Ship Goal?

CBO projected notional ship construction schedules that would allow the Navy to achieve a fleet of 355 ships in 20, 25, or 30 years, but it would fall short of that goal in 15 years (see Figure 2). Specifically, meeting the objective of 66 attack submarines in 15 years is not realistic because the capacity of the submarine-building industry is limited. Consequently, the 15-year buildup would yield just 346 ships by 2032, including 56 attack

6. For a discussion of real cost growth in naval shipbuilding, see Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2017 Shipbuilding Plan* (February 2017), p. 17, www.cbo.gov/publication/52324.

Figure 1.

Composition of the Fleet by Ship Type, Historically and Under Recent Force Structure Assessments



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

FSA = force structure assessment.

submarines. Under the 15-year alternative, the Navy would reach its 355-ship goal for all ship types by 2035. (See the supplemental tables on CBO's website for a year-by-year list of purchases and inventories by ship type.) Under the 20-year buildup, the Navy would achieve its 355-ship goal in 2037. That goal would be reached in 2042 under the 25-year alternative and in 2047 under the 30-year plan. For those three alternatives, the force goals for each ship type would be met within the stated time frame.

How Many Ships Would the Navy Need to Build to Meet Its Goal and How Much Would They Cost?

The total number of ships the Navy would need to purchase to establish and maintain a 355-ship fleet is nearly the same for all four alternatives: 328 to 330 ships. That represents an average construction rate of 11 ships per year over 30 years, although annual rates would differ substantially depending on how quickly the Navy tried to reach its goal. The costs of implementing those plans would average about $26.6 billion per year for ship construction over the entire 30-year period. Compared with the last buildup of the Navy—the Reagan Administration's drive to have a 600-ship Navy in the 1980s—a plan to build a 355-ship fleet would buy fewer ships. However, because the average price of constructing a Navy ship—and the capabilities on those ships—has risen since then, even after removing the effects of inflation, average shipbuilding budgets would need to be almost as high.[7]

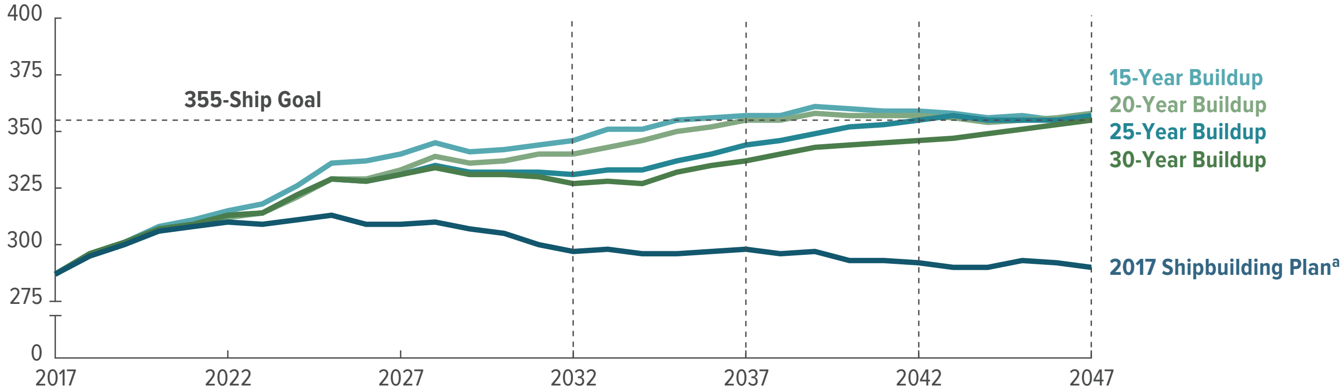
In developing alternative shipbuilding plans, CBO used existing ship designs and production lines for the first 10 years. But because the Navy is not specific about the design of the ships it plans to purchase beyond 2027, CBO made its own assumptions about the size and capabilities of those ships, which are consistent with those the agency made in its analysis of the Navy's 2017 shipbuilding plan.[8]

7. Between 1982 and 1988, the Navy purchased an average of 18.4 ships per year at an average annual cost of $28.9 billion in 2017 dollars.

8. For example, CBO assumed that in the latter part of the 2020s the Navy would need to design an all-new large surface combatant as well as a new small surface combatant that was similar in size to the retired Oliver Hazard Perry class frigate. See Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2017 Shipbuilding Plan* (February 2017), pp. 29–30, www.cbo.gov/publication/52324. Some senior Navy officials have also argued that to increase the size of the fleet, the Navy

Figure 2.

Annual Inventory of Battle Force Ships Under CBO's Four Alternatives



Source: Congressional Budget Office.

a. The Navy's 2017 shipbuilding plan is based in part on a 308-ship force goal, which was described in a 2014 update to the 2012 force structure assessment. The 2017 plan, however, falls short of the 308-ship force goal in 22 of the 30 years covered by the plan.

Although overall shipbuilding costs would be similar among the alternatives, the timing of those purchases—and thus shipbuilding costs—would vary (see Figure 3). In the first five years, ship purchases would increase from a little more than 8 per year under the Navy's 2017 shipbuilding plan to more than 12 per year under the alternatives. In the mid-2020s, the 15-year buildup, which would entail buying an average of nearly 15 ships per year, would incur the highest costs. The 30-year buildup, the alternative with the lowest costs in that period, would buy 11 ships per year. Shipbuilding budgets in the 2020s would need to be commensurately large: The 15-year buildup would require average shipbuilding budgets of $33 billion per year, compared with $26 billion annually for the 30-year buildup.[9]

Beyond the 2020s, however, ship purchases and shipbuilding costs under all of the alternatives would be more closely aligned, although some variation would remain. By the final five-year period, 2043 to 2047, ship purchases and costs would be about the same under the alternatives to maintain the fleet at 355 ships beyond 2047. Ship purchases would average 11 per year, and shipbuilding costs would average a little more than $26 billion per year across all four alternative plans.

How Would a Larger Fleet Affect Manpower Requirements and Operating Costs?

A larger fleet would require more sailors to crew the additional ships and more personnel (both military and civilian) to support those sailors. Today, the Navy employs about 106,000 men and women to operate the combat ships in its 275-ship fleet and incurs about $23 billion per year in direct operation and support costs. That is the amount of money needed to pay

should use existing ship designs, at least in the near term. See Sydney J. Freedberg, "Build More Ships, But Not New Designs: CNO Richardson on McCain Plan," *Breaking Defense.com* (January 17, 2017), http://tinyurl.com/gmsxhp3. In considering longer-term plans, others envision a future fleet composed of several types of ships that are quite different from those the Navy plans to buy. See Megan Eckstein and Sam LaGrone, "Trio of Studies Predict the U.S. Navy Fleet of 2030," *USNI News* (February 14, 2017), http://tinyurl.com/hv3t77h; and Senator John McCain, *Restoring American Power: Recommendations for the FY 2018–FY 2022 Defense Budget*, https://tinyurl.com/gt8o4cq.

9. CBO estimates the cost of ships on the basis of the relationship between weight and cost of analogous existing ships. The resulting amount is then adjusted for factors such as the production efficiencies that occur as more ships of the same type are built simultaneously at a given shipyard and additional efficiencies that occur as more ships are built over the duration of the production run. CBO also incorporates into its estimates a projection that labor and material costs would continue to grow faster in the naval shipbuilding industry than in the economy as a whole, as they have for the past several decades. For more detail, see Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2017 Shipbuilding Plan* (February 2017), pp. 33–36, www.cbo.gov/publication/52324.

Figure 3.

Average Annual Ship Purchases and Costs of Building a 355-Ship Fleet Under CBO's Four Alternatives and the Navy's 2017 Shipbuilding Plan

Source: Congressional Budget Office.

a. The Navy's 2017 shipbuilding plan is based in part on a 308-ship force goal, which was described in a 2014 update to the 2012 force structure assessment. The 2017 plan, however, falls short of the 308-ship force goal in 22 of the 30 years covered by the plan.

the crews, to buy fuel and supplies, and to repair and maintain the ships. The Navy's combat logistics and support ships employ another 7,600 military and civilian personnel. (Other operation and support expenses, such as indirect costs—which include operating the combat logistics and support ships—and overhead costs, are discussed below.) When the Navy designs and builds new classes of ships, it endeavors to reduce the size of the crews of those new ships to reduce operating costs. However, even if all new ship classes had smaller crews than their predecessors, increasing the fleet to 355 ships—a nearly 30 percent increase over today's fleet—would require more personnel.[10]

According to CBO's estimates, the combat ships of a 355-ship fleet would need crews totaling about 125,000 sailors, an increase of 18 percent over today's Navy (see Figure 4). The larger fleet would incur annual direct operation and support costs of about $27 billion. (The combat logistics and support ships that the Navy would include in that larger fleet would require crews of about

10. The Navy's efforts to design ships that require smaller crews have met with mixed results. The new Ford class aircraft carrier

7,400 military and civilian personnel.) Since the 15-year buildup would reach 355 ships by 2035, its operation and support costs would be the highest among the four alternatives, primarily because it would require operating a larger fleet for a longer period of time than the other three. Conversely, the 30-year buildup would cost the least to operate over the entire period because it would not reach 355 ships until 2047, employing fewer sailors overall throughout the period. However, across the alternatives, the differences in costs (which are discussed in more detail in the next section) are relatively small.

What Would Be the Total Average Annual Costs of a 355-Ship Fleet?

Altogether over the 30-year period, the total amount of money the Navy would spend to build up and operate a fleet of 355 ships is about the same across the four alternatives—approximately $102 billion per year, including costs both for ship procurement and for operation and support (see Figure 5). Ship procurement for each alternative would average about $26.6 billion per year between 2018 and 2047. Operation and support costs would average another $75.3 billion per year over the 30-year period. Those totals include direct, indirect, and overhead operating costs. (Direct costs are described above. Indirect costs include expenditures for various support units and organizations that are necessary for combat units to fight effectively. Overhead costs refer to expenditures for various functions that also support combat units, such as recruiting, training, acquisition offices, maintenance, and medical care.)[11] Those totals exclude the costs of aircraft, weapons, and unmanned systems in the average annual totals. However, each of those categories would be about the same under each alternative but higher than they would be under the 2017 shipbuilding plan. The marginal additional costs for purchasing the aircraft needed to equip the airwing that would fly off the additional aircraft carrier and the helicopters that would be carried by the additional surface combatants would total about $15 billion over 30 years, CBO estimates.[12] CBO did not calculate the marginal costs of additional weapons and unmanned systems needed to arm a larger fleet. Those costs could vary considerably depending on how the Navy employed new weapons and unmanned systems in the future.

Overall, total costs through 2047 for the most expensive alternative—the 15-year buildup—would be $3.1 trillion, or $80 billion (3 percent) more than the least expensive alternative, the 30-year buildup. Procurement and operating costs under the four alternatives would total $300 billion to $400 billion more than under the Navy's 2017 shipbuilding plan.

What Would Be the Implications for the Shipbuilding Industry?

All of the Navy's new-ship construction is performed by five large and two smaller private shipyards. Two of the large shipyards are owned by Huntington Ingalls Industries: Ingalls Shipbuilding, which builds large surface combatants and amphibious warfare ships for the Navy, as well as the national security cutter for the Coast Guard; and Newport News Shipbuilding, which builds nuclear-powered aircraft carriers and submarines. (Newport News also refuels those aircraft carriers at the midpoint of their service life, when the reactors typically run out of nuclear fuel.) General Dynamics owns the other three large shipyards: Bath Iron Works, which builds large surface combatants; Electric Boat, which builds nuclear-powered submarines; and National Steel

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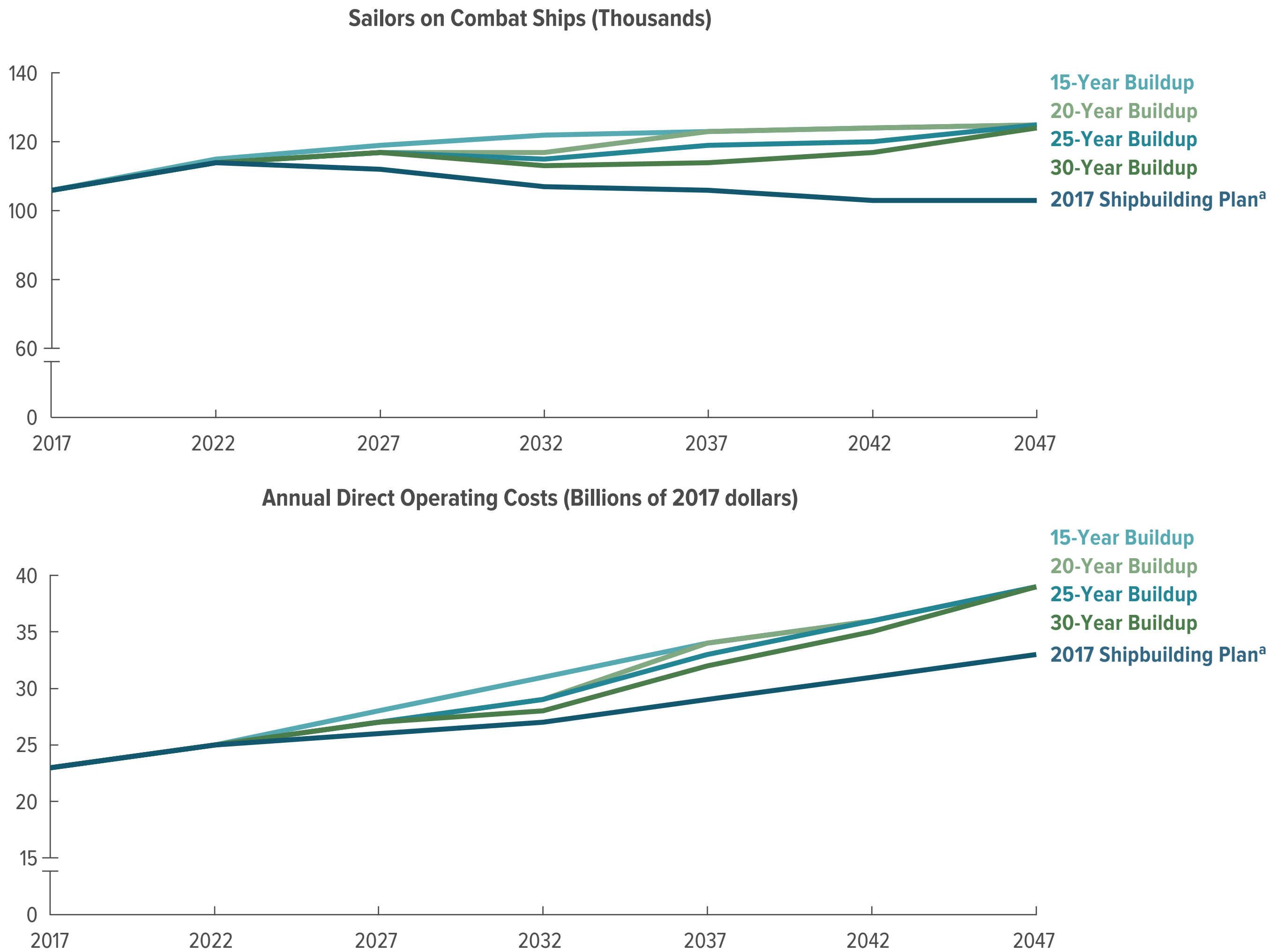
requires 660 fewer crew members than its predecessor, the Nimitz class, a reduction of about 20 percent—although that number may change once the ship is fully tested and operational. The littoral combat ships have small crews, but as a result, they require more support from the Navy's shore-based infrastructure. The new DDG-1000 Zumwalt class destroyer has a crew that is about half the size of a DDG-51Arleigh Burke class destroyer, but it will require years of operation at sea to determine whether a smaller crew can operate and maintain the ship—which is physically 50 percent larger than a DDG-51—as well as a larger crew could. By contrast, the new Columbia class ballistic missile submarine will have only four fewer crew members than the Ohio class it will replace.

11. For operation and support costs, CBO categorized every line item in the Department of Defense's (DoD's) five-year future years defense program, or FYDP, into major combat units, support units, or administrative and overhead organizations. Costs that directly pay for a combat unit, such as an infantry brigade or aircraft carrier, are direct costs. Organizations that support those major combat units, such as intelligence, maintenance, or transport units represent the indirect costs of supporting combat. Finally, administrative or overhead costs include organizations that DoD needs to sustain and support its forces over the long run, such as recruiting and medical organizations that provide health care to active-duty soldiers, reservists, and retirees, and their families. For more detail, see Congressional Budget Office, *The U.S. Military's Force Structure: A Primer* (July 2016), pp. 8–9, www.cbo.gov/publication/51535.

12. The 2016 FSA would increase the number of carriers from 11 to 12 and the number of large surface combatants from 88 to 104.

Figure 4.

Number of Sailors Required to Crew a 355-Ship Fleet and Annual Operating Costs, 2017 to 2047



Source: Congressional Budget Office.

Direct operating costs represent the amount of funding needed to pay crews, buy fuel and supplies, and repair and maintain the combat ships of the Navy's fleet. CBO counts the costs for the combat logistics and support ships as indirect costs and, therefore, their crews and costs are excluded from this figure.

a. The Navy's 2017 shipbuilding plan is based in part on a 308-ship force goal, which was described in a 2014 update to the 2012 force structure assessment. The 2017 plan, however, falls short of the 308-ship force goal in 22 of the 30 years covered by the plan.

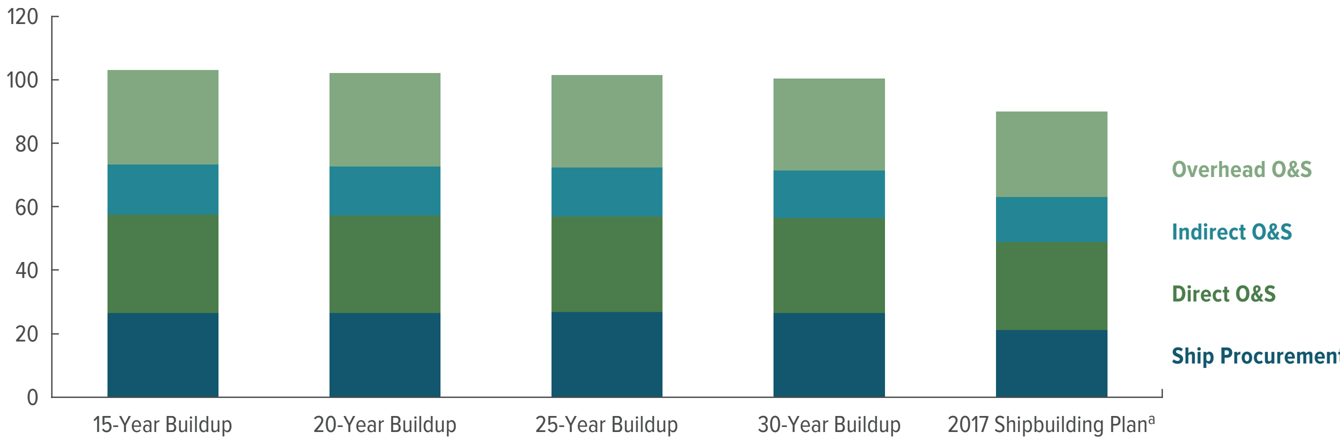
and Shipbuilding Company—better known by its acronym, NASSCO—which builds various types of combat logistics and support ships. The two smaller shipyards are Fincantieri Marinette Marine, which builds the steel monohull variant of the littoral combat ship (with Lockheed Martin as the prime integrator and provider of the combat systems); and Austal USA, which builds the aluminum trimaran version of the littoral combat ship as well as the expeditionary fast transport, which until recently was known as the joint high speed vessel—a fast ferry that the Navy uses for intratheater transport.

Enlarging the fleet to 355 ships would place a higher demand on the shipbuilding services of those seven (and possibly other) shipyards. Over the past decade, the Navy

Figure 5.

Average Annual Ship Construction and Operation and Support Costs for a 355-Ship Fleet Under CBO's Four Alternatives and the Navy's 2017 Shipbuilding Plan

Billions of 2017 Dollars



Source: Congressional Budget Office.

Overhead costs refer to expenditures for various functions that also support combat units, such as recruiting, training, acquisition offices, maintenance, and medical care. Indirect operating costs include expenditures for various support units and organizations that are necessary for combat units to fight effectively. Direct operating costs represent the amount of money needed to pay crews, buy fuel and supplies, and repair and maintain the Navy's combat ships. (CBO counts the costs for the combat logistics and support ships as indirect costs.)

O&S = operation and support.

a. The Navy's 2017 shipbuilding plan is based in part on a 308-ship force goal, which was described in a 2014 update to the 2012 force structure assessment. The 2017 plan, however, falls short of the 308-ship force goal in 22 of the 30 years covered by the plan.

has purchased an average of 8.3 ships per year. Under the four alternatives, average annual shipbuilding rates over the next 10 years would increase to 12 to 15 ships per year. To meet that demand, all seven shipyards would need to increase their workforces and several would need to make improvements to their infrastructure in order to build ships at a faster rate. However, certain sectors face greater obstacles in constructing ships at faster rates than others: Building more submarines to meet the goals of the 2016 force structure assessment would pose the greatest challenge to the shipbuilding industry. Increasing the number of aircraft carriers and surface combatants would pose a small to moderate challenge to builders of those vessels. Finally, building more amphibious ships and combat logistics and support ships would be the least problematic for the shipyards. The workforces across those yards would need to increase by about 40 percent over the next 5 to 10 years. Managing the growth and training of those new workforces while maintaining the current standard of quality and efficiency would represent the most significant industrywide challenge. In addition, industry and Navy sources indicate that as much as $4 billion would need to be invested in the physical infrastructure of the shipyards to achieve the higher production rates required under the 15-year and 20-year buildups. Less investment would be needed for the 25-year or 30-year buildups.

Submarines

The Navy's 2017 shipbuilding plan already posed a considerable challenge to the submarine-building industry. Currently, the Navy purchases 2 Virginia class attack submarines (SSNs) per year. In 2019, the Navy plans to enlarge the ships by about 30 percent by inserting what the service calls the Virginia payload module (a new section to carry additional missiles or unmanned systems) in each new SSN. The Navy is also starting the new Columbia class ballistic missile submarine (SSBN), with design work and the procurement of items with long lead times occurring between 2017 and 2020. Full construction of the first Columbia, which is two and a half times larger than a Virginia, is slated to begin in

2021. Thus, under the Navy's 2017 plan, the workload in the submarine-building yards was already expected to double with the Columbia class, even though the Navy would reduce purchases of Virginia class submarines to 1 per year in each year it purchased a new SSBN.

Although the Navy and the submarine industry have been planning for this increase in production for several years, the first Columbia SSBN will be the most technically challenging lead ship the Navy will build over the next 20 years. Maintaining SSN production at 2 submarines per year or increasing to 3 or 4 per year while the Navy is building the Columbia class would require a substantial increase in the workforces at both Electric Boat and Newport News as well as substantial investment in their infrastructure over the next 5 to 10 years. Notably, the investment required to maintain a production rate of 2 SSNs per year would be a fraction of that needed to build 3 or 4 SSNs per year while building the new SSBN at the same time.

Of the four alternatives, the 15-year buildup would present the greatest challenge. CBO's analysis of that quick buildup is based on the assumption that the industry would continue building 2 SSNs per year through 2022, ramp up to 3 per year from 2022 through 2024, and then increase further to 4 per year from 2025 through 2028. (Under the Navy's plan for the Columbia class, the first ship would be ordered in 2021, but the second SSBN would not be ordered until 2024 and the third not until 2026.) Even with that aggressive building schedule, the Navy would not meet its goal of 66 attack submarines until 2035. Such a steep increase in construction has two advantages: The Navy would meet its goal of 66 SSNs more quickly, and the unit costs of the submarines could be reduced by spreading the shipyards' fixed overhead costs among more ships. One disadvantage of such a steep increase in SSN construction is that the need to train the large number of new employees could lead to production inefficiencies, such as correcting work that was not done properly the first time (called rework), schedule delays, and potentially increased costs. Another disadvantage would be that by 2031 an equally steep decline in submarine construction would occur with the procurement rate falling back to 1 per year, if the Navy did not want to increase the size of the force above 66 SSNs.

None of the other three alternatives would necessitate building 4 SSNs per year to meet the goal of 66 attack submarines in the stated time frame. The 20-year buildup would require the Navy to purchase 3 submarines per year from 2022 through 2031 (with the exception of 2024 when only 2 would be purchased). The 25-year buildup would increase SSN construction to 3 per year in 2026 for six years. And the 30-year buildup would build two SSNs per year except in 2029 and 2031, when 3 ships would be ordered in those years, and in 2034, when 1 ship would be ordered as the start of a new class of SSNs.

Aircraft Carriers

To achieve the Navy's goal of a 12-carrier force, construction of those ships would have to move from today's rate of 1 every five years (called five-year centers) to 1 every three years (or three-year centers). Once the carrier force reached 12, however, the Navy could build carriers on four-year centers to maintain that level over the long-term. Under the 15-year buildup, the Navy would need to move to three-year centers after 2018, when it plans to order the next aircraft carrier. For the other alternatives, CBO used a transition period of four-year centers initially and then three-year centers. Thus, under both the 20-year and 25-year buildups, the Navy would purchase 1 carrier in 2018, 1 in 2022, and then 1 every three years thereafter. For the 30-year buildup, the Navy would purchase 1 carrier per year in 2018, 2022, and 2026, and then 1 every three years.

Moving from five-year centers to three would most likely result in more efficient carrier production and, potentially, slightly reduced costs for the ships. Initially, faster carrier production would require a larger workforce and a modest expansion of the infrastructure at Newport News. But with faster production and a larger workforce, the shipyard's average worker would have to perform fewer types of tasks, although with greater frequency, thereby enhancing efficiency. Also, three-year centers could make it easier for the Navy to purchase materials for more than 1 ship at a time, potentially generating other savings that would result from bulk purchases of materials.[13] However, because it was unclear how much savings would be possible by moving to three-year centers, CBO did not incorporate those savings into its estimates.

13. A RAND report came to similar conclusions. See John F. Schank and others, *Modernizing the U.S. Aircraft Carrier Fleet: Accelerating CVN 21 Production Versus Mid-Life Refueling* (RAND Corporation, 2005), http://www.rand.org/pubs/monographs/MG289.html.

Surface Combatants

In the four alternatives, the most ambitious program for surface combatants would be to build 4 large surface combatants per year (2 in each shipyard) and 4 small surface combatants per year (also 2 in each yard). For both Ingalls and Bath, as well as Marinette Marine and Austal USA, that would double the number of ships that they are currently authorized to build annually. For both Ingalls and Bath, producing 2 large surface combatants per year would require those shipyards to enlarge their workforces slightly and make some modest improvements in their infrastructure. (Each yard has underused infrastructure capacity because they are producing only 1 large surface combatant per year.) For Austal and Marinette, both yards were producing 2 small surface combatants (littoral combat ships) per year from 2012 to 2014, and then 3 ships were split between the two yards in 2015 and 2016. Thus, building 4 small surface combatants a year would simply return the production rate of those ships to the point that it was from 2012 to 2014.

Amphibious Warfare Ships

Ingalls Shipbuilding is the only producer of both large and small amphibious warfare ships, although other yards could produce those ships if it was necessary or cost-effective to do so. As is the case with builders of small surface combatants, Ingalls's amphibious warfare ship lines have excess capacity. Currently, the Navy is purchasing large deck amphibious assault ships (LHAs) on four-year centers; however, Ingalls's facilities are optimized to build LHAs on three-year centers. Moreover, under the Navy's 2017 plan, there would be a seven-year gap after the next ship is ordered in 2017. In addition, the small deck amphibious warfare ships—amphibious transport docks (LPD-17s) and the future replacement for dock landing ships (LX-Rs)—are being built at a rate of one every two years, sometimes less frequently. Building 1 of those ships every year would result in more efficient production without requiring an expansion of Ingalls's workforce or facilities. Building LHAs on three-year centers and 1 LPD or LX-R per year or every two years would meet the Navy's goal of having 38 amphibious warfare ships by 2025 under all four alternatives.

Combat Logistics and Support Ships

Over the past 20 years, NASSCO has won all contracts to build the Navy's oilers, dry cargo ships, and other large support ships, such as expeditionary sea bases (formerly called afloat forward staging bases) or expeditionary transfer docks (formerly called mobile landing platforms). Building those ships at a rate of 1 or 2 per year, which is all that would be required under the four alternatives, is consistent with NASSCO's production in the recent past. Compared with the work it would likely receive under the Navy's 2017 shipbuilding plan, NASSCO would need to enlarge its workforce and would probably need some modest investment in its infrastructure. But the increase in the workforce would be similar to (or less than) an increase NASSCO underwent between 2014 and 2015.

This testimony reprises the Congressional Budget Office's report *Costs of Building a 355-Ship Navy*, which was released on April 24, 2017. The report was prepared at the request of the Chairman and Ranking Member of the Subcommittee on Seapower and Projection Forces of the House Committee on Armed Services. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Eric J. Labs wrote the report with guidance from David Mosher and Edward Keating. Raymond Hall produced the ship cost estimates with guidance from Sarah Jennings. Emily Stern of CBO provided comments on the report, as did Mandy Smithberger of the Project on Government Oversight and Bryan Clark of the Center for Strategic and Budgetary Assessments. (The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.)

Wendy Edelberg and Jeffrey Kling reviewed the report on which this testimony is based, Loretta Lettner edited it, and Jorge Salazar prepared it for publication. Electronic versions of this testimony and the report are available on CBO's website (www.cbo.gov/publication/52911 and www.cbo.gov/publication/52632, respectively).