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Navy Ship Acquisition: Options for Lower-Cost Ship Designs—Issues for Congress

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Summary

Rising procurement costs for Navy ships are a matter of concern for both Navy officials and Members of Congress who track Navy-related issues. The Congressional Budget Office (CBO) estimates that executing the 30-year shipbuilding plan that the Navy submitted to Congress in early 2006 may require annual funding levels about 33% higher than the Navy plans, and about 76% more than the Navy has received on average in recent years. The issue for Congress is how to respond to rising Navy ship procurement costs.

Aside from reducing planned ship procurement rates, one option would be to reduce Navy ship procurement costs by shifting from currently planned designs to designs with lower unit procurement costs. Lower-cost ship designs have been proposed in recent reports by the CBO, Department of Defense's Office of Force Transformation (OFT), and the Center for Strategic and Budgetary Assessments (CSBA).

Options for lower-cost submarines include a non-nuclear-powered submarine and a reduced-cost SSN design using new technologies now being developed. Options for lower-cost aircraft carriers include a medium-sized, conventionally powered carrier and a small, high-speed carrier. Options for lower-cost major surface combatants include a new-design 11,000-ton cruiser-destroyer, a 6,000-ton frigate (FFG(X)), or a lower-cost gunfire support ship. Options for a lower-cost smaller surface combatant include a 1,000- or 100-ton surface ship.

FY2007 Defense Authorization Act (H.R. 5122/P.L. 109-364). Section 121 of P.L. 109-364 (conference report H.Rept. 109-702 of September 29, 2006) authorizes 4-year incremental funding for the CVN-21 class aircraft carriers CVN-78, CVN-79, and CVN-80. Section 122 establishes unit procurement cost caps for CVN-21 class aircraft carriers. Section 123 increases a previously legislated procurement cost cap for the CVN-77 aircraft carrier. Section 125 establishes a unit procurement cost cap for LHA(R) amphibious assault ships. Section 126 establishes unit procurement cost caps for four LPD-17 class amphibious ships. Section 215 authorizes $4 million for implementing or evaluating Navy shipbuilding technology proposals under the Defense Acquisition Challenge Program. Section 1016 directs the Navy to conduct an assessment of naval vessel construction efficiencies and of the effectiveness of special contractor incentives. The sections establishing new procurement cost caps allow the caps to be adjusted upward for inflation and other factors.

This CRS report will be updated when events warrant.

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Introduction and Issue For Congress

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The issue for Congress is how to respond to rising Navy ship procurement costs. Congress's decisions on this issue could affect future Navy capabilities, Navy funding requirements, and the shipbuilding industrial base.

Aside from reducing planned ship procurement rates, options for responding to rising Navy ship procurement costs include the following:

- increasing annual Navy ship-procurement funding;
- changing the way Navy ships are funded in the budget;
- making greater use of multiyear procurement (MYP) in Navy ship-procurement;
- changing the acquisition strategy for building certain Navy ships;
- taking steps to reduce the amount of shipyard fixed overhead costs that are incorporated into the procurement costs of Navy ships;
- improving the operating efficiency of yards building Navy ships;
- building ships without some of their planned equipment (or with less expensive substitute equipment); and
- building ships in foreign shipyards where construction costs may be lower to due lower wages and material prices or other factors.

For additional comments relating to these options, see **Appendix**.

An additional option, particularly if the above options are not implemented or prove insufficient, would be to reduce Navy ship procurement costs by shifting from currently planned designs to designs with lower unit procurement costs. This report focuses on this option.

The following section of the report provides background information on notional options for lower-cost attack submarines, aircraft carriers, larger surface combatants, and smaller surface combatants. The section that follows discusses issues that Congress may consider in assessing the merits—the potential advantages and disadvantages—of shifting to lower-cost designs. The final section of the report reviews recent legislative activity relating to rising Navy ship procurement costs.

[1] For details on the CBO estimate, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Background

Recent Reports Proposing Lower-Cost Designs

Lower-cost designs for attack submarines, aircraft carriers, larger surface combatants, and smaller surface combatants have been proposed in recent reports on the future of the Navy by the CBO,[2] DOD's Office of Force Transformation (OFT),[3] and an independent policy-research organization called the Center for Strategic and Budgetary Assessments (CSBA).[4] Several of the lower-cost ship designs discussed below are taken from these reports.

Basic Approaches For Arriving At Lower-Cost Designs

Options for lower-cost Navy ship designs can be generated by starting with currently planned Navy ship designs and making one or more of the following changes:

- **Reducing ship size.** For a given type of ship, procurement cost tends to be broadly proportional to ship size. Reducing ship size can thus reduce procurement cost. The Navy can be viewed as using this strategy for the Littoral Combat Ship (LCS), which is to be considerably smaller than existing major Navy surface combatants, but the strategy can be applied more widely.
- **Shifting from nuclear to conventional propulsion.** This is a strategy that can be considered for the Navy's submarines and aircraft carriers, whose current designs are nuclear-powered. Equipping a Navy ship with a conventional (i.e., fossil-fuel) propulsion plant rather than a nuclear propulsion plant can reduce the ship's procurement cost by several hundred million dollars.
- **Shifting from a hull built to military survivability standards to a hull built to commercial-ship survivability standards.** A hull built to military survivability standards has more armoring and internal compartmentalization than a hull built to commercial-ship standards, making it more expensive to build than a commercial-like hull. The Navy is considering building ships for its planned Maritime Prepositioning Force (Future), or MPF(F), squadron, with commercial-like hulls, but the strategy can be applied more widely.
- **Using a common hull design for multiple ship classes.** Using a common hull design for multiple ship classes avoids the cost of designing a new hull for each new class of ship, and permits ship classes sharing a common hull to benefit from improved production economies of scale regarding their hulls. The Navy plans to use the hull design for its planned DDG-1000 (formerly DD(X)) destroyer as the hull for its planned CG(X) cruiser, but the strategy can be applied more widely. The OFT report proposes building four large surface ships—an aircraft carrier, a missile-and-rocket ship, an amphibious assault ship,

[2] Congressional Budget Office, *Options for the Navy's Future Fleet*, May 2006, pp. 56 and 57 (Box 3-1); and Congressional Budget Office, *Budget Options*, Feb. 2005, pp. 18-19; and Congressional Budget Office, *Transforming the Navy's Surface Combatant Force*, Mar. 2003, pp. 27-28, 63. (Hereafter cited as CBO 2005 report, and CBO 2003 report, respectively.)

[3] Department of Defense, Office of the Secretary of Defense, *Alternative Fleet Architecture Design*, 2005. (Hereafter cited as OFT report.)

[4] Robert O. Work, *Winning the Race: A Naval Fleet Platform Architecture for Enduring Maritime Supremacy*, Center for Strategic and Budgetary Assessments, Washington, 2005. (Hereafter cited as CSBA report.)

and a small-craft "mother" ship—using a common merchant-like hull. The CSBA report proposes using hull design for the Navy's LPD-17 class amphibious ship for building other kinds of ships.

Most of the lower-cost ship options presented below use one or more of these four approaches. Information on the estimated procurement costs of the lower-cost designs is presented when available. Lower-cost ship designs using these approaches will in most cases be individually less capable than the currently planned ship designs from which they are derived, and this is one of the assessment factors that is discussed in the final section of the report.

Options for Lower-Cost Ships

For each category of ship below, the discussion describes the current design and then outlines potential lower-cost options. The discussions are descriptive only; the potential advantages and disadvantages of shifting to the lower-cost designs are discussed in the final section of the report.

Attack Submarines

***Current design*:**

- *Virginia (SSN-774) class nuclear-powered submarine*

Potential lower-cost options:

- *AIP-equipped non-nuclear-powered submarine*
- *Reduced-cost "Tango Bravo" nuclear-powered submarine*

Virginia-Class (SSN-774) Nuclear-Powered Submarine[5]

The Navy is currently procuring one Virginia (SSN-774) class nuclear-powered attack submarine (SSN) per year. Each submarine currently costs about $2.6 billion to procure. The FY2007-FY2011 Future Years Defense Plan (FYDP) maintains Virginia-class procurement at one per year through FY2011.

The Navy is proposing to maintain in coming years a fleet of 313 ships, including 48 SSNs.[6] Fully supporting the Navy's reportedly planned force of 48 boats could involve procuring a total of 35 boats during the 16-year period FY2007-FY2022, or an average of about 2.2 boats per year.[7] A continuation beyond FY2011 of the current one-per-year rate, in contrast, could reduce the SSN force to fewer than 30 boats by about 2030, before recovering to a steady-state level of 33 boats.[8]

One option for a lower-cost attack submarine would be a non-nuclear-powered submarine equipped with an air-independent propulsion (AIP) system that could be procured in tandem with Virginia-class SSNs. Another option would be a reduced-cost SSN using new "Tango Bravo" technologies being developed by the Navy and the Defense Advanced Research Projects Agency (DARPA) that would be procured as a successor to the Virginia-class design.

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[5] For more on the Virginia-class program, see CRS Report RL32418, *Navy Attack Submarine Procurement: Background and Issues for Congress*, by Ronald O'Rourke. (Hereafter cited as CRS Report RL32418.)

[6] For additional discussion, see CRS Report RL32665, op cit.

[7] See CRS Report RL32418.

[8] Ibid.

AIP-Equipped Non-Nuclear-Powered Submarine

Non-nuclear-powered submarines are less expensive than nuclear-powered submarines not only because of the difference in propulsion systems, but also because non-nuclear-powered submarines tend to be smaller than nuclear-powered submarines.

The OFT report proposed a future Navy consisting of several new kinds of ships, including air-independent propulsion (AIP)-equipped non-nuclear-powered submarines.[9] An AIP system such as a fuel-cell or closed-cycle diesel engine extends the stationary or low-speed submerged endurance of a non-nuclear-powered submarine. AIP-equipped submarines are currently being acquired by certain foreign navies.

AIP submarines could be procured in tandem with Virginia-class boats. One possibility, for example, would be to procure one Virginia-class boat plus one or more AIP submarines each year.

The OFT report recommended substituting four AIP submarines for one Virginia-class submarine in each carrier strike group, suggesting that four AIP submarines might be procured for the same cost ($2.4 billion to $3.0 billion in the FY2006-FY2011 FYDP) as one Virginia-class submarine. This suggests an average unit procurement cost for an AIP submarine of roughly $600 million to $750 million each. Although AIP submarines being built by other countries might cost this much to procure, a U.S. Navy AIP submarine might be built to higher capability standards and consequently cost more to procure, possibly reducing the equal-cost ratio of substitution to three to one or possibly something closer two to one. If so, then the annual cost of procuring one Virginia-class SSN plus one, two, or perhaps three AIP submarines could be equal to or less than that of procuring two Virginia-class boats per year.

Reduced-Cost "Tango Bravo" SSN

The Virginia class was designed in the early to mid-1990s, using technologies that were available at the time. New technologies that have emerged since that time may now permit the design of a new SSN that is equivalent in capability to the Virginia class design, but substantially less expensive to procure. The Navy and DARPA are now pursuing the development of these technologies under a program called Tango Bravo, a name derived from the initial letters of the term "technology barriers." As described by the Navy,

> TANGO BRAVO will execute a technology demonstration program to enable design options for a reduced-size submarine with equivalent capability as the VIRGINIA Class design. Implicit in this focus is the goal to reduce platform infrastructure and, ultimately, the cost of future design and production. Additionally, reduced platform infrastructure provides the opportunity for greater payload volume.
>
> The intent of this collaborative effort is to overcome selected technology barriers that are judged to have a significant impact on submarine platform infrastructure cost. Specifically, DARPA and the Navy will jointly formulate technical objectives for critical technology demonstrations in (a) shaftless propulsion, (b) external weapons, (c) conformal alternatives to the existing spherical array, (d) technologies that eliminate or substantially simplify existing submarine systems, and (e) automation to reduce crew workload for standard tasks.[10]

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[9] See also Christopher J. Castelli, "Defense Department Nudges Navy Toward Developing Diesel Subs," *Inside the Navy*, Mar. 7, 2005; Dave Ahearn, "Lawmakers Assail Navy Budget, But Eye Non-Nuke Subs," *Defense Today*, Mar. 3, 2005.

[10] Navy information paper on advanced submarine system development provided to CRS by Navy Office of Legislative

Some Navy and industry officials believed in 2004 that if these technologies are developed, it might be possible to design a new submarine equivalent in capability to the Virginia class, but with a procurement cost of perhaps 75% of the Virginia class. Such a submarine could more easily be procured within available resources at a rate of two per year.

Consequently, as an alternative to the option of procuring AIP submarines, another option would be to start design work now on a new "Tango Bravo" SSN. The idea of designing a submarine with capability equivalent to that of Virginia-class and a procurement cost that is less than that of the Virginia class has been discussed by Navy and industry officials. Under this option, Virginia-class procurement could continue at one per year until the Tango Bravo submarine was ready for procurement, at which point Virginia-class procurement would end, and procurement of the Tango Bravo submarine would begin.

If design work on a Tango Bravo submarine is begun now and pursued in a concerted manner, the first Tango Bravo submarine might be ready for procurement a few years from now.

Aircraft Carriers

Current design:

- *Large nuclear-powered carrier, as exemplified by the George H.W. Bush (CVN-77) and CVN-78*

Potential lower-cost options:

- *Medium-sized, conventionally powered carrier based on LHA(R) amphibious assault ship design*
- *Medium-sized, conventionally powered carrier based on a commercial-like hull design*
- *Small carrier based on high-speed surface effect ship (SES)/ catamaran hull design*

CVN-77 and CVN-78[11]

The Navy is currently building large nuclear-powered aircraft carriers (CVNs). These ships have a full load displacement of about 100,000 tons and can embark an air wing of about 75 conventional takeoff and landing (CTOL) airplanes and helicopters.

The George H. W. Bush (CVN-77), the last Nimitz (CVN-68) class carrier, was procured in FY2001 at a total cost of $4.975 billion, but the ship's estimated construction cost has since risen to about $6.1 billion. The ship is scheduled to enter service in 2008.

The FY2007-FY2011 FYDP proposes to procure the next aircraft carrier, called CVN-78, in FY2008. CVN-78 is the lead ship of a planned new carrier class called the CVN-21 class. (CVN-21 simply means aircraft carrier for the 21st Century.) The Navy estimates CVN-78's procurement

Affairs, Jan. 21, 2005. For additional discussion of the Tango Bravo program, see Aarti Shah, "Tango Bravo Technology Contract Awards Expected This Spring," *Inside the Navy*, Mar. 14, 2005; Andrew Koch, "US Navy In Bid To Overhaul Undersea Combat," *Jane's Defence Weekly*, Mar. 9, 2005, p. 11; Lolita C. Baldor, "Smaller Subs Could Ride Waves Of The Future," *NavyTimes.com*, Feb. 4, 2005; Robert A. Hamilton, "Navy, DARPA Seek Smaller Submarines," *Seapower*, Feb. 2005, pp. 22, 24-25.

[11] For more on CVN-77 and CVN-78, see CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by Ronald O'Rourke.

cost at $10.5 billion, including $2.4 billion in detailed design and nonrecurring engineering (DD/NRE) costs and $8.1 billion in hands-on construction costs.[12] Advance procurement funding for CVN-78 has been provided since FY2001. If the ship is procured in FY2008, it would enter service in 2015.

The next carrier, called CVN-79, is currently planned for procurement in FY2012. If the ship is procured in FY2012, it would enter service around 2019. The next carrier after that, CVN-80, is planned for procurement in FY2016.

One option for a lower-cost aircraft carrier involves designing a medium-sized, conventionally powered aircraft carrier based on the design for a new amphibious assault ship called LHA-6 or the LHA Replacement ship (LHA(R)), that is currently being developed by the Navy.[13] A second option involves designing a medium-sized, conventionally powered aircraft carrier based on a commercial-like hull design. A third option involves designing a small, high-speed, conventionally powered aircraft carrier built on a surface effect ship (SES)/catamaran hull design.[14]

Medium-Sized Carrier Based on LHA(R) Design

The CSBA report recommended procuring CVN-21-class aircraft carriers as needed to maintain a force of 10 large carriers (two ships less than the current 12-ship force). It also recommended procuring an additional four medium-sized, conventionally powered aircraft carriers based on the LHA(R) design. This ship might displace about 40,000 tons and embark an air wing of perhaps about two dozen vertical/short takeoff or landing (VSTOL) versions of the F-35 Joint Strike Fighter (JSF). Its unit procurement cost might be roughly $3 billion.[15]

Medium-Sized Carrier Based on Commercial-Like Hull

The OFT report recommended procuring a medium-sized carrier based on a relatively inexpensive, commercial-like hull design developed in 2004 for the Navy's Maritime Prepositioning Force (Future), or MPF(F), analysis of alternatives.[16] This carrier, which would have a full load displacement of about 57,000 tons, would embark a notional air wing of 36 manned aircraft—30 Joint Strike Fighters (JSFs) and 6 MV-22 Osprey tilt-rotor aircraft—and 15 unmanned air vehicles (UAVs).

This ship would be somewhat larger than the LHA(R)-based carrier recommended in the CSBA report, and roughly the same size as the United Kingdom's new aircraft carrier design. (The LHA(R)-based ship and the UK carrier, however, would use military hulls.) The OFT report

[12] The total estimated acquisition cost of CVN-78, which also includes $3.2 billion in research and development funding for the ship, is $13.7 billion.

[13] Navy amphibious ships are given designations beginning with the letter L, which stands for landing, as in amphibious landing. LHA can be translated as amphibious ship (L), helicopter platform (H), assault (A). Navy LHAs and closely related ships designated LHDs (the D standing for well deck, an opening in the stern of the ship for landing craft that the LHAs also have) have flight decks that run the length of the ship, giving these ships an aircraft-carrier-like appearance.

[14] A surface effect ship is supported above the water by a cushion of air that is trapped beneath the ship.

[15] For more on the LHA(R), see CRS Report RL32513, *Navy-Marine Corps Amphibious and Maritime Prepositioning Ship Programs: Background and Oversight Issues for Congress*, by Ronald O'Rourke. (Hereafter cited as CRS Report RL32513.)

[16] For more on the MPF(F) program, see CRS Report RL32513. The OFT report also recommended using this same 57,000-ton hull as the basis for a missile-and-rocket ship, an amphibious ship, and a small-combatant mother ship.

recommended substituting two of these 57,000-ton carriers for each of the Navy's current large carriers, so that the number of manned aircraft based at sea would remain about the same.

Small Carrier Using High-Speed SES/Catamaran Hull Design

As an alternative to the 57,000-ton medium-sized carrier, the OFT report recommended procuring a small, high-speed carrier displacing 13,500 tons that would use a surface effect ship (SES)/catamaran hull. The ship was based on a design for an unmanned aerial vehicle/unmanned combat aerial vehicle (UAV/UCAV) carrier that was developed in 2000-2002 by a team at the Naval Postgraduate School.[17] The OFT report recommended using the ship to embark a notional air wing of 10 manned aircraft—8 JSFs and 2 MV-22s—and 8 UAVs, and have a maximum speed of 50 to 60 knots.

This ship would be slightly larger than Thailand's 11,500-ton aircraft carrier, which was commissioned in 1997. It would be smaller than Spain's 17,000 aircraft carrier, which was based on a U.S. design[18] and was commissioned in 1988, or the UK's three existing 20,600-ton carriers, which were commissioned between 1980 and 1985. The OFT-recommended ship would be much faster than the Thai, Spanish, or existing UK carriers, or any other aircraft carrier now in operation. The OFT report recommended substituting eight of these 13,500-ton carriers for each of the Navy's current large carriers, so that the number of manned aircraft based at sea would remain about the same.

Additional Potential Options

Studies of aircraft carrier acquisition options over the years have discussed many other potential designs, including the following:

- **A large, conventionally powered carrier.** Such a ship, which might use the same hull design as CVN-78, might displace about 100,000 tons. It would be broadly similar to the Kitty Hawk (CV-63) and John F. Kennedy (CV-67), the Navy's two remaining conventionally powered carriers, which displace roughly 82,000 tons and embark air wings similar to those embarked by the Navy's large nuclear-powered carriers. The ship might have a procurement cost several hundred million dollars less than that of CVN-78.
- **A medium-sized nuclear-powered carrier.** Such a ship might be based on the LHA(R) hull and use a half-sized version of the CVN-78 nuclear propulsion plant.[19] Like the CSBA-recommended conventionally powered carrier based on the LHA(R) design, this ship might displace about 40,000 tons and embark about

[17] The design was developed by the Total Ship Systems Engineering group at the Naval Postgraduate School under an effort called the Crossbow project. Within that project, the carrier was referred to as Sea Archer. For more on the Sea Archer, see http://web.nps.navy.mil/~me/tsse/files/2001.htm. See also Jason Ma, "Naval Postgraduate School Issues Report on Crossbow Project," *Inside the Navy*, Oct. 28, 2002; Randy Woods, "Students Design Small, Fast Carrier At Projected Cost Of $1.5 Billion," *Inside the Navy*, Jan. 7, 2002. The latter article quoted the leader of the project as saying that if the ship's speed were reduced from 60 knots to 40 knots, the ship's estimated procurement cost of $1.5 billion could be reduced substantially.

[18] The U.S. design, which was called the Sea Control Ship, was never built for the U.S. Navy.

[19] The nuclear propulsion plant planned for CVN-78, like those on almost all the Navy's nuclear-powered aircraft carriers, includes two nuclear reactors and two sets of associated propulsion equipment. (The sole Navy carrier with a different propulsion plant arrangement is the Enterprise [CVN-65], the Navy's first nuclear-powered carrier, whose plant includes eight smaller nuclear reactors.) A half-sized version of the CVN-78 plant would use one reactor and one set of associated equipment.

two dozen VSTOL JSFs. If the CSBA-recommended conventionally powered carrier would cost roughly $3 billion, a nuclear-powered version would cost more than $3 billion. The ship might be considered broadly similar to the France's nuclear-powered carrier, the Charles de Gaulle, which was commissioned in 2001, displaces 42,000 tons, and embarks an air wing of about 34 conventional takeoff and landing (CTOL) airplanes and two helicopters.

- **A very small, high-speed VSTOL carrier.** The Naval War College in 2000 developed a conceptual design for a very small, high-speed VSTOL carrier with a displacement of about 4,000 tons, a maximum speed of 60 knots, and an embarked air wing of about seven VSTOL JSFs and two helicopters.[20]

Matrix of Possible Designs

Table 1 below shows how ship size, propulsion type, and hull type create a matrix of notional aircraft carrier options, including the large nuclear-powered carriers currently being procured and the potential alternatives described above.

Medium-sized carriers of 40,000 to 70,000 tons might operate either VSTOL or CTOL aircraft, though ships at the higher end of this size range might be able to operate CTOL aircraft more easily or efficiently. Small carriers, because of their shorter length, would likely be limited to VSTOL aircraft.

Although the table does not provide any examples of large or small conventionally powered carriers using a commercial-like hulls, or any examples of a small nuclear-powered carrier, such ships are possible. Regarding the possibility of a small nuclear-powered carrier, the Navy between FY1957 and FY1975 procured a total of nine nuclear-powered cruisers with displacements ranging from about 9,000 tons to about 17,500 tons.[21]

The table also does not provide examples of ships combining a nuclear propulsion plant with a commercial-like hull. Although a small number of nuclear-powered commercial cargo ships were built years ago, a combat ship such as an aircraft carrier that combined a relatively expensive nuclear propulsion plant with a commercial-like hull having relatively limited survivability features might be viewed as a contradictory design.

[20] Christian Bohmfalk, "War College Explores Notion of Small, Fast Aircraft Carrier Fleets," *Inside the Navy*, October 9, 2000.

[21] The nine cruisers—three one-of-a-kind ships, a class of two ships, and a class of four ships—entered service between 1961 and 1980 and were decommissioned between 1993 and 1999. Procurement of nuclear-powered cruisers was halted after FY1975 due largely to a desire to constrain the procurement costs of future cruisers. In deciding in the late 1970s on the design for the new cruiser that would carry the Aegis defense system, two nuclear-powered design options were rejected in favor of the option of placing the Aegis system onto the smaller, conventionally powered hull developed for the Spruance (DD-963) class destroyer. The resulting design became the Ticonderoga (CG-47) class Aegis cruiser. The first Aegis cruiser was procured in FY1978. Although nuclear power was abandoned for Navy cruisers, it was retained for the Navy's large aircraft carriers because adding nuclear power increases total ship procurement cost in percentage terms less for a large carrier than for a cruiser, and because the mobility advantages of nuclear power for a surface ship (see the discussion on mobility in the next section of the report) were viewed as important for carriers in light of their combat capabilities and limited numbers. Some observers believe that if oil prices are deemed likely to remain high, the option of nuclear-powered surface combatants might bear revisiting.

Table 1. Matrix of Notional Options For Aircraft Carriers

	Military hull		Commercial-like hull	
Ship size (full load displacement)	**Nuclear-powered**	**Conventionally powered**	**Nuclear-powered**	**Conventionally powered**
Large CTOL carrier (~80,000 to ~100,000tons)	CVN-77 or CVN-78	Ship broadly similar to CV-63 and CV-67		
Medium CTOL or VSTOL carrier (~40,000 to ~70,000 tons)	Carrier based on LHA(R) design (CSBA) or ship similar to new French carrier	Carrier based on LHA(R) design (CSBA) or ship similar to new UK carrier design		57,000-ton carrier (OFT)
Small VSTOL carrier (~4,000 to ~30,000 tons)		13,500-ton high-speed carrier (OFT) or ship similar to Spanish, Thai, or existing UK carriers		

Source: Table prepared by CRS based on Navy data, OFT and CSBA reports, and *Jane's Fighting Ships 2004-2005*.

Notes: CTOL = conventional takeoff land landing aircraft. VSTOL = vertical/short takeoff and landing aircraft.

Larger Surface Combatants

Current design:

- *14,500-ton DDG-1000 (formerly DD(X)) destroyer/CG(X) cruiser*

Potential lower-cost options:

- *Roughly 11,000-ton cruiser-destroyer (SCD)*
- *Roughly 6,000-ton frigate (FFG(X))*
- *Low-cost gunfire support ship*

14,500-Ton DDG-1000 Destroyer/CG(X) Cruiser[22]

The Navy currently plans to procure DDG-1000 destroyers and, starting in FY2011, CG(X) cruisers. The CG(X) would be based on the DDG-1000 design and could be somewhat larger and more expensive than the DDG-1000. The Navy's FY2007 budget requests procurement funding for the first two DDG-1000s, both of which are to be procured in FY2007 using split funding (i.e., incremental funding) across FY2007 and FY2008.

The DDG-1000 would have a full-load displacement of about 14,500 tons, which would make it roughly 50% larger than the Navy's current 9,000-ton Aegis cruisers and destroyers, and larger than any U.S. Navy destroyer or cruiser since the nuclear-powered cruiser Long Beach (CGN-9), which was procured in FY1957.

[22] For more on the DDG-1000 and CG(X) programs, see CRS Report RL32109, *Navy DDG-1000 and DDG-51 Destroyer Programs: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke. (Hereafter cited as CRS Report RL32109.)

The Navy estimates that the first two DDG-1000s would cost about $3.3 billion each, and that the third, fourth, and fifth ships would cost an average of about $2.5 billion each.

The Congressional Budget Office believes and the Cost Analysis Improvement Group (CAIG) within the Office of the Secretary of Defense (OSD) reportedly believes, that DDG-1000 procurement costs may be considerably higher than the Navy estimates.[23]

The Navy originally envisaged procuring a total of 16 to 24 DDG-1000s, but now plans, as part of its proposed 313-ship fleet, to procure a total of 7. The proposed 313-ship fleet also includes 19 CG(X)s. The FY2006-FY2011 FYDP submitted to Congress in February 2005 reduced planned DDG-1000 procurement to one per year for FY2007-FY2011, for a total of five ships through FY2009. The FY2007-FY2011 FYDP maintains an average procurement rate of one DDG-1000 per year for the period FY2007-FY2011.

Options for a reduced-cost surface combatant include a roughly 11,000-ton cruiser-destroyer, a roughly 6,000-ton frigate, and a lower-cost gunfire support ship based on the basic LPD-17 amphibious ship hull design.

Roughly 11,000-Ton Cruiser-Destroyer Combatant (SCD)

One option for a lower-cost surface combatant would be a new-design ship of about 11,000 tons. Such a ship would be roughly 25% smaller than the current DDG-1000 design, roughly equal in size to two classes of nuclear-powered cruisers that the Navy procured in the 1970s,[24] and about 1,800 tons larger than today's Arleigh Burke (DDG-51) class Aegis destroyers. Such a ship, which might be called the smaller cruiser-destroyer (SCD) could:

- be intended as a replacement for either the CG(X) program or both the DDG-1000 and CG(X) programs;
- incorporate many of the same technologies now being developed for the DDG-1000 and CG(X);
- cost substantially less to procure than a DDG-1000 or CG(X);
- be similar to the DDG-1000 and CG(X) in terms of using a reduced-size crew to achieve annual operation and support costs that are considerably less than those of the current DDG-51 design;
- carry a payload—a combination of sensors, weapon launchers, weapons, related computers and displays, aircraft, and fuel—that is smaller than that of the DDG-1000 or CG(X), but greater than of current Ticonderoga (CG-47) Aegis cruisers or DDG-51 class Aegis destroyers..

A land-attack oriented version of the SCD could carry two Advanced Gun Systems, or AGSs (a new-design 155mm gun), like the DDG-1000, while reducing other payload elements. An air- and missile-defense version of the SCD would preserve CG(X) radar capabilities while reducing other payload elements.

Roughly 6,000-Ton Frigate (FFG(X))

A second option for a smaller, less expensive, new-design ship that has been suggested by CBO would be a frigate intended as a replacement for both the DDG-1000/CG(X) effort and the Littoral Combat Ship (LCS) program that is discussed later in this report. CBO estimated that

[23] See CRS Report RL32109.

[24] These are the two California (CGN-36) and four Virginia (CGN-38) class cruisers.

such a ship, which it calls the FFG(X), might displace about 6,000 tons. CBO estimates that a 6,000-ton FFG(X) might have a unit procurement cost of about $800 million.

A 6,000-ton FFG(X) might be too small to be equipped with the AGS, in which case it could not provide the additional naval gunfire capability that would be provided by the DDG-1000. A 6,000-ton FFG(X) might, however, be capable of performing the non-gunfire missions that would be performed by both the DDG-1000 and the LCS. A 6,000-ton FFG(X) would could be viewed as a replacement in the surface combatant force structure for the Navy's Oliver Hazard Perry (FFG-7) class frigates and Spruance (DD-963) class destroyers. Since a 6,000-ton FFG(X) would be roughly midway in size between the 4,000-ton FFG-7 design and the 9,000-ton DD-963 design, it might be suitable for carrying more modern versions of the mission equipment currently carried by the FFG-7s and DD-963s.

Low-Cost Gunfire Support Ship

CBO and CSBA have suggested a third option for a smaller, less expensive, new-design ship—a lower-cost gunfire support ship based on the San Antonio (LPD-17) amphibious ship. This option would involve placing one or two AGSs on the basic LPD-17 hull design. LPD-17s currently under construction for supporting Marine operations are to displace about 25,000 tons, but a basic version of the LPD-17 hull equipped with one or two AGSs might have a different displacement.[25] CBO estimates that an initial AGS-armed LPD-17 might cost about $1.9 billion, including detailed design and nonrecurring engineering costs, and that subsequent ships might cost about $1.5 billion each.[26]

Smaller Surface Combatants

Current design:

- *2,500- to 3,000-ton Littoral Combat Ship (LCS)*

***Potential Lower-Cost Options*:**

- *Roughly 1,000-ton surface combatant*
- *Roughly 100-ton surface combatant*

2,500- to 3,000-Ton Littoral Combat Ship (LCS)[27]

In addition to DDG-1000 destroyers and CG(X) cruisers, the Navy currently plans to procure, as part of its proposed 313-ship fleet, a total of 55 Littoral Combat Ships (LCSs), which would be small (2,500- to 3,000-ton), fast surface combatants that would use modular "plug-and-fight" weapon systems. One LCS was procured in FY2005 and another three were procured in FY2006. The proposed FY2007 budget requests funding for another two. The Navy wants the procurement cost of each LCS sea frame (i.e., the basic version of the ship, without any modular weapons

[25] The Navy currently plans to procure a total of nine LPD-17 class ships, with the ninth ships to be procured in FY2008. An additional surface combatant option recommended in the OFT report is a large missile-and-rocket ship based on the same 57,000-ton commercial-like hull design that the report recommended using as the basis for a medium-sized aircraft carrier. Although this ship would be based on a commercial-like hull, the unit procurement cost of this ship would be higher than, not lower than, that of the DDG-1000.

[26] Congressional Budget Office, *Options for the Navy's Future Fleet*, op cit, p. 57 (Box 3-1).

[27] For more on the LCS program, see CRS Report RL33741, *Navy Littoral Combat Ship (LCS) Program: Background, Oversight Issues, and Options for Congress*, by Ronald O'Rourke.

systems) to be no more than $220 million. Figures from the FY2006-FY2011 FYDP suggest that when the cost of the mission modules is added in, the LCS program might have an average ship procurement cost of about $387 million, and that a program of 55 might therefore have a total acquisition (i.e., research and development plus procurement) cost of about $22.1 billion.[28]

1,000-Ton Surface Combatant

Rather than procuring the LCS, the OFT report recommended procuring a 1,000-ton surface combatant. Like the LCS, this ship would have a maximum speed of 40 to 50 knots and standard interfaces for accepting various modular mission packages, and would self-deploy to the theater of operations. The ship would be supported in theater by one or more larger types of ships that were also recommended by OFT.

100-ton Surface Combatant

As an alternative to the 1,000-ton surface combatant, the OFT report recommended procuring a 100-ton surface combatant with a maximum speed of 60 knots and standard interfaces for accepting various modular mission packages. These ships would be transported to the theater by a "mother ship" based on the same 57,000-ton commercial-like hull used for OFT's proposed medium-sized aircraft carrier. The 100-ton surface combatants would be supported in theater by the mother ship and possibly another larger ship that was recommended by OFT.

Issues For Congress

The potential lower-cost ship designs outlined above can be assessed in terms of cost, capability, technical risk, homeporting arrangements, and potential impact on the shipbuilding industrial base.

Cost

Although the potential ship designs outlined in the previous section would have lower unit procurement costs than currently planned designs, a complete assessment of the cost implications of these options would take into account development and design cost, procurement cost, life-cycle operation and support cost (O&S), and end-of-life disposal costs. Each of these are discussed below.

Development And Design Cost

Developing and designing a large, complex Navy ship can cost billions of dollars. Consequently, if a currently planned ship has already been developed and designed, stopping that program in favor of a new, lower-cost design could incur substantial additional development and design costs, and consequently might save money over the long run (i.e., reach the financial break-even point compared to continuing with the current design) only if the lower-cost design is procured in large enough total numbers so that the cumulative procurement savings were greater than the additional up-front development and design costs. The earlier in the development and design process that an existing ship acquisition program is stopped, the earlier in the future it might be that a lower-cost alternative design might reach the break-even point. In addition, if a lower-cost ship could use many of the same technologies intended for the more-expensive ship, or

[28] For a discussion, see CRS Report RL32109.

technologies already developed for other ships, then the cost to develop the new design could be reduced, perhaps substantially.

Procurement Cost

Through a process common to many manufacturing activities called moving down the learning curve, the number of shipyard labor hours required to build a ship design decreases as a shipyard builds more ships to that design and shipyard workers become increasingly familiar with the design.[29] Consequently, if some number of ships have already been built to a currently planned design, the difference in cost between that design and the first units of a lower-cost alternative design might be less than if the currently planned design had not yet entered production, and the break-even point for the lower-cost design will be further into the production run than if the currently planned design had not yet entered production. On the other hand, if the lower-cost design can be procured at a greater annual rate than the currently planned design (e.g., two ships per year for the lower-cost design vs. one ship per year for the currently planned design), then the lower-cost design could benefit from greater spreading of the shipyard's annual fixed overhead costs and also move down the learning curve more quickly and achieve the cost-reducing benefits of the learning curve more fully than the currently planned design.

Life-Cycle Operation and Support (O&S) Cost

Navy ships are expensive to operate and support, and can remain in service for many years—20 or more years for a small combatant, 30 or more years for an attack submarine or larger surface combatant, and up to 50 years for an aircraft carrier. Consequently, although ship procurement costs are often more visible in the budget than ship O&S costs, a ship's life-cycle O&S cost can contribute as much as, or even more than, its procurement cost to total long-term Navy expenditures.

Personnel and Maintenance Costs

Reducing a ship's life-cycle O&S cost can sometimes involve including design features that increase its procurement cost. Personnel costs are a major component of ship O&S costs, and reducing crew size can involve fitting the ship with technology for automating functions that were previously performed by people, including damage control, which is a function that traditionally has contributed to a need for larger crews. If the cost of added technology is greater than the avoided expense of building extra crew-related spaces into the ship, then adding the technology will increase the ship's procurement cost. Maintenance costs are another major component of ship O&S costs, and reducing maintenance costs might require building certain parts of the ship with more-durable but more-expensive materials, or increasing the size (and thus construction cost) of certain spaces on the ship, so as to provide room for easier access during maintenance.

In light of these considerations, it is possible for an alternative ship design to have a lower procurement cost in part because it incorporates features that give it a higher life-cycle O&S cost. If so, then procuring this ship rather than the currently planned design might not reduce total Navy expenditures over the long run as much as might be expected by looking only at ship procurement costs.

[29] For more on learning-curve effects in Navy shipbuilding, see CRS Report 96-785, *Navy Major Shipbuilding Programs and Shipbuilders: Issues and Options for Congress*, by Ronald O'Rourke, pp. 59, 95-110. (Out of print; available from the author to congressional clients upon request.)

Fuel Costs

The life-cycle O&S cost of a conventionally powered ship includes the cost of all the fuel the ship uses over its life. That is not the case for nuclear-powered ships, because the procurement cost of a nuclear-powered ship includes the cost of the nuclear fuel core that is loaded into the ship's reactor at the time the ship is built. In the case of a nuclear-powered attack submarine, that fuel core in 2004 cost about $158 million and is designed to power the ship for its entire 33-year expected life, while in the case of a nuclear-powered carrier, the core in 2004 cost about $300 million and is designed to power the ship for one-half of its 50-year expected life.[30]

Consequently, although a nuclear-powered submarine or carrier is more expensive to procure than an otherwise-equal conventionally powered submarine or carrier, the nuclear-powered submarine will incur no fuel-related O&S costs over its lifetime, while the conventionally powered carrier will incur no fuel-related O&S costs during the first half of its lifetime.

This difference in accounting for fuel costs means that when procurement and life-cycle O&S costs are added together, the difference in cost between a nuclear-powered submarine and a conventionally submarine will be smaller than the difference in procurement cost alone. The same can true in comparing a nuclear-powered carrier to a conventionally-powered carrier, if the cost of the nuclear-powered carrier's second core is less than the cost of the conventionally powered carrier's fuel over its entire life. The higher the price of oil during conventionally powered carrier's life, the more likely this is to be the case.

A more general consideration arising out of this discussion is that other things held equal, the higher that oil costs are expected to be in coming decades, the more cost-effective nuclear power might be compared to conventional power for powering a given type of ship. In theory, if the cost of oil is high enough, the total ownership cost (i.e., the sum of procurement cost, life-cycle O&S cost, and end-of-life disposal cost discussed below) of a nuclear powered ship could be less than that of an otherwise-equal conventionally powered ship.

End-Of-Life Disposal Cost

Other things held equal, nuclear-powered ships have higher end-of-life disposal costs than conventionally powered ships because of the need to defuel, cut out, and seal up the reactor compartment and transport it to the permanent Navy reactor-plant storage area at the Hanford nuclear reservation in Washington state. For a nuclear-powered submarine, this work might cost about $30 million to $35 million, while for a nuclear-powered carrier, which has a much larger nuclear propulsion plant, it might cost roughly $570 million.[31]

Capability

As mentioned earlier, lower-cost ship designs in most cases will be individually less capable than their higher-cost counterparts. One exception to this might be the reduced-cost Tango Bravo SSN,

[30] Source for cost figures: Telephone discussion with Naval Nuclear Propulsion Office, May 21, 2004. The $158-million figure is for a 33-year core for a Virginia-class submarine, while the $300 million figure is for a 25-year core for the aircraft carrier CVN-78. Both figures are in constant FY2005 dollars.

[31] Telephone consultation with the office of the Navy Nuclear Propulsion Program, Apr. 28, 2005. The office stated that the total cost to inactivate, dismantle, and dispose of a retired nuclear-powered submarine is currently about $64 million, and that work related to the reactor compartment accounts for roughly half of this total. The office stated that the currently estimated cost to inactivate the nuclear-powered carrier Enterprise (CVN-65) in 2013 is about $1.1 billion in then-year dollars, which equates to about $830 million in FY2005 dollars, and that work related to the reactor compartment accounts for about $570 million of this $830-million figure.

which might be equal in capability to the Virginia-class design due to its use of the more advanced technologies being pursued under the Navy-DARPA Tango Bravo program.

Aspects of capability that may be considered include ship payload, ship detectability and survivability, ship mobility, and the value of ship numbers in naval operations.

Payload

As the size of a Navy combat ship decreases, its total payload—the weight and volume of the ship's sensors, weapon launchers, weapons, related computers and displays, aircraft, and fuel—tends to decrease. Indeed, due to certain factors relating to ship design, as ship size decreases, payload can often decrease more quickly, making the smaller ship not just less capable than the larger ship, but proportionately less capable. One factor contributing to this effect relates to propulsion: As ship size increases, the amount of horsepower needed to move a ton of the ship's weight through the water at a certain speed tends to decrease. As a result, as ship size increases, the size of the propulsion plant increases less than proportionately, leaving proportionately more room for payload.[32]

Consequently, for example, as the size of an aircraft carrier is reduced, the total weight of the aircraft that can be embarked on the carrier can decline even more quickly. A 40,000-ton LHA(R)-based medium-sized carrier, for example, is about 40% as large as a 100,000 ton carrier, but its potential air wing of about two dozen aircraft might have a total weight equivalent to less than 40% of the 75 aircraft on the 100,000-ton carrier.

Moreover, if a medium-sized carrier's air wing is transferred to a larger carrier, the larger carrier may be able to use that air wing to generate more sorties (i.e., flights) per day because of its larger flight deck and greater fuel and ordnance capacities. According to one study, for example, a carrier capable of embarking 75 aircraft, can, with a 55-aircraft air wing, generate 40% more strike sorties per day than a medium-sized carrier that is sized for that same 55-aircraft air wing.[33]

Reducing ship size can, in addition to reducing total payload, make it difficult or impossible for a ship to be equipped with certain desired systems. A carrier smaller than a certain size, for example, would not be able to operate CTOL aircraft, while a surface combatant smaller than a certain size could not be equipped with certain large radars, sonars, missile-launching tubes, or guns.

A principal implication of payload decreasing more rapidly than ship size is that the total cost to put a certain collection of combat-related equipment to sea can go up as the size of the ships used to put the equipment to sea goes down. If total fleet payload is held constant, in other words, then reducing *unit* procurement costs by shifting to smaller ships can lead to a fleet design with a higher *total* procurement cost. In addition, if crew size and fuel consumption does not go down proportionately with ship size, then a similar effect could occur with regard to total fleet operation and support (O&S) costs.

The OFT report counters some of these points by arguing that using new technologies would permit the payload fraction of its recommended 1,000- and 100-ton surface combatants to be greater than what would have been possible in the past. Another counter-argument is that improvements in precision-guidance technology for weapons is permitting weapon size to be

[32] The Navy's 100,000-ton carriers, for example, are about 11 times as large as the Navy's 9,000-ton DDG-51 class destroyers, and both types of ships have a maximum sustained speed of more than 30 knots. In terms of shaft horsepower, however, the carriers' propulsion plant is less than three times as powerful as the DDG-51-class propulsion plant (about 280,000 shaft horsepower vs. about 100,000 shaft horsepower, respectively).

[33] David A. Perin, "Are Big Decks Still the Answer?," *U.S. Naval Institute Proceedings*, June 2001, pp. 30-33.

reduced because a smaller warhead that lands precisely on a target can do the same amount of damage to the target as a larger warhead that lands less precisely. As a result, it could be argued, payload related to weapons and weapon launchers can be reduced without reducing the ship's capability. Any improvements in technology that would permit a reduction in the weight and volume of sensors (e.g., radars or sonars) could lead to a similar argument relating to the sensor portion of a ship's payload.

Detectability and Survivability

Supporters of larger ships could argue that with careful design and construction, a large ship can be made no more susceptible to detection by enemy sensors (e.g., radars, sonars, or infrared sensors) than a much smaller ship. They could also argue that other things held equal, larger ships and ships built to military survivability standards are better able to withstand a hit from a weapon of a given size than a smaller ship or a ship built with an equal-sized commercial-like hull. A larger ship or a ship built to military survivability standards, they could argue, might be able to continue operations to some degree after being hit, or would at least would not be sunk, whereas a smaller ship or a ship built with a commercial-like hull is more likely to be sunk or rendered completely operable.

Supporters of smaller ships or ships built with commercial-like hulls could argue that making larger ships less detectable adds to their cost, and that a fleet composed of a large number of small ships could, by presenting the enemy with a large number of targets, overwhelm the enemy's target-tracking capabilities.[34] They could also argue that even large ships built to military survivability standards can be sunk or put out of operation, and that a fleet consisting of a relatively small number of such ships concentrates too large a fraction of the fleet's total capability and replacement value in each individual platform. They could argue that the most important measure of survivability is not individual-ship survivability but overall fleet survivability, and that a fleet consisting of a larger number of smaller ships can have superior overall fleet survivability. They could also argue that U.S. leaders might be averse to using expensive, highly capable Navy ships in certain high-threat situations because they would not want to risk one or more of them being heavily damaged or sunk, in which case the effective utility of these ships would be reduced.

Mobility

Nuclear Power

Since nuclear propulsion plants do not require access to the atmosphere to generate power, equipping a submarine with a nuclear propulsion plant produces a fundamental change in ship mobility and consequently in the kinds of operations for which the submarine may be suitable. Some observers, particularly supporters of nuclear-powered submarines, have stated that without nuclear power, ships referred to as submarines are simply submersibles—ships that occasionally and for limited periods of time operate below the surface—and that it is the addition of nuclear power that creates a true submarine—a ship whose primary operating environment is below the surface.

As mentioned earlier, an AIP system such as a fuel-cell or closed-cycle diesel engine extends the stationary or low-speed submerged endurance of a non-nuclear-powered submarine. A conventional diesel-electric submarine has a stationary or low-speed submerged endurance of a

[34] The OFT report makes the second argument.

few days, while an AIP-equipped submarine may have a stationary or low-speed submerged endurance of up to two or three weeks.

An AIP system does not, however, significantly increase the high-speed submerged endurance of a non-nuclear-powered submarine. A non-nuclear-powered submarine, whether equipped with a conventional diesel-electric propulsion system or an AIP system, has a high-speed submerged endurance of perhaps 1 to 3 hours, a performance limited by the electrical storage capacity of the submarine's batteries, which are exhausted quickly at high speed.

In contrast, a nuclear-powered submarine's submerged endurance, at any speed, tends to be limited by the amount of food that it can carry. In practice, this means that a nuclear-powered submarine can remain submerged for weeks or months at a time, operating at high speeds whenever needed.

As a consequence of their very limited high-speed submerged endurance, non-nuclear-powered submarines, even those equipped with AIP systems, are not well suited for submarine missions that require:

- long, completely stealthy transits from home port to the theater of operation,
- submerged periods in the theater of operation lasting more than two or three weeks, or
- submerged periods in the theater of operation lasting more than a few hours or days that involve moving the submarine at something more than low speed.

With regard to the first of the three points above, the OFT report proposes transporting the AIP submarines into the overseas theater of operations aboard a transport ship.[35] In doing so, the OFT report accepts that the presence of a certain number of U.S. AIP submarines in the theater of operations will become known to others. A potential force-multiplying attribute of having an SSN in a carrier strike group, in contrast, is that the SSN can be detached from the strike group, and redirected to a different theater to perform some other mission, without alerting others to this fact. Opposing forces in the strike group's theater of operations could not be sure that the SSN was not in their own area, and could therefore continue to devote resources to detecting and countering it. This would permit the SSN to achieve military effects in two theaters of operation at the same time—the strike group's theater of operations, and the other theater to which it is sent.

With regard to the second and third points above, the effectiveness of an AIP submarine would depend on what kinds of operations the submarine might need to perform on a day-to-day basis or in conflict situations while operating as part of a forward-deployed carrier strike group.

For aircraft carriers, the effects of adding nuclear power are less dramatic than they are for submarines, but still significant. Nuclear-powered carriers can make high-speed transits over long distances to respond to urgent crises without need for stopping or slowing down to refuel along the way. They do not need to be refueled upon arriving at the area of operations, permitting them to commence combat operations immediately upon arrival. And since they do not need large fuel tanks to store fossil fuel for their own propulsion plant, they can devote more of their internal volume to the storage of aircraft fuel and ammunition, which permits them to sustain combat operations for longer periods of time before they need to be resupplied.

[35] The strategy of transporting the AIP submarines to the theater using transport ships is not mentioned in the report but was explained at a Feb. 18, 2005 meeting between CRS and analysts who contributed to the OFT report.

Maximum Speed

Proponents of higher-speed ships like the LCS, the 13,500-ton carrier recommended in the OFT report, or the 1,000- or 100-ton surface combatants recommended in the OFT report, argue that the higher maximum speeds of these ships increases their capability by enabling them to shift locations more rapidly and making them more difficult for the enemy to track and target. Skeptics could argue that the advantages of ship speeds much higher than about 30 knots are unproven or overrated.

Ship Numbers In Naval Operations

Advocates of a fleet with a larger number of ships, which is something that might be facilitated by shifting to lower-cost ship designs, argue that a ship cannot be in two places at the same time, and consequently that a fleet with a larger number of ships would be better able to maintain a day-to-day presence in multiple locations around the world or be better able to respond to simultaneous crises or conflicts in multiple locations. A fleet consisting of a larger number of less-capable ships, they could argue, might offer more flexibility for responding to situations with an appropriate amount of naval capability, as opposed to being forced to deploy a naval force with more capability than needed at a high daily O&S cost.[36] Advocates of a fleet with a larger number of ships could also argue that under the theory of network-centric warfare, the capability of the force grows as a function of the number of nodes (e.g., ships, aircraft, unmanned vehicles, and distributed sensors) that make up the network, and that increasing the number of ship nodes will consequently increase the total capability of the force.[37] Advocates who make this last argument in some cases might argue that in light of networking and other advanced technologies, U.S. military forces in general should shift to less concentrated and more highly distributed force designs.

Defenders of a fleet consisting of a smaller number of more-expensive ships could argue that being able to deploy ships to a greater number of locations around the world might be of limited value if those ships are less-capable designs that are not capable of performing required missions. They could also argue that the Navy has taken steps in recent years to increase the fraction of the fleet that is deployed, or ready to be deployed, at any given time, mitigating the effects of having a relatively limited total number of ships in the fleet.[38] They could argue that current ship designs already provide adequate flexibility for creating naval formations with appropriate amounts of capability for responding to various situations. They could also argue that when numbers of aircraft, unmanned vehicles, and distributed sensors are taken into account, a fleet consisting of a smaller number of more-expensive ships would still have an adequate number of nodes for engaging in network-centric warfare.

Technical Risk

Of the lower-cost options outlined earlier, those that might pose some technical risk for the Navy include the AIP-equipped non-nuclear-powered submarine (because a non-nuclear-powered submarine has not been designed and built for the U.S. Navy since the 1950s), the Tango Bravo

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[36] The OFT report makes this point from a budgetary perspective as well, arguing that a fleet consisting of lower-cost ships can be adjusted in size more smoothly to adapt to changes in available funding levels.

[37] For more on network-centric warfare, see CRS Report RL32411, *Network Centric Operations: Background and Oversight Issues for Congress*, by Clay Wilson; and CRS Report RS20557, *Navy Network-Centric Warfare Concept: Key Programs and Issues for Congress*, by Ronald O'Rourke.

[38] For additional discussion of this point, see CRS Report RS21338, *Navy Ship Deployments: New Approaches—Background and Issues for Congress*, by Ronald O'Rourke.

nuclear-powered submarine (because of the need to mature the Tango Bravo technologies), the 13,500-ton high-speed carrier (because of its fairly large SES/catamaran hull design), and perhaps the 1,000- and 100-ton surface combatants (because of the new technologies that are intended to increase their payload fractions).

Homeporting Arrangements

Smaller ships might offer a wider range of homeporting possibilities because some ports might not have large enough berthing spaces or deep enough waters to accommodate ships of more than a certain size.

Homeporting a nuclear-powered carrier or submarine can be a more complex undertaking than homeporting a conventionally powered ship due to requirements that are unique to nuclear-powered ships, such as having access in the home port to a nuclear-certified maintenance shop. In addition, gaining permission to forward-homeport a Navy ship in a foreign country can be politically more difficult if the ship in question is nuclear-powered and there are substantial anti-nuclear sentiments in the intended host country.

Impact On Shipbuilding Industrial Base

Lower-cost ship designs could affect the shipbuilding industrial base by changing the total volume of Navy shipbuilding work or the distribution of that work among various shipyards.

Total Volume Of Work

The total volume of Navy shipbuilding work is to a large degree a function of the total amount of funding available for Navy ship procurement. Consequently, the effect that shifting to lower-cost designs might have on the total volume of shipbuilding work would depend to a large degree on whether the shift somehow affects the total amount of funding available for Navy ship procurement. At least three scenarios are possible:

- One possibility is that shifting to lower-cost designs does not substantially affect the total amount of funding available for Navy ship procurement, in which case the total volume of Navy shipbuilding work might not change substantially.
- A second possibility is that the shift to lower-cost designs is used to reduce the total cost of building the same total number of ships as previously planned, in which case the total volume of Navy shipbuilding work would be reduced.
- A third possibility is that the shift to lower-cost designs makes Navy ships appear more cost-effective compared to competing Navy or DOD programs, in which case the total amount of funding available for Navy ship procurement might be increased, enabling an increase in the total volume of Navy shipbuilding work.

Distribution Of Work Among Shipyards

The lower-cost ship designs in this report could affect the distribution of shipbuilding work among various shipyards in one or more of the following ways:

- **Attack submarines.** A Tango Bravo nuclear-powered submarine would be designed and built by one or both of the country's two current nuclear-submarine construction shipyards—General Dynamics' Electric Boat (GD/EB) of Groton, CT, and Quonset Point, RI, and Northrop Grumman Newport News (NGNN) of Newport News, VA. If both GD/EB and NGNN are involved in the program, the division of work between the two yards could be different than the current, roughly even, division of work the two yards have for building Virginia-class submarines. An AIP-equipped non-nuclear powered submarine could be designed and built by GD/EB or NGNN, or by a non-nuclear shipyard, such as the Ingalls shipyard at Pascagoula, MS, that forms part of Northrop Grumman Ship Systems (NGSS). Ingalls has been associated with past proposals for building non-nuclear-powered submarines for export to foreign countries. If AIP submarines were procured in lieu of nuclear-powered submarines, that could reduce the total amount of work available to U.S. naval nuclear propulsion component manufacturers, many of whom are sustained by the work provided by the Navy's nuclear submarine and aircraft carrier programs.

- **Aircraft carriers.** NGNN is the only U.S. yard that can build large nuclear-powered carriers (and the only yard that could readily build large conventionally powered carriers). A medium-sized, conventionally powered carrier based on the LHA(R) design could be built by NGNN or by another yard, such as Ingalls, the builder of previous ships similar to the LHA(R). A medium-sized, conventionally powered carrier based on a merchant-like hull could be built by NGNN, Ingalls, or other shipyards, particularly those with experience building merchant-like hulls, such as the Avondale shipyard near New Orleans that also forms part of NGSS or General Dynamics' National Steel and Shipbuilding Company (GD/NASSCO) of San Diego, CA. A small, high-speed carrier using an SES/catamaran hull design might be built at a number of yards, particularly any that might have experience building SES/catamaran hulls. If conventionally powered carriers were procured in lieu of nuclear-powered carriers, that could reduce the total amount of work available to U.S. naval nuclear propulsion component manufacturers, many of whom are sustained by the work provided by the Navy's nuclear submarine and aircraft carrier programs. In terms of the amount of work provided to these manufacturers, a carrier nuclear propulsion plant is considered roughly equivalent to five submarine nuclear propulsion plants.
- **Larger surface combatants.** DDG-1000 destroyers are to be built at NGSS (particularly Ingalls) and General Dynamics' Bath Iron Works (GD/BIW) of Bath, ME. A 11,000-ton SCD, a 6,000-ton FFG(X), or a low-cost gunfire support ship would likely be built at one or both of the same yards, but could also be built at other yards, such as Avondale or NGNN. If built at both NGSS and GD/BIW, the division of work between the two yards might not be the same as would occur under the DDG-1000 program.
- **Smaller surface combatants.** One version of the LCS is to be built at Marinette Marine of Marinette, WI, and Bollinger Shipyards of Louisiana and Texas. The other version is to be built at the Austal USA shipyard at Mobile, AL. A 1,000- or 100-ton surface combatant could be built at either of these yards or at other yards, particularly yards that focus on building smaller ships.

Legislative Activity For FY2007

FY2007 Defense Authorization Act (H.R. 5122/P.L. 109-364)

House

Sections 122, 123, and 124 of H.R. 5122 would limit the procurement costs of CVN-21 class aircraft carriers, LHA(R) class ships, and LPD-17 class ships, respectively, to current Navy cost estimates, with adjustments permitted for inflation and other factors. Section 1014 would establish a shipbuilding industrial base improvement program.

The House Armed Services Committee, in its report (H.Rept. 109-452 of May 5, 2006) on H.R. 5122, stated:

> The rising cost and lengthening production schedules of major defense acquisition programs has led to more expensive platforms fielded in fewer numbers. The committee believes that internal DOD pressure to develop follow-on weapons systems that include all necessary and anticipated military capabilities may create an over-reliance on individual ‘‘mega’’ systems that are potentially more expensive and time-consuming to develop than less sophisticated but capable systems. These increases in cost and development time generally result in smaller numbers of platforms purchased, creating a ‘‘high demand, low density’’ situation in which the needed platforms have higher operational tempos, wear out faster, increase stress on military personnel, undermine the ability to conduct traditional presence missions intended to shape the strategic choices of potential adversaries and limit the strategic depth of United States forces responding to multiple contingencies. (Pages 14-15; see also pages 350-351)

Regarding the affordability of the Navy's shipbuilding plan, the report stated:

> The committee applauds the Chief of Naval Operations for developing the Navy's future force structure and the accompanying long-term shipbuilding plan to build it. This long-term plan provides the shipbuilding industry a view into the future that has been lacking.
>
> However, the committee is concerned that the plan was developed using unrealistic assumptions that will not make the plan executable. Of greatest concern to the committee is the affordability of the ship construction plan. According to the Navy's estimates, execution of this plan requires a significant increase in shipbuilding funds from $8.7 billion in fiscal year 2006 to $17.2 billion in fiscal year 2011. Obtaining these additional funds in a period of anticipated federal spending reductions will be difficult. The plan also assumes that individual ship acquisition programs can avoid the cost growth that has plagued most Navy ship acquisition programs.
>
> The committee is concerned about the affordability of the Navy's long-term shipbuilding plan, recreating much of the uncertainty about the future of naval shipbuilding that the plan was designed to eliminate. (Page 67)

The report also stated:

> The committee is concerned that the U.S. shipbuilding/ship repair industrial base has significant capacity beyond what is necessary for all anticipated DOD new construction and maintenance work, and believes that Navy ship acquisition programs are paying the price....
>
> The committee directs the Secretary of the Navy to report to the congressional defense committees on measures that can be taken to manage the capacity of the shipbuilding/ship repair industrial base in a manner that would make Navy shipbuilding more affordable.

> Such report shall be submitted by the submission of the President's request for fiscal year 2008, as required by section 1105 of title 31, United States Code. (Pages 70-71)

Regarding the Navy's cost estimates for ships, the report stated:

> The committee is deeply concerned about the process used for establishing the Navy's ship cost estimates. The committee notes that the original cost estimates on numerous existing ship classes have regularly been described by the Navy as inaccurate and unrealistic when those ships near completion of construction. The committee notes that in several cases it has been informed that ship cost estimates delivered to the committee in prior years either intentionally or unintentionally excluded certain known shipbuilding costs such as escalation, and that these cost estimates were known to be inaccurate on the day they were first delivered to the committee. The committee recommends that the process for deriving ship cost estimates be revised to ensure that all major known elements of ship cost are routinely included in all ship cost estimates.
>
> The committee notes that Sections 122, 123, and 124 of the bill would impose cost limitations on three current ship classes based on the Navy's latest costs estimates. The committee further notes that the imposition of these statutory cost limitations makes the need for a high level of confidence in the cost estimates for these ship classes unusually important. Accordingly, the committee directs that the Secretary of the Navy revalidate the cost estimates for CVN-21, for the ships currently programmed in the LHA Replacement program, and for the eight ships of the San Antonio class amphibious ship that follow the lead ship. The committee further directs that the revalidated costs estimates be submitted for review and approval by the Under Secretary of Defense for Acquisition, Technology, and Logistics. Finally, the committee directs that no later than July 1, 2006, the Secretary of the Navy submit a report in writing to the congressional defense committees containing the revalidated cost estimates for these ship classes including a certification by the Secretary that all known and anticipated major elements of cost have been included in the estimate. (Page 71)

Regarding the DDG-1000 program, the report also stated:

> The committee does not believe the DD(X) is affordable.... the committee understands there is no prospect of being able to design and build the two lead ships for the $6.6 billion budgeted....
>
> Originally, the Navy proposed building 32 next generation destroyers, reduced that to 24, then finally to 7 in order to make the program affordable. In such small numbers, the committee struggles to see how the original requirements for the next generation destroyer, for example providing naval surface fire support, can be met.... By reducing the requirements for the DD(X), a smaller, less expensive destroyer could be procured in greater numbers. Because of its expense, the committee does not believe that DD(X) will be procured in sufficient numbers to meet the operational need.... The committee supports the construction of up to two DD(X)s to demonstrate technologies that could be incorporated into future, more affordable, major surface combatants. (Pages 69-70)

Regarding Section 1014 and other measures intended to improve the efficiency of Navy shipbuilding, the report states:

> *Maritime technology*
>
> The budget request contained no funds in PE 78730N for the maritime technology program.
>
> The committee understands that the purpose of the maritime technology (MARITECH) program is to reduce the cost of naval ship construction, modification, and repair by enhancing the efficiency and competitiveness of the U.S. shipbuilding and ship repair industries. The committee understands that since the late 1970s the Navy has considered capital for facility investments to be an allowable cost on contracts that are not firm fixed

price. The committee is also aware that in the past three years, the Navy and industry have agreed to specific recapitalization contract incentives in the Virginia class submarine and the CVN-21 programs. These incentive clauses have allowed the Navy and the contractors to identify improvements in sequencing and build processes to lower construction costs. The committee encourages the expansion of these efforts to all ship procurements, including the Lewis and Clark (T-AKE) class program.

The committee includes a provision (section 1014) that creates a shipbuilding industrial base improvement program through which the Secretary of the Navy shall award grants and loan guarantees to qualified shipyards to improve their productivity and cost effectiveness. These authorities will allow the Navy to work to an even greater extent with shipbuilders to identify and finance process changes, equipment investments, and facilities improvements to lower the cost of Navy ship procurement. The committee expects that these authorities will allow the Navy to achieve savings in the construction of the T-AKE class ships, in addition to other ship classes, and improve the competitiveness of U.S. shipyards. Consequently, the committee recommends providing funds for the shipbuilding industrial base improvement program and for the enhancement of the U.S. shipbuilding and ship repair industrial base.

The committee recommends $120.0 million in PE 78730N for the maritime technology program.

National shipbuilding research program

The budget request contained no funds in PE 78730N for the national shipbuilding research program.

The committee understands that the national shipbuilding research program (NSRP) provides a unique collaborative environment where shipbuilders and government agencies examine processes, tooling and management techniques to improve the efficiency of the United States shipbuilding industry. The committee understands that NSRP operates on a 50-50 cost share between government and industry, all results are shared with all members, and a conservative estimate for NSRP's return on investment is five to one.

The committee recommends $20.0 million in PE 78730N for the national shipbuilding research program.

Shipbuilding industrial base improvement grants

The budget request contained no funds in PE 78730N for shipbuilding industrial base improvement grants.

The committee understands the national security importance of sustaining viable and efficient shipbuilding and ship repair industries in the United States. Accordingly, the committee recommends providing grants to U.S. shipyards to facilitate the development of innovative design and production technologies and processes for naval vessel construction, and the development of modernized shipbuilding infrastructure.

The committee recommends $50.0 million in PE 78730N for shipbuilding industrial base improvement grants.

Shipbuilding industrial base improvement loan guarantees

The budget request contained no funds in PE 78730N for shipbuilding industrial base improvement loan guarantees.

The committee understands the national security importance of sustaining viable and efficient shipbuilding and ship repair industries in the United States. Accordingly, the committee recommends providing loan guarantees to U.S. shipyards to facilitate the acquisition of technologies, processes and infrastructure to enhance the efficiency and competitiveness of the U.S. shipbuilding and ship repair industries.

> The committee recommends $50.0 million in PE 78730N for shipbuilding industrial base improvement loan guarantees. (Pages 192-193)

Senate

Section 121 of S. 2766 would authorize 4-year incremental funding and economic order quantity (EOQ) purchases of long-lead components for CVN-21 class aircraft carriers. Section 123 would increase a previously legislated cost limit on CVN-77 to $6,057 million.

Regarding Section 121 on procurement of aircraft carriers, the Senate Armed Services Committee, in its report (S.Rept. 109-254 of May 9, 2006) on S. 2766, stated:

> In reviewing the budget request for fiscal year 2006, the committee received testimony from the Navy and industry that the low rate of shipbuilding was driving higher costs, which in turn further reduced shipbuilding rates, creating a downward spiral. The committee believes that stable ship requirements, increased funding in the shipbuilding budget, and increased flexibility for funding large capital ships are critical elements of any strategy to reverse this trend....
>
> Elsewhere in this report, the committee has expressed concern with cost growth on the CVN-77 program, and has urged the Navy and the shipbuilder to identify opportunities to improve affordability of future aircraft carriers. Procurement delays, excess inflation, and material escalation have been reported as significant contributors to CVN-77 cost growth. The shipbuilder has proposed to achieve significant CVN-21 class program savings through a stable procurement plan, and through procurement of economic order quantity material for CVN-79 and CVN-80 in conjunction with CVN-78 procurement.
>
> In view of the potential for significant program savings, the committee recommends an increase of $50.0 million in SCN for CVN-21 class advance procurement, and directs the Secretary of the Navy to review economic order quantity and long lead time material procurement for the CVN-21 class. The Secretary is to submit a report to the congressional defense committees with the fiscal year 2008 budget request, outlining the advance procurement requirements to potentially optimize economic order quantity savings and escalation avoidance (to include offsetting factors) for the first three vessels of the CVN-21 class. Of the amount authorized to be appropriated for advance procurement for CVN-79 and CVN-80, none of the funds are available for obligation prior to 30 days following receipt of the Secretary's report. (Page 67)

Regarding Section 123 on the cost limit for CVN-77, the report states:

> The procurement cost increase to $6.057 billion, which equals the government's maximum contractual liability, is attributed to extraordinary escalation impacts, increased labor hours and overhead rates, and costs related to schedule delays. The fiscal year 2007 budget request included $348.4 million for CVN-77 cost growth, with the balance of additional funding to be included in future budget requests. The committee is aware that the Navy has taken a series of management actions to contain cost on CVN-77, including deferral of upgrades that are not required for safe system operation or certification; minimization of contract change orders; implementation of a joint Navy-shipbuilder Lean Six-Sigma program; and a schedule revision to enable a more efficient completion of CVN-77. The committee is concerned, however, that despite these management actions, the Navy is projecting CVN-77 cost to grow to the contract ceiling, in excess of 30 percent above the baseline cost cap.
>
> The committee notes that the Secretary's report to Congress on the long-range plan for construction of naval vessels establishes cost estimates for future ship construction, which target improved performance based on a series of management actions similar to ongoing efforts to control CVN-77 cost. Visibility into cost performance while completing CVN-77 is necessary in order to assess the effectiveness of these management actions, and will

> assist in determining further actions necessary to improve affordability of the future force. Improved visibility into completion cost performance will also afford greater opportunity to deliver CVN-77 below the contract ceiling. Accordingly, the Secretary of the Navy is directed to submit a quarterly report to the congressional defense committees, beginning December 1, 2006, providing the following information regarding the CVN-77 ship construction contract:
>
> (1) contract target cost;
>
> (2) Program Manager's Estimate at Completion;
>
> (3) contractor's Estimate at Completion;
>
> (4) contract ceiling price;
>
> (5) end of period actual costs; and
>
> (6) percent progress. (Page 69)

Regarding the Littoral Combat Ship (LCS) program, the report states:

> The construction of lead LCS vessels at two shipyards inherently adds cost risk, which will persist until these ships near completion in 2007 and 2008. The emphasis on cost control would dictate that the Navy pursue competition, commonality, and the results of learning curves to the extent practical in the procurement of this 55 ship class.
>
> The committee views LCS as an important component of the Navy's strategy for conducting the global war on terror, and has supported the Navy's approach to rapidly field this capability. The design and construction of LCS in parallel with development of the mission modules requires heightened management of program risk to ensure affordable, full mission capability of the LCS program. However, the committee is concerned that the affordability appeal of the LCS program is being overtaken by apparent cost growth, and that the rapid ramp up in LCS procurement will compound the issue. The stated emphasis on affordability is obscured by the absence of a clear acquisition strategy to guide strategic program decisions.
>
> Additionally, it is unclear that the Navy has assessed the added cost for training, maintenance, configuration management, planning and engineering, and supply support for the two flight 0 ship classes. Further, by virtue of budgeting the costs for procuring the flight 0 LCS vessels in three different appropriations, total costs for the program's start are difficult to discern. In view of these concerns, the committee directs the Secretary of the Navy to submit a report on the LCS program, no later than December 1, 2006 to the congressional defense committees. The report shall outline the Navy's acquisition strategy for the program, including the competition plan, the flight strategy, and the cost containment strategy for the program; contain a clear representation of all R&D and procurement costs for the total program; and assess the added life cycle costs associated with operation and support for two dissimilar flight 0 LCS designs. (Page 113)

Regarding shipyard costs and efficiency, the report states:

> The budget request included no funding in PE 78730N for maritime technology. The National Shipbuilding Research Program-Advanced Shipbuilding Enterprise (NSRP-ASE) is a collaborative effort between the Navy and industry, which has yielded new processes and techniques that reduce the cost of building and repairing ships. Annual Navy funding, which is matched and exceeded by industry investment, has achieved savings and cost avoidance for the Navy, a positive return on investment, and a high research-to-implementation transition rate. The committee believes that continuation of the NSRP-ASE provides a vital contribution towards achieving the overarching objective of improving the affordability of naval warship construction and maintaining a healthy, innovative shipbuilding industrial base. The committee recommends an increase of $10.0 million in PE 78730N to support NSRP-ASE efforts, including:

> (1) establishing a comprehensive national program for development and training of a skilled shipbuilding production and engineering workforce;
>
> (2) establishing a concept for a national supply chain that will enable leveraging buying power across product lines in an effort to reduce the high cost of material in ship construction;
>
> (3) exploring secondary and commercial markets for private shipbuilders to broaden the business base and share the overhead applied to naval shipbuilding; and
>
> (4) developing and deploying an industry-wide architecture for computer interoperability. (Pages 181-182)

Conference Report

Section 121 of H.R. 5122 (conference report H.Rept. 109-702 of September 29, 2006) authorizes 4-year incremental funding for the CVN-21 class aircraft carriers CVN-78, CVN-79, and CVN-80. Section 122 establishes unit procurement cost caps for CVN-21 class aircraft carriers. Section 123 increases a previously legislated procurement cost cap for the CVN-77 aircraft carrier. Section 125 establishes a unit procurement cost cap for LHA(R) amphibious assault ships. Section 126 establishes unit procurement cost caps for four LPD-17 class amphibious ships. Section 215 authorizes $4 million for implementing or evaluating Navy shipbuilding technology proposals under the Defense Acquisition Challenge Program. Section 1016 directs the Navy to conduct an assessment of naval vessel construction efficiencies and of the effectiveness of special contractor incentives. The sections establishing new procurement cost caps allow the caps to be adjusted upward for inflation and other factors.

Regarding Section 122, the report states:

> The amendment would not provide the Secretary authority to adjust the limitation amounts for cost increases attributable to congressional actions that impact on the shipbuilding program of record. However, the conferees understand that such action could have significant impact on program cost, and therefore direct that the Secretary include, within the annual written notice to the congressional defense committees regarding changes to the cost limitations, an assessment of any negative impact of congressional action on program costs.
>
> The conferees understand that the CVN–21 class budget represents the Navy's risk-balanced assessment of the cost for completing design and construction of the future class of nuclear powered aircraft carriers. The conferees recognize that many uncertainties remain with regard to completion of CVN–21 design and construction, including innumerable, inestimable events which will impact cost during the next 15 years of performance on the program. Accordingly, the amendment would allow adjustment to the cost limitation for non-recurring design and engineering in order to enable the Navy to reduce this risk in the execution of the design effort.
>
> The conferees expect that the Navy will ultimately manage program execution within the bounds of the budget estimate. Accordingly, the conferees understand that compliance with this provision will require procurement cost trade-offs to be accomplished, which could reduce the capabilities, system performance, safety, crew quality of life, future growth margin, or other important factors in the design and construction of the CVN–21 class. The conferees believe that most of these trade-offs will be within the purview of the program office and requirements office. However, the Secretary shall notify the Committees on Armed Services of the Senate and the House of Representatives not less than 30 days prior to implementing any cost-driven reduction which would unacceptably impact safety, crew quality of life, or otherwise preclude the program from meeting the requirements of the CVN–21 Operational Requirements Document. The Secretary's notification shall identify

> the specific characteristic proposed to be reduced and the cost avoidance provided by such reduction. (Page 552)

Regarding Section 125, the report states:

> The amendment would not provide the Secretary authority to adjust the limitation amounts for cost increases attributable to congressional actions that impact on the shipbuilding program of record. However, the conferees understand that such action could have significant impact on program cost, and therefore direct that the Secretary include, within the annual written notice to the congressional defense committees regarding changes to the cost limitations, an assessment of any negative impact of congressional action on program costs.
>
> The conferees understand that the LHA-6 budget represents the Navy's risk-balanced assessment of the cost for completing design and construction of the future LHA Replacement ship. The conferees recognize that many uncertainties remain with regard to completion of LHA-6 design and construction, including innumerable, inestimable events which will impact cost during the next 6 years of performance on the program. Accordingly, the amendment would allow adjustment to the cost limitation for non-recurring design and engineering in order to enable the Navy to reduce this risk in the execution of the design effort.
>
> The conferees expect that the Navy will ultimately manage program execution within the bounds of the budget estimate. The conferees understand that compliance with this provision will require procurement cost trade-offs to be accomplished, which could reduce the capabilities, system performance, safety, crew quality of life, future growth margin, or other important factors in the design and construction of the LHA Replacement ship. The conferees believe that most of these trade-offs will be within the purview of the program office and requirements office. However, the Secretary shall notify the Committees on Armed Services of the Senate and the House of Representatives not less than 30 days prior to implementing any cost-driven reduction which would unacceptably impact safety, crew quality of life, or otherwise preclude the program from meeting the requirements of the LHA Replacement program Capability Development Document. The Secretary's notification shall identify the specific characteristic proposed to be reduced and the cost avoidance provided by such reduction. (Pages 553-554)

FY2007 Defense Appropriations Act (H.R. 5631/P.L. 109-289)

House

The House Appropriations Committee, in its report (H.Rept. 109-504 of June 16, 2006) on H.R. 5631, stated that

> the Committee believes that the viability of the Navy's long range [shipbuilding] plan will remain tied to the service's ability to control costs in ship design and construction. Navy leadership agrees that cost control is essential, but the Navy has produced no plan or initiatives to meet the cost targets assumed in the long range shipbuilding plan. Furthermore, the recent history of ongoing shipbuilding programs indicates the trend in cost growth may be getting worse, and not better. The Committee encourages the Navy to set firm cost targets in its future shipbuilding programs, to develop specific initiatives addressing cost control, and to sign contracts that reduce the likelihood of cost growth. (Page 139)

The report recommended reducing by $141.4 million the Navy's request for FY2007 procurement funding to cover cost growth on ships procured in prior years. The report stated:

The Committee remains concerned over the lack of cost control in Navy shipbuilding programs. In last year's report, the Committee noted the rising cost growth in ongoing ship construction contracts, and required the Navy to submit a plan on resolving these issues. That report was submitted two months late, and was little more than a summary of cost overruns in shipbuilding over the past two decades. The Committee is concerned about the gap between the Navy's public statements about the need for firm cost controls, and the programmatic and contractual actions needed to accomplish that objective. Navy briefings this year document a litany of programs, including the CVN-77 aircraft carrier and certain attack submarines of the Virginia class, that continue to defy attempts to control costs. The Navy estimates an overrun of $867,900,000 over the next 3 years alone in the CVN-77 production effort. These funds cannot be obligated without Congressional legislation to raise the current cost cap on the program—a cap that was put in place several years ago to control costs. The fiscal year 2007 budget requests $136,000,000 for further cost growth in the U.S.S. Texas (SSN-775), and cost performance on the U.S.S. North Carolina (SSN-777) is seriously below Navy expectations. In fact, current cost performance on the Virginia class jeopardizes the ability of the Navy to meet the performance goals of the multiyear contract signed in 2004 as well as cost targets needed to increase the submarine production rate in future years. The Committee is unwilling to provide increased appropriations for cost overruns in the absence of compelling justification or a realistic and detailed plan for cost control. The Committee recommendation provides $436,449,000 for Completion of Prior Year Shipbuilding Programs, a reduction of $141,400,000 from the request. The reduction should be allocated against the following programs: CVN-77 (-$30,000,000); SSN-777 (-$48,000,000); SSN-776 (-$10,000,000); SSN-775 (-$10,000,000); and the LPD-17 class (-$43,400,000). (Page 140)

Appendix. Other Options for Responding to Rising Ship Costs

Aside from reducing planned ship procurement rates or shifting or shifting to lower-cost ship designs, one option for responding to rising Navy ship procurement costs would be to increase annual ship-procurement funding. The Navy's proposed FY2007 budget and the FY2007-FY2011 shipbuilding plan propose increasing annual funding for ship construction to an average of roughly $14.4 billion per year in constant FY2007 dollars. Increasing annual ship-procurement funding substantially from current levels, however, may not be easy. In a situation of finite defense funding, increasing funding for Navy ship procurement could require reducing funding for other Navy or DOD priorities. The Navy has worked in recent years to operate more efficiently on a day-to-day basis so that the resulting savings could be applied to Navy procurement programs. In practice, however, savings from these efficiencies have been offset by rising Navy costs in other areas, such as personnel-related costs.

A second option would be to modify the way in which new Navy ships are funded in the budget. Possible changes that have been suggested include making greater use of incremental funding or starting to use advance appropriations. This option, which is examined in CRS Report RL32776,[39] might marginally increase the number of ships that could be procured for a given total amount of money. As discussed in that report, however, it could also pose potentially significant issues relating to Congress's power of the purse and Congress's responsibility for conducting effective oversight of DOD activities.

A third option would be to make greater use in Navy ship-procurement programs of a contracting method known as multiyear procurement (MYP). This option, like the previous one, might marginally increase the number of ships that could be procured for a given total amount of money. Not all Navy ship-procurement programs, however, would meet the legal requirements for MYP,[40] and making greater use of MYP could reduce DOD's and Congress's flexibility to adjust ship-procurement plans in future years to respond to changing strategic and budgetary circumstances.[41]

A fourth option would be to change the acquisition strategy for building certain Navy ships. For example, the Navy estimated in 2005 that changing from a strategy of dividing DDG-1000 destroyers evenly between two yards to a strategy of having all DDG-1000s built by a single yard could reduce the cost for building 10 DDG-1000s by a total of $3 billion, or an average of $300 million per ship.[42] Shifting to a single-yard acquisition strategy, however, could cause the second yard to permanently exit the business of building that kind of ship. That could leave the Navy with a single source for building that kind of ship, which could prevent the Navy in the future from using competition or benchmarking[43] to spur design innovation, constrain costs, maintain production quality, and ensure adherence to scheduled delivery dates.

Another potential change in acquisition strategy would be to make greater use of competition in Navy ship acquisition. Competition is used today in Navy ship acquisition primarily in the early stages of ship-acquisition programs, to determine who will design and build the lead ship in each

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[39] CRS Report RL32776, *Navy Ship Procurement: Alternative Funding Approaches—Background and Options for Congress*, by Ronald O'Rourke. (Hereafter cited as CRS Report RL32776.)

[40] These requirements are set forth in 10 U.S.C. § 2306b, the statute governing MYP arrangements.

[41] For further discussion, see CRS Report RL32776.

[42] See CRS Report RL32109.

[43] Benchmarking, which can take place in the absence of active competition, is the process of using one yard's performance in building a certain kind of ship to help measure or judge the performance of another yard in building that kind of ship.

new class. Making greater use of competition in Navy ship acquisition could involve using competition between shipyards in awarding contracts for building follow-on ships in each class. This step, if taken, would represent a return to Navy practices in the 1980s. Employing competition in the awarding of contracts for building follow-on ships, however, requires either an annual procurement rate for the class of ship in question that is high enough so that the government can contemplate giving ships to one yard or another without endangering the financial health of either yard, or a willingness on the part of the government to have contract award lead to a decision by the losing yard to permanently withdraw from the business of building that kind of ship, or Navy ships generally. In the latter case, the Navy's contract-award decision could leave the Navy with a single source for that kind of ship in the future.[44]

A fifth option would be to take steps to reduce the amount of shipyard fixed overhead costs that are incorporated into the procurement costs of Navy ships. This could be accomplished by eliminating any excess capacity among the yards building Navy ships, which would eliminate the fixed overhead costs associated with maintaining that capacity, or by increasing other kinds of work done by those yards, so that this other work could absorb a greater portion of the yards' fixed overhead costs. Potential other forms of work include construction of ships for other U.S. government agencies, such as the Coast Guard or the National Oceanic and Atmospheric Administration (NOAA), construction of commercial ships, overhaul and repair of Navy or other U.S. government ships, and overhaul and repair of commercial ships.

A sixth option would be to improve the operating efficiency of yards building Navy ships by incorporating more advanced design and production processes and equipment. The National Shipbuilding Research Program (NSRP) Advanced Shipbuilding Enterprise (ASE) is one effort aimed at this goal.[45] A May 2005 DOD report compares the operating efficiency of the yards that build the Navy's major ships relative to that of foreign shipyards that are considered to be among the world's most efficient, and makes recommendations for how to improve the operating efficiency of the U.S. yards.[46]

A seventh option would be to build Navy ships without some of their planned equipment (or with less expensive substitute equipment). Building a ship without some of its planned equipment (or with less expensive substitute equipment) would likely reduce its capabilities. Equipment not installed during the original construction process could be added back later, after the ship had entered service. This would restore the ship's lost capability but add back the cost of this equipment, in which case the ship's procurement cost, instead of being reduced, would have been partially deferred into the future. Installing this equipment on an in-service ship, moreover, may be more expensive than building it into the ship during its original construction process. As a consequence, this strategy over the long run could increase the procurement total cost of the ship above what it would have been if the ship had been built from the beginning with all its planned equipment.

An eighth option would be to build Navy ships in foreign shipyards where construction costs may be lower to due lower wages and material prices or other factors. Regarding this option, 10 U.S.C. § 7309 states that "no vessel to be constructed for any of the armed forces, and no major component of the hull or superstructure of any such vessel, may be constructed in a foreign shipyard." The provision permits the President to authorize exceptions when the President

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[44] For further discussion of competition in Navy ship acquisition, see David H. Lewis, "No Bucks, No Buck Rogers," *U.S. Naval Institute Proceedings*, May 2005, pp. 54-58.

[45] For more on this program, see the NSRP ASE website at http://www.nsrp.org/.

[46] U.S. Department of Defense, *Global Shipbuilding Industrial Base Benchmarking Study, Part I: Major Shipyards*, Washington, 2005, 184 pp. (May 2005, Office of the Deputy Under Secretary of Defense [Industrial Policy].)

determines that it is in the national security interest. In such cases, the President is to notify Congress of the determination, and no contract may be made until the end of the 30-day period beginning on the date on which the notice is received. The provision also exempts inflatable boats and rigid inflatable boats. In addition to 10 U.S.C. § 7309, the annual DOD appropriations act contains a provision in the section entitled "Shipbuilding and Conversion, Navy," stating that funds for Navy shipbuilding are made available for the fiscal year in question provided, among other things, "That none of the funds provided under this heading for the construction or conversion of any naval vessel to be constructed in shipyards in the United States shall be expended in foreign facilities for the construction of major components of such vessel: Provided further, that none of the funds provided under this heading shall be used for the construction of any naval vessel in foreign shipyards."

A recent report from the RAND Corporation provides additional discussion of why Navy ships cost much more today than they did decades ago, and of options for reducing the cost of Navy ships.[47]

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Disclaimer

[47] Mark V. Arena, Irv Blickstein, et al., *Why Has the Cost of Navy Ships Risen? A Macroscopic Examination of the Trends in U.S. Naval Ship Costs Over the Past Several Decades*, RAND Corporation, Santa Monica (CA), 2006. (National Defense Research Institute, MG-484-Navy) 98 pp.