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Navy Virginia (SSN-774) Class Attack Submarine Procurement: Background and Issues for Congress

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Summary

The Navy has been procuring Virginia (SSN-774) class nuclear-powered attack submarines (SSNs) since FY1998. The two Virginia-class boats that the Navy has requested for procurement in FY2019 would be the 29th and 30th boats in the class, and the first two to be covered under a multiyear procurement (MYP) contract for at least 10 Virginia-class submarines to be procured in FY2019-FY2023.

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2019 at $6,502.3 million (i.e., about $6.5 billion). The second of these two boats is to be the first Virginia-class boat built with the Virginia Payload Module (VPM), an additional, 84-foot-long, midbody section equipped with four large-diameter, vertical launch tubes for storing and launching additional Tomahawk missiles or other payloads. The Navy plans to build all Virginia-class boats procured in FY2020 and subsequent years with the VPM, and the Navy's FY2019 budget submission shows that VPM-equipped Virginia-class boats in FY2020 and beyond have an estimated recurring unit procurement cost of about $3.2 billion in today's dollars.

The two boats requested for procurement in FY2019 have received an estimated total of $2,128.9 million in prior-year "regular" advance procurement (AP) funding. (This figure is an estimate, because Congress has not yet completed action on the FY2018 Department of Defense appropriations act.) Based on this estimate, the Navy's proposed FY2019 budget requests the remaining $4,373.4 million in procurement funding needed to complete the boats' estimated combined procurement cost. The Navy's proposed FY2019 budget also requests $1,810.9 million in "regular" AP funding for Virginia-class boats to be procured in future fiscal years, and $985.5 million in additional Economic Order Quantity (EOQ) AP funding for components of Virginia-class boats to be procured under the FY2019-FY2023 Virginia-class MYP contract, bringing the total amount of procurement, "regular" AP, and EOQ AP funding requested for the program in FY2019 to $7,169.8 million (i.e., about $7.2 billion), excluding outfitting and postdelivery costs.

The Navy's force-level goal, released in December 2016, is to achieve and maintain a 355-ship fleet, including 66 SSNs. To increase the size of the SSN force toward the 66-boat goal, the FY2019 30-year shipbuilding plan includes 16 more SSNs than the Navy's previous (FY2017) 30-year shipbuilding plan. The first of the 16 additional SSNs is a second Virginia-class boat in FY2021. Under the Navy's FY2019 30-year shipbuilding plan, a 66-boat SSN force would be achieved in FY2048. CRS and CBO estimated in 2017 that adding even more SSNs to the earlier years of the 30-year shipbuilding plan could accelerate the attainment of a 66-boat force to as early as 2037. The Navy's FY2019 30-year shipbuilding plan shows options for adding another 12 SSNs to the 30-year plan, but only 3 of the 12 occur in the earlier years of the plan.

From the mid-2020s through the early 2030s, the number of SSNs is projected to experience a dip or valley, reaching a minimum of 42 boats (i.e., 24 boats, or about 36%, less than the 66-boat force-level goal) in FY2028. This projected valley is a consequence of having procured a relatively small number of SSNs during the 1990s, in the early years of the post-Cold War era. Some observers are concerned that this projected valley could lead to a period of heightened operational strain for the SSN force, and perhaps a period of weakened conventional deterrence against potential adversaries such as China. The projected SSN valley was first identified by CRS in 1995 and has been discussed in CRS reports and testimony every year since then. As one measure for mitigating this valley, the Navy's FY2019 budget submission proposes to refuel and extend the service life of one older Los Angeles (SSN-688) class submarine. The Navy states that this could become the first of as many as five Los Angeles-class SSNs to be refueled and have their service lives extended.

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Introduction

This report provides background information and issues for Congress on the Virginia-class nuclear-powered attack submarine (SSN) program. The Navy's proposed FY2019 budget requests $7,169.8 million (i.e., about $7.2 billion) in procurement and advance procurement (AP) funding for the program. Decisions that Congress makes on procurement of Virginia-class boats could substantially affect U.S. Navy capabilities and funding requirements, and the U.S. shipbuilding industrial base.

The Navy's Columbia (SSBN-826) class ballistic missile submarine program, previously known as the Ohio Replacement or SSBN(X) program, is discussed in another CRS report.[1]

For an overview of the strategic and budgetary context in which the Virginia-class program and other Navy shipbuilding programs may be considered, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by (name redacted) .

Background

U.S. Navy Submarines[2]

The U.S. Navy operates three types of submarines—nuclear-powered ballistic missile submarines (SSBNs),[3] nuclear-powered cruise missile and special operations forces (SOF) submarines (SSGNs),[4] and nuclear-powered attack submarines (SSNs). The SSNs are general-purpose submarines that can (when appropriately equipped and armed) perform a variety of peacetime and wartime missions, including the following:

- covert intelligence, surveillance, and reconnaissance (ISR), much of it done for national-level (as opposed to purely Navy) purposes;
- covert insertion and recovery of SOF (on a smaller scale than possible with the SSGNs);

[1] See CRS Report R41129, *Navy Columbia Class (Ohio Replacement) Ballistic Missile Submarine (SSBN[X]) Program: Background and Issues for Congress*, by (name redacted) .

[2] In U.S. Navy submarine designations, SS stands for submarine, N stands for nuclear-powered, B stands for ballistic missile, and G stands for guided missile (such as a cruise missile). Submarines can be powered by either nuclear reactors or non-nuclear power sources such as diesel engines or fuel cells. All U.S. Navy submarines are nuclear-powered. A submarine's use of nuclear or non-nuclear power as its energy source is not an indication of whether it is armed with nuclear weapons—a nuclear-powered submarine can lack nuclear weapons, and a non-nuclear-powered submarine can be armed with nuclear weapons.

[3] The SSBNs' basic mission is to remain hidden at sea with their nuclear-armed submarine-launched ballistic missiles (SLBMs) and thereby deter a strategic nuclear attack on the United States. The Navy's SSBNs are discussed in CRS Report R41129, *Navy Columbia Class (Ohio Replacement) Ballistic Missile Submarine (SSBN[X]) Program: Background and Issues for Congress*, by (name redacted) , and CRS Report RL31623, *U.S. Nuclear Weapons: Changes in Policy and Force Structure*, by (name redacted)

[4] The Navy's four SSGNs are former Trident SSBNs that have been converted (i.e., modified) to carry Tomahawk cruise missiles and SOF rather than SLBMs. Although the SSGNs differ somewhat from SSNs in terms of mission orientation (with the SSGNs being strongly oriented toward Tomahawk strikes and SOF support, while the SSNs are more general-purpose in orientation), SSGNs can perform other submarine missions and are sometimes included in counts of the projected total number of Navy attack submarines. The Navy's SSGNs are discussed in CRS Report RS21007, *Navy Trident Submarine Conversion (SSGN) Program: Background and Issues for Congress*, by (name redacted) .

- covert strikes against land targets with the Tomahawk cruise missiles (again on a smaller scale than possible with the SSGNs);
- covert offensive and defensive mine warfare;
- anti-submarine warfare (ASW); and
- anti-surface ship warfare.

During the Cold War, ASW against Soviet submarines was the primary stated mission of U.S. SSNs, although covert ISR and covert SOF insertion/recovery operations were reportedly important on a day-to-day basis as well.[5] In the post-Cold War era, although anti-submarine warfare remained a mission, the SSN force focused more on performing the other missions noted on the list above. In light of the recent shift in the strategic environment from the post-Cold War era to a new situation featuring renewed great power competition that some observers conclude has occurred, ASW against Russian and Chinese submarines may once again become a more prominent mission for U.S. Navy SSNs.[6]

U.S. Attack Submarine Force Levels

Force-Level Goal

The Navy's previous force-level goal was to achieve and maintain a 308-ship fleet, including 48 SSNs. The Navy's new force-level goal, released in December 2016, is to achieve and maintain a 355-ship fleet, including 66 SSNs.[7] For a review of SSN force-level goals since the Reagan Administration, see **Appendix A**.

Force Level at End of FY2017

The SSN force included more than 90 boats during most of the 1980s, when plans called for achieving a 600-ship Navy including 100 SSNs. The number of SSNs peaked at 98 boats at the end of FY1987 and declined after that in a manner that roughly paralleled the decline in the total size of the Navy over the same time period. The 51 SSNs in service at the end of FY2017 included the following:

- 35 Los Angeles (SSN-688) class boats;
- 3 Seawolf (SSN-21) class boats; and
- 13 Virginia (SSN-774) class boats.

Los Angeles- and Seawolf-Class Boats

A total of 62 Los Angeles-class submarines, commonly called 688s, were procured between FY1970 and FY1990 and entered service between 1976 and 1996. They are equipped with four

[5] For an account of certain U.S. submarine surveillance and intelligence-collection operations during the Cold War, see Sherry Sontag and Christopher Drew with Annette Lawrence Drew, *Blind Man's Bluff* (New York: Public Affairs, 1998).

[6] For further discussion of this shift in the strategic environment and how it has led to, among other things, an increased emphasis in discussions of U.S. defense policy on submarines and ASW, see CRS Report R43838, *A Shift in the International Security Environment: Potential Implications for Defense—Issues for Congress*, by (name redacted) .

[7] For additional information on Navy force-level goals, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by (name redacted) .

21-inch diameter torpedo tubes and can carry a total of 26 torpedoes or Tomahawk cruise missiles in their torpedo tubes and internal magazines. The final 31 boats in the class (SSN-719 and higher) were built with an additional 12 vertical launch system (VLS) tubes in their bows for carrying and launching another 12 Tomahawk cruise missiles. The final 23 boats in the class (SSN-751 and higher) incorporate further improvements and are referred to as Improved Los Angeles class boats or 688Is. As of the end of FY2016, 27 of the 62 boats in the class had been retired.

The Seawolf class was originally intended to include about 30 boats, but Seawolf-class procurement was stopped after three boats as a result of the end of the Cold War and associated changes in military requirements and defense spending levels. The three Seawolf-class submarines are the *Seawolf* (SSN-21), the *Connecticut* (SSN-22), and the *Jimmy Carter* (SSN-23). SSN-21 and SSN-22 were procured in FY1989 and FY1991 and entered service in 1997 and 1998, respectively. SSN-23 was originally procured in FY1992. Its procurement was suspended in 1992 and then reinstated in FY1996. It entered service in 2005. Seawolf-class submarines are larger than Los Angeles-class boats or previous U.S. Navy SSNs.[8] They are equipped with eight 30-inch-diameter torpedo tubes and can carry a total of 50 torpedoes or cruise missiles. SSN-23 was built to a lengthened configuration compared to the other two ships in the class.[9]

Virginia (SSN-774) Class Program

General

The Virginia-class attack submarine (see **Figure 1**) was designed to be less expensive and better optimized for post-Cold War submarine missions than the Seawolf-class design. The Virginia-class design is slightly larger than the Los Angeles-class design,[10] but incorporates newer technologies. Virginia-class boats procured in recent years cost about $2.7 billion each to procure, but Virginia-class boats to be procured in coming years will be built to a lengthened configuration that includes the Virginia Payload Module (see discussion below) and have an estimated unit procurement cost of about $3.2 billion. The first Virginia-class boat entered service in October 2004.

Past and Projected Annual Procurement Quantities

Table 1 shows annual numbers of Virginia-class boats procured from FY1998 (the lead boat) through FY2017, the number requested for procurement in FY2018, and the numbers requested or projected for procurement under the FY2019-FY2023 Future Years Defense Plan (FYDP).

Table 1. Annual Numbers of Virginia-Class Boats Procured or Projected for Procurement

FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
1	1	0	1	1	1	1	1	1	1	1	1	1
FY11	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	***FY18***	***FY19***	***FY20***	***FY21***	***FY22***	***FY23***
2	2	2	2	2	2	2	*2*	*2*	*2*	*2*	*2*	*2*

Source: Table prepared by CRS based on U.S. Navy data.

[8] Los Angeles-class boats have a beam (i.e., diameter) of 33 feet and a submerged displacement of about 7,150 tons. Seawolf-class boats have a beam of 40 feet. SSN-21 and SSN-22 have a submerged displacement of about 9,150 tons.

[9] SSN-23 is 100 feet longer than SSN-21 and SSN-22 and has a submerged displacement of 12,158 tons.

[10] Virginia-class boats have a beam of 34 feet and a submerged displacement of 7,800 tons.

Figure 1. Virginia-Class Attack Submarine

Source: U.S. Navy file photo accessed by CRS on January 11, 2011, at http://www.navy.mil/search/display.asp?story_id=55715.

Multiyear Procurement (MYP)

The 10 Virginia-class boats shown in **Table 1** for the period FY2019-FY2023 (referred to as the Block V boats) are to be procured under a multiyear procurement (MYP) contract[11] that would be the fourth consecutive MYP contract used by the Virginia-class program—three earlier MYP contracts were used to procure the 10 Virginia-class boats shown in the table for the period FY2014-FY2018 (the Block IV boats), the 8 Virginia-class boats shown in the table for the period FY2009-FY2013 (the Block III boats), and the 5 Virginia-class boats shown in the table for the period FY2004-FY2008 (the Block II boats). The four boats shown in the table for the period FY1998-FY2002 (the Block I boats) were procured under a block buy contract, which is an arrangement somewhat similar to an MYP contract.[12] The boat procured in FY2003 fell between the FY1998-FY2002 block buy contract and the FY2004-FY2008 MYP contract, and was contracted for separately.

[11] For a discussion of MYP contracting, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by (name redacted) and (name redacted) .

[12] For a discussion of block buy contracting, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by (name redacted) and (name redacted) . The FY1998-FY2002 Virginia-class block buy contract was the first instance of block buy contracting—the mechanism of a block buy contract was essentially created for procuring the first for Virginia-class boats.

Joint Production Arrangement

Overview

Virginia-class boats are built jointly by General Dynamics' Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI, and Huntington Ingalls Industries' Newport News Shipbuilding (HII/NNS), of Newport News, VA. GD/EB and HII/NNS are the only two shipyards in the country capable of building nuclear-powered ships. GD/EB builds submarines only, while HII/NNS also builds nuclear-powered aircraft carriers and is capable of building other types of surface ships.

The arrangement for jointly building Virginia-class boats was proposed to Congress by GD/EB, HII/NNS, and the Navy, and agreed to by Congress in 1997, as part of Congress's action on the Navy's budget for FY1998, the year that the first Virginia-class boat was procured.[13] A primary aim of the arrangement is to minimize the cost of building Virginia-class boats at a relatively low annual rate in two shipyards (rather than entirely in a single shipyard) while preserving key submarine-construction skills at both shipyards.

Under the arrangement, GD/EB builds certain parts of each boat, HII/NNS builds certain other parts of each boat, and the yards have taken turns building the reactor compartments and performing final assembly of the boats. The arrangement has resulted in a roughly 50-50 division of Virginia-class profits between the two yards and preserves both yards' ability to build submarine reactor compartments (a key capability for a submarine-construction yard) and perform submarine final-assembly work.[14]

Navy's Proposed Submarine Unified Build Strategy (SUBS)

The Navy, under a plan it calls the Submarine Unified Build Strategy (SUBS), plans to build Columbia-class ballistic missile submarines jointly at GD/EB and HII/NNS, with most of the work going to GD/EB. As part of this plan, the Navy plans to adjust the division of work on the Virginia-class attack submarine program so that HII/NNS would receive a larger share of the work for that program than it has received in the past. Key elements SUBS include the following:

- GD/EB is to be the prime contractor for designing and building Columbia-class boats;
- HII/NNS is to be a subcontractor for designing and building Columbia-class boats;
- GD/EB is to build certain parts of each Columbia-class boat—parts that are more or less analogous to the parts that GD/EB builds for each Virginia-class attack submarine;

[13] See Section 121 of the FY1998 National Defense Authorization Act (H.R. 1119/P.L. 105-85 of November 18, 1997).

[14] The joint production arrangement is a departure from prior U.S. submarine construction practices, under which complete submarines were built in individual yards. The joint production arrangement is the product of a debate over the Virginia-class acquisition strategy within Congress, and between Congress and DOD, that occurred in 1995-1997 (i.e., during the markup of the FY1996-FY1998 defense budgets). The goal of the arrangement is to keep both GD/EB and HII/NNS involved in building nuclear-powered submarines, and thereby maintain two U.S. shipyards capable of building nuclear-powered submarines, while minimizing the cost penalties of using two yards rather than one to build a submarine design that is being procured at a relatively low annual rate. The joint production agreement cannot be changed without the agreement of both GD/EB and HII/NNS.

- HII/NNS is to build certain other parts of each Columbia-class boat—parts that are more or less analogous to the parts that HII/NNS builds for each Virginia-class attack submarine;
- GD/EB is to perform the final assembly on all 12 Columbia-class boats;
- as a result of the three previous points, the Navy estimates that GD/EB would receive an estimated 77%-78% of the shipyard work building Columbia-class boats, and HII/NNS would receive 22%-23%;
- GD/EB is to continue as prime contractor for the Virginia-class program, but to help balance out projected submarine-construction workloads at GD/EB and HII/NNS, the division of work between the two yards for building Virginia-class boats is to be adjusted so that HII/NNS would perform the final assembly on a greater number of Virginia-class boats than it would have under a continuation of the current Virginia-class division of work (in which final assemblies are divided more or less evenly between the two shipyards); as a consequence, HII/NNS would receive a greater share of the total work in building Virginia-class boats than it would have under a continuation of the current division of work.[15]

The Navy described the plan in February 25, 2016, testimony before the Seapower and Projection Forces subcommittee of the House Armed Services Committee. At that hearing, Navy officials testified the following:

> In 2014, the Navy led a comprehensive government-Industry assessment of shipbuilder construction capabilities and capacities at GDEB and HII-NNS to formulate the Submarine Unified Build Strategy (SUBS) for concurrent OR [Ohio replacement, i.e., Columbia-class] and Virginia class submarine production. This build strategy's guiding principles are: affordability, delivering OR on time and within budget, maintaining Virginia class performance with a continuous reduction in costs, and maintaining two shipbuilders capable of delivering nuclear-powered submarines. To execute this strategy, GDEB has been selected as the prime contractor for OR with the responsibilities to deliver the twelve OR [Ohio replacement] submarines [i.e., GD/EB will perform final assembly on all 12 boats in the program]. HII-NNS will design and construct major assemblies and OR modules leveraging their expertise with Virginia construction [i.e., HII/NNS will build parts of Ohio replacement boats that are similar to the parts it builds for Virginia-class boats]. Both shipbuilders will continue to deliver [i.e., perform final assembly of] Virginia class submarines throughout the period with GDEB continuing its prime contractor responsibility for the program. Given the priority of the OR Submarine Program, the delivery [i.e., final assembly] of Virginia class submarines will be adjusted with HII-NNS performing additional deliveries. Both shipbuilders have agreed to this build strategy.[16]

[15] See Richard B. Burgess, "Submarine Admirals: 'Unified Build Strategy' Seeks Affordability for Future Sub Fleet," *Seapower*, July 8, 2016; Julia Bergman, "Congressmen Visit EB A Day After It Is Named Prime Contractor for Ohio Reaplcement Program," *The Day (New London)*, March 29, 2016; Sydney J. Freedberg Jr., "Ohio Replacement Plan Is Good News For Electric Boat," *Breaking Defense*, March 29, 2016; Robert McCabe, "Newport News Shipbuilding's Share of Virginia-Class Submarine Deliveries to Grow," *Virginian-Pilot (Newport News)*, March 29, 2016; Valerie Insinna, "GD Electric Boat Chosen To Take Lead Role for Ohio Replacement Sub," *Defense Daily*, March 30, 2016: 1-3; Hugh Lessig, "Navy: More Submarine Work Coming to Newport news Shipyard," *Military.com*, March 30, 2016.

[16] Statement of the Honorable Sean J. Stackley, Assistant Secretary of the Navy (Research, Development and Acquisition), and Vice Admiral Joseph P. Mulloy, Deputy Chief of Naval Operations for Integration of Capabilities and Resources, and Lieutenant General Robert S. Walsh, Deputy Commandant, Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, before the Subcommittee on Seapower and Projection Forces of the House Armed Services Committee on Department of the Navy Seapower and Projection (continued...)

Cost-Reduction Effort

The Navy states that it achieved a goal of reducing the procurement cost of Virginia-class submarines so that two boats could be procured in FY2012 for a combined cost of $4.0 billion in constant FY2005 dollars—a goal referred to as "2 for 4 in 12." Achieving this goal involved removing about $400 million (in constant FY2005 dollars) from the cost of each submarine. (The Navy calculated that the unit target cost of $2.0 billion in constant FY2005 dollars for each submarine translated into about $2.6 billion for a boat procured in FY2012.)[17]

Schedule and Cost Performance on Deliveries

As noted in CRS testimony in 2014,[18] the Virginia (SSN-774) class attack program has been cited frequently in recent years as an example of a successful acquisition program. The program received a David Packard Excellence in Acquisition Award from DOD in 2008. Although the program experienced cost growth in its early years that was due in part to annual procurement rates that were lower than initially envisaged and challenges in restarting submarine production at Newport News Shipbuilding,[19] the lead ship in the program was delivered within four months of the target date that had been established about a decade earlier, and ships in recent years have been delivered largely on cost and ahead of schedule.[20]

Virginia Payload Module (VPM)

The Navy plans to build the second of the two Virginia-class boats requested for procurement in FY2019, and all Virginia-class boats to be procured in FY2020 and subsequent years, with an additional midbody section called the Virginia Payload Module (VPM). The VPM, with a length of 84 feet,[21] contains four large-diameter, vertical launch tubes that would be used to store and

(...continued)

Forces Capabilities, February 25, 2016, p. 12.

[17] The Navy says that, in constant FY2005 dollars, about $200 million of the $400 million in the sought-after cost reductions was accomplished simply through the improved economies of scale (e.g., better spreading of shipyard fixed costs and improved learning rates) of producing two submarines per year rather than one per year. The remaining $200 million in sought-after cost reductions, the Navy says, was accomplished through changes in the ship's design (which will contribute roughly $100 million toward the cost-reduction goal) and changes in the shipyard production process (which will contribute the remaining $100 million or so toward the goal). Some of the design changes are being introduced to Virginia-class boats procured prior to FY2012, but the Navy said the full set of design changes would not be ready for implementation until the FY2012 procurement.

Changes in the shipyard production process are aimed in large part at reducing the total shipyard construction time of a Virginia-class submarine from 72 months to 60 months. (If the ship spends less total time in the shipyard being built, its construction cost will incorporate a smaller amount of shipyard fixed overhead costs.) The principal change involved in reducing shipyard construction time to 60 months involves increasing the size of the modules that form each submarine, so that each submarine can be built out of a smaller number of modules. For detailed discussions of the Virginia-class cost-reduction effort, see David C. Johnson et al., "Managing Change on Complex Programs: VIRGINIA Class Cost Reduction," *Naval Engineers Journal*, No. 4, 2009: 79-94; and John D. Butler, "The Sweet Smell of Acquisition Success," *U.S. Naval Institute Proceedings*, June 2011: 22-28.

[18] See Statement of Statement of Ronald O'Rourke, Specialist in naval Affairs, Congressional Research Service, before the House Armed Services Committee on Case Studies in DOD Acquisition: Finding What Works, June 24, 2014, p. 4.

[19] See Statement of Ronald O'Rourke, Specialist in National Defense, Congressional Research Service, before the House Armed Services Committee Subcommittee on Seapower and Expeditionary Forces Hearing on Submarine Force Structure and Acquisition Policy, March 8, 2007, Table 10 on pp. 14-15.

[20] For a discussion of an exception to that record, see Christopher P. Cavas, "US Navy Submarine Program Loses Some of Its Shine," *Defense News*, March 13, 2017.

[21] Source: *Department of Defense Fiscal Year (FY) 2019 Budget Estimates, Navy, Justification Book Volume 1 of 1*, (continued...)

fire additional Tomahawk cruise missiles or other payloads, such as large-diameter unmanned underwater vehicles (UUVs).[22] The four additional launch tubes in the VPM could carry a total of 28 additional Tomahawk cruise missiles (7 per tube),[23] which would increase the total number of torpedo-sized weapons (such as Tomahawks) carried by the Virginia class design from about 37 to about 65—an increase of about 76%.[24]

Building Virginia-class boats with the VPM is intended to compensate for a sharp loss in submarine force weapon-carrying capacity that will occur with the retirement in FY2026-FY2028 of the Navy's four Ohio-class cruise missile/special operations forces support submarines (SSGNs).[25] Each SSGN is equipped with 24 large-diameter vertical launch tubes, of which 22 can be used to carry up to 7 Tomahawks each, for a maximum of 154 vertically launched Tomahawks per boat, or 616 vertically launched Tomahawks for the four boats. Twenty-two Virginia-class boats built with VPMs could carry 616 Tomahawks in their VPMs.

As mentioned earlier, Virginia-class boats procured in recent years without VPM cost about $2.7 billion each to procure, while Virginia-class boats to be procured in coming years with VPM have an estimated unit procurement cost of about $3.2 billion. After taking inflation into account, this suggests that adding VPM to the Virginia-class design increases the unit procurement cost of a Virginia-class boat by upwards of $500 million.

The joint explanatory statement for the FY2014 Department of Defense (DOD) Appropriations Act (Division C of H.R. 3547/P.L. 113-76 of January 17, 2014) required the Navy to submit biannual reports to the congressional defense committees describing the actions the Navy is taking to minimize costs for the VPM.[26]

Acoustic and Other Improvements

In addition to the VPM, the Navy is introducing acoustic and other improvements to the Virginia-class design that are intended to help maintain the design's superiority over Russian and Chinese submarines.[27]

(...continued)

Shipbuilding and Conversion, Navy, February 2018, p. 37.

[22] For an illustration of the VPM, see http://www.gdeb.com/news/advertising/images/VPM_ad/VPM.pdf, which was accessed by CRS on March 1, 2012.

[23] Michael J. Conner, "Investing in the Undersea Future," *U.S. Naval Institute Proceedings*, June 2011: 16-20.

[24] A Virginia-class SSN can carry about 25 Tomahawks or other torpedo-sized weapons in its four horizontal torpedo tubes and associated torpedo room, and an additional 12 Tomahawk cruise missiles in its bow-mounted vertical lunch tubes, for a total of about 37 torpedo-sized weapons. Another 28 Tomahawks in four midbody vertical tubes would increase that total by about 76%.

[25] Michael J. Conner, "Investing in the Undersea Future," *U.S. Naval Institute Proceedings*, June 2011: 16-20.

[26] See PDF page 239 of 351 of the joint explanatory statement for Division C of H.R. 3547.

[27] For press reports discussing these improvements, see Kris Osborn, "Navy Launches Most High-Tech & Stealthy Attack Sub Ever," *Scout Warrior*, November 18, 2017; Megan Eckstein, "Navy Considering Mid-Block Virginia-Class Upgrades, SSGN Construction in Late 2030s," *USNI News*, November 2, 2017; Zachary Cohen, "US Launches 'Most Advanced' Stealth Sub Amid Undersea Rivalry," *CNN*, October 26, 2017; Franz-Stefan Gady, "US Navy Christens Most Advanced Attack Sub Ever," *The Diplomat*, October 17, 2017; Douglas Ernst, "Navy Christens Its 'Most Advanced' Attack Submarine Ever," *Washington Times*, October 16, 2017; Dave Majumdar, "Stealth and Armed to the Teeth: US Navy's Big Plan for Submarine Dominance," *National Interest*, July 9, 2016; Kris Osborn, "'Acoustic Superiority': US Navy's Secret Submarine Plan to Dominate the Seas," *National Interest*, June 20, 2016; Dave Majumdar, "This Is How the U.S. Navy's Submarine Force Dominates the World's Oceans," *National Interest*, May 17, 2016; Megan Eckstein, "Submarines To Become Stealthier Through Acoustic Superiority Upgrades, Operational Concepts," *USNI News*, March 1, 2016.

FY2019 Funding Request

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2019 at $6,502.3 million (i.e., about $6.5 billion). The two boats have received an estimated total of $2,128.9 million in prior-year "regular" advance procurement (AP) funding. (This figure is an estimate, because Congress has not yet completed action on the FY2018 Department of Defense appropriations act.) Based on this estimate, the Navy's proposed FY2019 budget requests the remaining $4,373.4 million in procurement funding needed to complete the boats' estimated combined procurement cost. The Navy's proposed FY2019 budget also requests $1,810.9 million in "regular" AP funding for Virginia-class boats to be procured in future fiscal years, and $985.5 million in additional Economic Order Quantity (EOQ) AP funding for components of Virginia-class boats to be procured under the FY2019-FY2023 Virginia-class MYP contract, bringing the total amount of procurement, "regular" AP, and EOQ AP funding requested for the program in FY2019 to $7,169.8 million (i.e., about $7.2 billion), excluding outfitting and post-delivery costs.

Submarine Construction Industrial Base

In addition to GD/EB and HII/NNS, the submarine construction industrial base includes hundreds of supplier firms, as well as laboratories and research facilities, in numerous states. Much of the total material procured from supplier firms for the construction of submarines comes from single or sole source suppliers. For nuclear-propulsion component suppliers, an additional source of stabilizing work is the Navy's nuclear-powered aircraft carrier construction program.[28] In terms of work provided to these firms, a carrier nuclear propulsion plant is roughly equivalent to five submarine propulsion plants. Much of the design and engineering portion of the submarine construction industrial base is resident at GD/EB; smaller portions are resident at HII/NNS and some of the component makers.

Projected SSN Force Levels

Table 2 shows the Navy's projection of the number of SSNs over time if the Navy's FY2019 30-year shipbuilding plan were fully implemented. As can be seen in the table, the FY2019 30-year shipbuilding plan would achieve the Navy's 66-boat SSN force-level goal by FY2048.

As also shown in the table, the number of SSNs is projected to experience a dip or valley from the mid-2020s through the early 2030s, reaching a minimum of 42 boats (i.e., 24 boats, or about 36%, less than the 66-boat force-level goal) in FY2028. This projected valley is a consequence of having procured a relatively small number of SSNs during the 1990s, in the early years of the post-Cold War era. Some observers are concerned that this projected valley in SSN force levels could lead to a period of heightened operational strain for the SSN force, and perhaps also a period of weakened conventional deterrence against potential adversaries such as China.[29] The

[28] For more on this program, see CRS Report RS20643, *Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress*, by (name redacted) .

[29] China has taken note of the valley. The November 2014 edition of a Chinese military journal, for example, includes an article with a passage that translates as follows:

> ... in 2028, the [U.S. Navy] force of nuclear attack submarines will fall from the current number of 55 down to 41 boats. Some are concerned about whether this force level can meet the requirements of the Asia-Pacific rebalance."
>
> (Lyle Goldstein, "Evolution of Chinese Power Projection Capabilities," presentation to Center for a New American Security (CNAS) roundtable discussion, September 29, 2016, slide 7 of 41.)

projected SSN valley was first identified by CRS in 1995 and has been discussed in CRS reports and testimony every year since then. As one measure for mitigating this valley, the Navy's FY2019 budget submission proposes to refuel and extend the service life of one older Los Angeles (SSN-688) class submarine. The Navy states that this could become the first of as many as five Los Angeles-class SSNs to be refueled and have their service lives extended.[30]

Table 2. Projected SSN Force Levels

As shown in Navy's FY2019 30-Year (FY2019-FY2048) Shipbuilding Plan

Fiscal year	Annual procurement quantity	Projected number of SSNs	Force level relative to current 66-boat goal	
			Number of ships	Percent
19	2	52	-14	-21%
20	2	53	-13	-20%
21	2	52	-14	-21%
22	2	52	-14	-21%
23	2	51	-15	-23%
24	2	48	-18	-27%
25	2	46	-20	-30%
26	2	45	-21	-32%
27	2	44	-22	-33%
28	2	42	-24	-36%
29	2	44	-22	-33%
30	2	45	-21	-32%
31	2	47	-19	-29%
32	2	48	-18	-27%
33	2	50	-16	-24%
34	2	52	-14	-21%
35	2	54	-12	-18%
36	2	56	-10	-15%
37	2	58	-8	-12%
38	2	58	-8	-12%
39	2	59	-7	-11%
40	2	59	-7	-11%
41	2	59	-7	-11%
42	2	61	-5	-8%
43	2	61	-5	-8%
44	2	62	-4	-6%
45	2	63	-3	-5%
46	2	64	-2	-3%
47	2	65	-1	-2%
48	2	66	--	--

Source: Table prepared by CRS based on Navy's FY2019 30-year shipbuilding plan. Percent figures rounded to nearest percent.

SSN Deployments Delayed Due to Maintenance Backlogs

In recent years, a number of the Navy's SSNs have had their deployments delayed due to maintenance backlogs at the Navy's four government-operated shipyards, which are the primary

[30] U.S. Navy, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2019*, February 2018, p. 5.

facilities for conducting depot-level maintenance work on Navy SSNs. Delays in deploying SSNs can put added operational pressure on other SSNs that are available for deployment. On March 29, 2017, the Navy testified that

> The high operational tempo in the post 9/11 era combined with reduced readiness funding and consistent uncertainty about when these reduced budgets will be approved have created a large maintenance mismatch between the capacity in our public shipyards and the required work. This has resulted in a large maintenance backlog which has grown from 4.7 million man-days to 5.3 million man-days between 2011 and 2017. Today, despite hiring 16,500 new workers since 2012, Naval Shipyards are more than 2,000 people short of the capacity required to execute the projected workload, stabilize the growth in the maintenance backlog and eventually eliminate that backlog. This shortfall, coupled with reduced workforce experience levels (about 50 percent of the workforce has less than five years of experience) and shipyard productivity issues have impacted Fleet readiness through the late delivery of ships and submarines. The capacity limitations and the overall priority of work toward our Ballistic Missile Submarines (SSBNs) and Aircraft Carriers (CVN) have resulted in our Attack Submarines (SSNs) absorbing much of the burden, causing several submarine availabilities that were originally scheduled to last between 22 and 25 months to require 45 months or more to complete. These delays not only remove the submarines from the Fleet for extended periods of time, but also have an impact on the crews' training and morale. This situation reached a boiling point this past summer when in order to balance the workload, the Navy decided to defer a scheduled maintenance availability on the USS BOISE (SSN 764) that will effectively take her off line until 2020 or later. Although the Navy has not made a final decision on BOISE, she will likely be contracted to the private sector at additional cost to the Navy in 2019.[31]

Issues for Congress

FY2019 Funding

One issue for Congress is whether to approve, reject, or modify the Navy's FY2019 procurement and advance procurement (AP) funding requests for the Virginia-class program. In considering this issue, Congress may consider several factors, including the amount of work the Navy is proposing to fund for the program in FY2019 and whether the Navy has accurately priced the work it is proposing to do in FY2019.

[31] Statement of Vice Admiral Paul A. Grosklags, Commander, Naval Air Systems Command, and Vice Admiral Thomas J. Moore, Commander, Naval Sea Systems Command, before the Subcommittee on Readiness and Management Support of the Senate Armed Services Committee on Depots, Shipyards, Arsenals and Ammo Plants, March 29, 2017, p. 4. See also Sydney J. Freedberg Jr., "Submarine Maintenance Backlog Threatens Crisis Response: Admiral," *Breaking Defense*, November 6, 2017; Sydney J. Freedberg Jr., "15 Subs Kept Out of Service: 177 Months Of Drydock Backups," *Breaking Defense*, October 31, 2017; Megan Eckstein, "Interview: NAVSEA 'Headed in the Right Direction' After Years of Maintenance Backlogs," *USNI News*, June 15, 2017; Megan Eckstein, "Attack Sub USS Boise Set for Private Yard Maintenance in 2019 After Public Yard Backlog Defers Job," *USNI News*, June 1, 2017; Sam LaGrone, "NAVSEA: 2,000 More Public Shipyard Workers Needed to Break Through Maintenance Backlog," *USNI News*, March 30, 2017.

Accelerating Attainment of 66-Boat SSN Force

Another potential issue for Congress is whether to accelerate the attainment of a 66-boat SSN force by inserting additional SSNs into the 30-year shipbuilding plan. In assessing this issue, Congress may consider several factors, including

- the impacts of having fewer than 66 boats on SSN force operational tempo and on conventional deterrence of potential adversaries such as China;
- the costs of procuring, operating, and supporting the additional SSNs, the impact that such costs might have in a situation of finite defense funding on funding available for other Navy or DOD programs, and the resulting net impact on Navy or DOD capabilities; and
- the capacity of the submarine construction industrial base for accommodating additional SSN construction work, the pace at which that capacity could be increased, the cost of increasing that capacity, and the ability of the Navy and industry to supervise the additional work so as to maintain production quality.

Increasing the capacity of the submarine construction industrial base would require additional tooling at the submarine construction shipyards (GD/EB and HII/NNS) and at supplier firms, and the hiring and training of additional production and supervisory workers at the shipyards and supplier firms. Implementing these actions—particularly the hiring and training of new workers—would take some time. As a result, the submarine production rate could not be substantially increased overnight—it would need to ramp up to higher levels over time. Any additional Virginia-class boats funded in FY2018-FY2020 would likely execute on a delayed schedule, making them look more like boats funded in later fiscal years. Congress in the past, however, has funded the procurement of nuclear-powered ships (specifically, aircraft carriers) that were not expected to begin construction right away. (For additional discussion, see **Appendix B**.) Increasing the submarine construction rate could pose industrial base management challenges for the Navy and industry.

A September 11, 2017, press report states the following:

> The two attack submarine manufacturers can support a three Virginia-class boat per year build rate in the years the Navy is not buying a ballistic missile submarine as long as the service supports industry in both planning and investment.
>
> Kenneth Perry, vice president for program integration at General Dynamics Electric Boat, told *Inside the Navy* Aug. 30 in Newport, RI, the company has sent the Navy an outline of what it will take for EB to build three Virginia-class attack submarines per year.
>
> This would include investments not only in EB's facilities but also in growing a skilled workforce, he said.[32]

A July 2017 Navy report to Congress on the submarine industrial base and the viability of producing additional attack submarines beyond those shown in the FY2017 shipbuilding plan during the period FY2017-FY2030 states the following:

> The VIRGINIA Class Submarine (VCS) program is healthy and maintaining a construction rate of two SSNs per year. The Navy is committed to maintaining this rate as long as feasible within budgetary constraints.

[32] Lee Hudson, "Industry Can Support Three Attack Submarine Per Year Build Rate," *Inside the Navy*, September 11, 2017.

The Navy assess that procurement of additional attack submarines beyond those in the FY 2017 shipbuilding plan is viable, and would have a positive effect on the overall submarine industrial base cost and workload profiles. In particular, the procurement of VCS [Virginia-class submarines] with the Virginia Payload Module (VPM) at a steady cadence of two per year during the procurement years of the COLUMBIA Class SSBN is achievable, and would provide benefit to [the] Navy's attack submarine force inventory. Maintaining a two per year VCS procurement cadence will result in the procurement of seven additional SSNs over the FY 2017 – FY 2030 timeframe. This ramp up in production will require increased management and investment, jointly managed by both the Navy and the shipbuilders, to ensure all aspects of the nuclear shipbuilding enterprise are prepared. The key areas of concern are shipbuilder facilities, work force readiness (manpower ramp up), and supplier/vendor industrial base health.

As increased VCS procurements will present facilities, manpower, and vendor base challenges additional to those already presented by the baseline FY 2017 shipbuilding plan, the Navy is working closely with the shipbuilders to ensure that these issues can be managed successfully and without negatively impacting the COLUMBIA Class program. A table construction plan and adequate funding lead time are critical to stabilize the vendor base health, and will also be needed to allow for facilities and manpower ramp ups at the shipyards to meet the increased workload volume. Maintaining a steady VCS procurement cadence would result in added labor and economic order quantity (EOQ) efficiencies, optimization of production facilities, and elimination of costly production surges and gaps, reducing VCS costs across the respective block buys.

The Navy continues to work with Congress to ensure authorities are in place to maximize acquisition efficiency and cost savings opportunities. In particular, near-term Congressional support in the form of multi-year procurements (MYP), EOQ, and buying across shipbuilding programs will be required in order to provide adequate lead time for industrial base preparations. During the years of COLUMBIA procurement, additional shipbuilding funding will be required in order to procure additional attack submarines without negatively impacting other Navy ship procurement programs.

The Navy is committed to working closely with Congress and industry to provide continued stability, acquisition efficiency, and cost savings opportunities to best support the production of additional attack submarines beyond the Navy's current shipbuilding plan.[33]

[33] U.S. Navy, *Report to Congress [on] The Submarine Industrial Base and the Viability of Producing Additional Attack Submarines Beyond the Fiscal Year 2017 Shipbuilding Plan in the 2017-2030 Timeframe*, July 2017, Executive Summary (p. ii). The report was posted at *USNI News* on July 18, 2017. See also Megan Eckstein, "Navy Report: Submarine Industrial Base Can Maintain 2-Attack Boast Construction Rate, Bolstering Lawmakers' Plans," *USNI News*, July 18, 2017.

Issues Raised in January 2018 DOT&E Report

Another oversight issue for Congress concerns Virginia-class program issues raised in a January 2018 report from DOD's Director, Operational Test and Evaluation (DOT&E)—DOT&E's annual report for FY2017.[34]

Problem with Hull Coating Reported in 2017

Another issue for Congress concerns a problem with the hull coating used on Virginia-class boats that was reported in 2017.[35]

Defective Parts Reported in 2016

Another issue for Congress concerns three Virginia-class boats that were reported in 2016 to have been built with defective parts, and the operational and cost implications of this situation.[36]

Legislative Activity for FY2019

Congressional Action on FY2019 Funding Request

Table 3 summarizes congressional action on the Navy's FY2019 funding request for the Virginia-class program.

Table 3. Congressional Action on FY2019 Funding

(Millions of dollars, rounded to nearest tenth)

		Authorization			Appropriation		
	Request	**HASC**	**SASC**	**Conf.**	**HAC**	**SAC**	**Conf.**
Virginia class procurement	4,373.4	5,311.4					
Virginia class advance procurement (AP)	2,796.4	2,796.4					
TOTAL	**7,169.8**	**8,107.8**					

Source: Table prepared by CRS based on Navy's FY2019 budget submission, committee and conference reports, and explanatory statements on FY2019 National Defense Authorization Act and FY2019 DOD Appropriations Act.

Notes: HASC is House Armed Services Committee; **SASC** is Senate Armed Services Committee, **SAC** is Senate Appropriations Committee, **HAC** is House Appropriations Committee, **Conf.** is conference agreement.

[34] Department of Defense, Director, Operational Test & Evaluation, *FY2017 Annual Report*, January 2018, pp. 217-218.

[35] For a press report discussing this issue, see William Cole, "Navy Subs Still Show Issue with Stealth Coating," *Military.com*, March 6, 2017.

[36] For press reports discussing this issue, see David Larter, "Secret Weld: How Shoddy Parts Disabled A $2.7 Billion Submarine," *Navy Times*, March 28, 2016; Sydney J. Freedberg Jr., "Welding Problems Fixed For Virginia Subs; Carter Tours Electric Boat," *Breaking Defense*, May 24, 2016; and David Larter, "Attack Sub Minnesota Rejoins Fleet After Parts Fiasco," *Navy Times*, June 4, 2016.

FY2019 National Defense Authorization Act (H.R. 5515)

House

The House Armed Services Committee, in its report (H.Rept. 115-676 of May 15, 2018) on H.R. 5515, recommended the funding levels for the Virginia-class program shown in the HASC column of **Table 3**. The net increase of $938 million in procurement funding includes an increase of $1,003.0 million in economic order quantity (EOQ) advance procurement (AP) funding for an additional Virginia-class boat to be procured in FY2022 and a second additional Virginia-class boat to be procured in FY2023; a reduction of $20.0 million for "Excess change order rate"; and a reduction of $45 million for "Forward financed in the FY18 Omnibus."[37] (Page 344)

Section 130 of H.R. 5515 as reported by the committee states the following:

> SEC. 130. Limitation on procurement of economic order quantities for Virginia class submarine program.
>
> Section 124 of the National Defense Authorization Act for Fiscal Year 2018 (Public Law 115–91) is amended—
>
> (1) in subsection (c)(2), by striking "material" and inserting "subject to subsection (d), material";
>
> (2) by redesignating subsection (d) through (f) as subsections (e) through (g), respectively; and
>
> (3) by inserting after subsection (c), the following:
>
> "(d) Limitation on procurement of economic order quantities.—The Secretary of the Navy may not enter into contracts for economic order quantities under subsection (c)(2) until the date on which the Secretary certifies to the congressional defense committees that any funds made available for such contracts will be used to procure economic order quantities of material and equipment for not fewer than 12 Virginia class submarines.".

Section 3117 of H.R. 5515 as reported by the committee states the following:

> SEC. 3117. Prohibition on availability of funds for research and development of advanced naval nuclear fuel system based on low-enriched uranium.
>
> (a) Prohibition.—Except as provided by subsection (b), none of the funds authorized to be appropriated by this Act or otherwise made available for fiscal year 2019 for the Department of Energy or the Department of Defense may be obligated or expended to plan or carry out research and development of an advanced naval nuclear fuel system based on low-enriched uranium.
>
> (b) Exception.—In accordance with section 7319 of title 10, United States Code, of the funds authorized to be appropriated by this Act or otherwise made available for fiscal year 2019 for defense nuclear nonproliferation, as specified in the funding table in division D, $10,000,000 shall be made available to the Deputy Administrator for Naval Reactors of the National Nuclear Security Administration for low-enriched uranium activities (including downblending of high-enriched uranium fuel into low-enriched uranium fuel, research and development using low-enriched uranium fuel, or the

[37] The FY2018 DOD Appropriations Act was enacted as Division C of H.R. 1625/P.L. 115-141 of March 23, 2018, the Consolidated Appropriations Act, 2018. The enactment of H.R. 1625/P.L. 115-141 came after the submission of the Administration's proposed FY2019 defense budget, which occurred on February 12, 2018. The explanatory statement for Division C of H.R. 1625 increased the Virginia-class program's FY2018 advance procurement (AP) funding request by $225 million for "Program increase—industrial base expansion" (PDF page 168 of 391).

modification or procurement of equipment and infrastructure related to such activities) to develop an advanced naval nuclear fuel system based on low-enriched uranium.

Appendix A. Past SSN Force-Level Goals

This appendix summarizes attack submarine force-level goals since the Reagan Administration (1981-1989).

The Reagan-era plan for a 600-ship Navy included an objective of achieving and maintaining a force of 100 SSNs.

The George H. W. Bush Administration's proposed Base Force plan of 1991-1992 originally called for a Navy of more than 400 ships, including 80 SSNs.[38] In 1992, however, the SSN goal was reduced to about 55 boats as a result of a 1992 Joint Staff force-level requirement study (updated in 1993) that called for a force of 51 to 67 SSNs, including 10 to 12 with Seawolf-level acoustic quieting, by the year 2012.[39]

The Clinton Administration, as part of its 1993 Bottom-Up Review (BUR) of U.S. defense policy, established a goal of maintaining a Navy of about 346 ships, including 45 to 55 SSNs.[40] The Clinton Administration's 1997 QDR supported a requirement for a Navy of about 305 ships and established a tentative SSN force-level goal of 50 boats, "contingent on a reevaluation of peacetime operational requirements."[41] The Clinton Administration later amended the SSN figure to 55 boats (and therefore a total of about 310 ships).

The reevaluation called for in the 1997 QDR was carried out as part of a Joint Chiefs of Staff (JCS) study on future requirements for SSNs that was completed in December 1999. The study had three main conclusions:

- "that a force structure below 55 SSNs in the 2015 [time frame] and 62 [SSNs] in the 2025 time frame would leave the CINC's [the regional military commanders-in-chief] with insufficient capability to respond to urgent crucial demands without gapping other requirements of higher national interest. Additionally, this force structure [55 SSNs in 2015 and 62 in 2025] would be sufficient to meet the modeled war fighting requirements";
- "that to counter the technologically pacing threat would require 18 Virginia class SSNs in the 2015 time frame"; and

[38] For the 80-SSN figure, see Statement of Vice Admiral Roger F. Bacon, U.S. Navy, Assistant Chief of Naval Operations (Undersea Warfare) in U.S. Congress, House Armed Services Committee, Subcommittee on Seapower and Strategic and Critical Materials, *Submarine Programs*, March 20, 1991, pp. 10-11, or Statement of Rear Admiral Raymond G. Jones Jr., U.S. Navy, Deputy Assistant Chief of Naval Operations (Undersea Warfare), in U.S. Congress, Senate Armed Services Committee, Subcommittee on Projection Forces and Regional Defense, *Submarine Programs*, June 7, 1991, pp. 10-11.

[39] See Richard W. Mies, "Remarks to the NSL Annual Symposium," *Submarine Review*, July 1997, p. 35; "Navy Sub Community Pushes for More Subs than Bottom-Up Review Allowed," *Inside the Navy*, November 7, 1994, pp. 1, 8-9; *Attack Submarines in the Post-Cold War Era: The Issues Facing Policymakers*, op. cit., p. 14; Robert Holzer, "Pentagon Urges Navy to Reduce Attack Sub Fleet to 50," *Defense News*, March 15-21, 1993, p. 10; Barbara Nagy, " Size of Sub Force Next Policy Battle," *New London Day*, July 20, 1992, pp. A1, A8.

[40] Secretary of Defense Les Aspin, U.S. Department of Defense, *Report on the Bottom-Up Review*, October 1993, pp. 55-57.

[41] Secretary of Defense William S. Cohen, U.S. Department of Defense, *Report of the Quadrennial Defense Review*, May 1997, pp. 29, 30, 47.

- "that 68 SSNs in the 2015 [time frame] and 76 [SSNs] in the 2025 time frame would meet all of the CINCs' and national intelligence community's highest operational and collection requirements."[42]

The conclusions of the 1999 JCS study were mentioned in discussions of required SSN force levels, but the figures of 68 and 76 submarines were not translated into official DOD force-level goals.

The George W. Bush Administration's report on the 2001 QDR revalidated the amended requirement from the 1997 QDR for a fleet of about 310 ships, including 55 SSNs. In revalidating this and other U.S. military force-structure goals, the report cautioned that as DOD's "transformation effort matures—and as it produces significantly higher output of military value from each element of the force—DOD will explore additional opportunities to restructure and reorganize the Armed Forces."[43]

DOD and the Navy conducted studies on undersea warfare requirements in 2003-2004. One of the Navy studies—an internal Navy study done in 2004—reportedly recommended reducing the attack submarine force level requirement to as few as 37 boats. The study reportedly recommended homeporting a total of nine attack submarines at Guam and using satellites and unmanned underwater vehicles (UUVs) to perform ISR missions now performed by attack submarines.[44]

In March 2005, the Navy submitted to Congress a report projecting Navy force levels out to FY2035. The report presented two alternatives for FY2035—a 260-ship fleet including 37 SSNs and 4 SSGNs, and a 325-ship fleet including 41 SSNs and 4 SSGNs.[45]

In May 2005, it was reported that a newly completed DOD study on attack submarine requirements called for maintaining a force of 45 to 50 boats.[46]

In February 2006, the Navy proposed to maintain in coming years a fleet of 313 ships, including 48 SSNs.

Although the Navy's ship force-level goals have changed repeatedly in subsequent years, the figure of 48 SSNs remained unchanged until December 2016, when the Navy released a force-level objective for achieving and maintaining a force of 355 ships, including 66 SSNs.

[42] Department of Navy point paper dated February 7, 2000. Reprinted in *Inside the Navy*, February 14, 2000, p. 5.

[43] U.S. Department of Defense, *Quadrennial Defense Review*, September 2001, p. 23.

[44] Bryan Bender, "Navy Eyes Cutting Submarine Force," *Boston Globe*, May 12, 2004, p. 1; Lolita C. Baldor, "Study Recommends Cutting Submarine Fleet," *NavyTimes.com*, May 13, 2004.

[45] U.S. Department of the Navy, *An Interim Report to Congress on Annual Long-Range Plan for the Construction of Naval Vessels for FY 2006*. The report was delivered to the House and Senate Armed Services and Appropriations Committees on March 23, 2005.

[46] Robert A. Hamilton, "Delegation Calls Report on Sub Needs Encouraging," *The Day (New London, CT)*, May 27, 2005; Jesse Hamilton, "Delegation to Get Details on Sub Report," *Hartford (CT) Courant*, May 26, 2005.

Appendix B. Options for Funding SSNs

This appendix presents information on some alternative profiles for funding the procurement of SSNs. These alternatives include but are not necessarily limited to the following:

- **two years of advance procurement (AP) funding followed by full funding**—the traditional approach, under which there are two years of AP funding for the SSN's long-leadtime components, followed by the remainder of the boat's procurement funding in the year of procurement;
- **one year of AP funding followed by full funding**—one year of AP funding for the SSN's long-leadtime components, followed by the remainder of the boat's procurement funding in the year of procurement;
- **full funding with no AP funding (single-year full funding, aka point-blank full funding)**—full funding of the SSN in the year of procurement, with no AP funding in prior years;
- **incremental funding**—partial funding of the SSN in the year of procurement, followed by one or more years of additional funding increments needed to complete the procurement cost of the ship; and
- **advance appropriations**—a form of full funding that can be viewed as a legislatively locked in form of incremental funding.[47]

Navy testimony to Congress in early 2007, when Congress was considering the FY2008 budget, suggested that two years of AP funding are required to fund the procurement of an SSN, and consequently that additional SSNs could not be procured until FY2010 at the earliest.[48] This testimony understated Congress's options regarding the procurement of additional SSNs in the near term. Although SSNs are normally procured with two years of AP funding (which is used primarily for financing long-leadtime nuclear propulsion components), Congress can procure an SSN without prior-year AP funding, or with only one year of AP funding. Consequently, Congress at that time had the option of procuring an additional SSN in FY2009 and/or FY2010.

Single-year full funding has been used in the past by Congress to procure nuclear-powered ships for which no prior-year AP funding had been provided. Specifically, Congress used single-year full funding in FY1980 to procure the nuclear-powered aircraft carrier CVN-71, and again in FY1988 to procure the CVNs 74 and 75. In the case of the FY1988 procurement, under the Administration's proposed FY1988 budget, CVNs 74 and 75 were to be procured in FY1990 and FY1993, respectively, and the FY1988 budget was to make the initial AP payment for CVN-74. Congress, in acting on the FY1988 budget, decided to accelerate the procurement of both ships to

[47] For additional discussion of these funding approaches, see CRS Report RL32776, *Navy Ship Procurement: Alternative Funding Approaches—Background and Options for Congress*, by (name redacted) .

[48] For example, at a March 1, 2007, hearing before the House Armed Services Committee on the FY2008 Department of the Navy budget request, Representative Taylor asked which additional ships the Navy might want to procure in FY2008, should additional funding be made available for that purpose. In response, Secretary of the Navy Donald Winter stated in part: "The Virginia-class submarines require us to start with a two-year advanced procurement, to be able to provide for the nuclear power plant that supports them. So we would need to start two years in advance. What that says is, if we were able to start in '08 with advanced procurement, we could accelerate, potentially, the two a year to 2010." (Source: Transcript of hearing.) Navy officials made similar statements before the same subcommittee on March 8, 2007, and before the Senate Armed Services Committee on March 29, 2007.

FY1988, and fully funded the two ships that year at a combined cost of $6.325 billion. The ships entered service in 1995 and 1998, respectively.[49]

The existence in both FY1980 and FY1988 of a spare set of Nimitz-class reactor components was not what made it possible for Congress to fund CVNs 71, 74, and 75 with single-year full funding; it simply permitted the ships to be built more quickly. What made it possible for Congress to fund the carriers with single-year full funding was Congress's constitutional authority to appropriate funding for that purpose.

Procuring an SSN with one year of AP funding or no AP funding would not materially change the way the SSN would be built—the process would still encompass about two years of advance work on long-leadtime components, and an additional six years or so of construction work on the ship itself. The outlay rate for the SSN could be slower, as outlays for construction of the ship itself would begin one or two years later than normal, and the interval between the recorded year of full funding and the year that the ship enters service would be longer than normal.

Congress in the past has procured certain ships in the knowledge that those ships would not begin construction for some time and consequently would take longer to enter service than a ship of that kind would normally require. When Congress procured two nuclear-powered aircraft carriers (CVNs 72 and 73) in FY1983, and another two (CVNs 74 and 75) in FY1988, it did so in both cases in the knowledge that the second ship in each case would not begin construction until some time after the first.

[49] In both FY1988 and FY1980, the Navy had a spare set of Nimitz (CVN-68) class nuclear propulsion components in inventory. The existence of a spare set of components permitted the carriers to be built more quickly than would have otherwise been the case, but it is not what made the single-year full funding of these carriers possible. What made it possible was Congress's authority to appropriate funds for the purpose.

Appendix C. 2006 Navy Study on Options for Mitigating Projected Valley in SSN Force Level

This appendix presents background information on a study initiated by the Navy in 2006 for mitigating the valley in the SSN force levels projected for the 2020s and 2030s. The study was completed in early 2007 and briefed to CRS and CBO on May 22, 2007.[50] At the time of the study, the SSN force was projected to bottom out at 40 boats and then recover to 48 boats by the early 2030s. Principal points in the Navy study (which cite SSN force-level projections as understood at that time) include the following:

- The day-to-day requirement for deployed SSNs is 10.0, meaning that, on average, a total of 10 SSNs are to be deployed on a day-to-day basis.[51]
- The peak projected wartime demand is about 35 SSNs deployed within a certain amount of time. This figure includes both the 10.0 SSNs that are to be deployed on a day-to-day basis and 25 additional SSNs surged from the United States within a certain amount of time.[52]
- Reducing Virginia-class shipyard construction time to 60 months—something that the Navy already plans to do as part of its strategy for meeting the Virginia-class cost-reduction goal (see earlier discussion on cost-reduction goal)—will increase the size of the SSN force by two boats, so that the force would bottom out at 42 boats rather than 40.[53]
- If, in addition to reducing Virginia-class shipyard construction time to 60 months, the Navy also lengthens the service lives of 16 existing SSNs by periods ranging from 3 months to 24 months (with many falling in the range of 9 to 15 months), this would increase the size of the SSN force by another two boats, so that the force would bottom out at 44 boats rather than 40 boats.[54] The total cost of

[50] Navy briefing entitled, "SSN Force Structure, 2020-2033," presented to CRS and CBO on May 22, 2007.

[51] The requirement for 10.0 deployed SSNs, the Navy stated in the briefing, was the current requirement at the time the study was conducted.

[52] The peak projected wartime demand of about 35 SSNs deployed within a certain amount of time, the Navy stated, is an internal Navy figure that reflects several studies of potential wartime requirements for SSNs. The Navy stated that these other studies calculated various figures for the number of SSNs that would be required, and that the figure of 35 SSNs deployed within a certain amount of time was chosen because it was representative of the results of these other studies.

[53] If shipyard construction time is reduced from 72 months to 60 months, the result would be a one-year acceleration in the delivery of all boats procured on or after a certain date. In a program in which boats are being procured at a rate of two per year, accelerating by one year the deliveries of all boats procured on or after a certain date will produce a one-time benefit of a single year in which four boats will be delivered to the Navy, rather than two. In the case of the Virginia-class program, this year might be around 2017. As mentioned earlier in the discussion of the Virginia-class cost-reduction goal, the Navy believes that the goal of reducing Virginia-class shipyard construction time is a medium-risk goal. If it turns out that shipyard construction time is reduced to 66 months rather than 60 months (i.e., is reduced by 6 months rather than 12 months), the size of the SSN force would increase by one boat rather than two, and the force would bottom out at 41 boats rather than 42.

[54] The Navy study identified 19 existing SSNs whose service lives currently appear to be extendable by periods of 1 to 24 months. The previous option of reducing Virginia-class shipyard construction time to 60 months, the Navy concluded, would make moot the option of extending the service lives of the three oldest boats in this group of 19, leaving 16 whose service lives would be considered for extension.

extending the lives of the 16 boats would be roughly $500 million in constant FY2005 dollars.[55]

- The resulting force that bottoms out at 44 boats could meet the 10.0 requirement for day-to-day deployed SSNs throughout the 2020-2033 period if, as an additional option, about 40 SSN deployments occurring in the eight-year period 2025-2032 were lengthened from six months to seven months. These 40 or so lengthened deployments would represent about one-quarter of all the SSN deployments that would take place during the eight-year period.
- The resulting force that bottoms out at 44 boats could not meet the peak projected wartime demand of about 35 SSNs deployed within a certain amount of time. The force could generate a total deployment of 32 SSNs within the time in question—3 boats (or about 8.6%) less than the 35-boat figure. Lengthening SSN deployments from six months to seven months would not improve the force's ability to meet the peak projected wartime demand of about 35 SSNs deployed within a certain amount of time.
- To meet the 35-boat figure, an additional four SSNs beyond those planned by the Navy would need to be procured. Procuring four additional SSNs would permit the resulting 48-boat force to surge an additional three SSNs within the time in question, so that the force could meet the peak projected wartime demand of about 35 SSNs deployed within a certain amount of time.
- Procuring one to four additional SSNs could also reduce the number of seven-month deployments that would be required to meet the 10.0 requirement for day-to-day deployed SSNs during the period 2025-2032. Procuring one additional SSN would reduce the number of seven-month deployments during this period to about 29; procuring two additional SSNs would reduce it to about 17, procuring three additional SSNs would reduce it to about 7, and procuring four additional SSNs would reduce it to 2.

The Navy added a number of caveats to these results, including but not limited to the following:

- The requirement for 10.0 SSNs deployed on a day-to-day basis is a current requirement that could change in the future.
- The peak projected wartime demand of about 35 SSNs deployed within a certain amount of time is an internal Navy figure that reflects recent analyses of potential future wartime requirements for SSNs. Subsequent analyses of this issue could result in a different figure.
- The identification of 19 SSNs as candidates for service life extension reflects current evaluations of the material condition of these boats and projected use rates for their nuclear fuel cores. If the material condition of these boats years from now turns out to be worse than the Navy currently projects, some of them might no longer be suitable for service life extension. In addition, if world conditions over the next several years require these submarines to use up their nuclear fuel cores more quickly than the Navy now projects, then the amounts of time that their service lives might be extended could be reduced partially, to zero,

[55] The Navy stated that the rough, order-of-magnitude (ROM) cost of extending the lives of 19 SSNs would be $595 million in constant FY2005 dollars, and that the cost of extending the lives of 16 SSNs would be roughly proportional.

or to less than zero (i.e., the service lives of the boats, rather than being extended, might need to be shortened).

- The analysis does not take into account potential rare events, such as accidents, that might force the removal of an SSN from service before the end of its expected service life.[56]
- Seven-month deployments might affect retention rates for submarine personnel.

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[56] In January 2005, the Los Angeles-class SSN *San Francisco* (SSN-711) was significantly damaged in a collision with an undersea mountain near Guam. The ship was repaired in part by transplanting onto it the bow section of the deactivated sister ship *Honolulu* (SSN-718). (See, for example, Associated Press, "Damaged Submarine To Get Nose Transplant," *Seattle Post-Intelligencer*, June 26, 2006.) Prior to the decision to repair the *San Francisco*, the Navy considered the option of removing it from service. (See, for example, William H. McMichael, "Sub May Not Be Worth Saving, Analyst Says," *Navy Times*, February 28, 2005; Gene Park, "Sub Repair Bill: $11M," *Pacific Sunday News (Guam)*, May 8, 2005.)