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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 one Virginia-class boat that the Navy is requesting for procurement in FY2021 would be the 33rd boat in the class. The Navy's FY2020 budget submission had projected that the Navy would request two Virginia-class boats in FY2021.

Virginia-class boats scheduled for procurement in FY2019-FY2023 are being procured under a multiyear procurement (MYP) contract. Most Virginia-class boats procured in FY2019 and subsequent years are to be built with the Virginia Payload Module (VPM), an additional, 84-foot-long, mid-body section equipped with four large-diameter, vertical launch tubes for storing and launching additional Tomahawk missiles or other payloads.

The Navy's FY2021 budget submission estimates the procurement cost of the Virginia-class boat requested for procurement in FY2021 at $3,539.4 million (i.e., about $3.5 billion). The boat has received $915.7 million in prior-year "regular" advance procurement (AP) funding, and $289.0 million in prior-year Economic Order Quantity (EOQ) AP funding for components of boats being procured under the FY2019-FY2023 MYP contract. The Navy's proposed FY2021 budget requests the remaining $2,334.7 million needed to complete the boat's estimated procurement cost, as well as $1,473.8 million in "regular" AP funding for Virginia-class boats to be procured in future fiscal years and $427.4 million in EOQ AP funding for components of boats being procured under the FY2019-FY2023 MYP contract, bringing the total amount of procurement and AP funding requested for the program in FY2021 to $4,235.9 million (i.e., about $4.2 billion), excluding outfitting and post-delivery costs.

The FY2019-FY2023 MYP contract for the Virginia-class program includes a total of nine boats (in annual quantities of 2-2-1-2-2), with an option for adding a 10th boat. The contract allows for the 10th boat to be added in either FY2021 (which would make for a total procurement of two Virginia-class boats in FY2021) or a subsequent year. The Navy's FY2021 unfunded priorities list (UPL) reportedly lists the 10th boat as the Navy's top unfunded priority for FY2021 and states that fully funding this additional boat in FY2021 would require an additional $2.76 billion in funding.

The Navy's force-level goal for SSNs is to achieve and maintain a force of 66 boats. The Navy's SSN force included 50 boats at the end of FY2019. From the mid-2020s through the early 2030s, the number of SSNs is projected to experience a valley or trough, reaching a minimum of 42 boats in FY2027-FY2028. 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. The Navy's FY2020 30-year shipbuilding plan projects that, after reaching its projected 42-boat minimum, the SSN force will increase to 66 boats by FY2048.

Issues for Congress regarding the Virginia-class program include whether to provide funding for procuring a second Virginia-class boat in FY2021 (which would be the 10th boat under the MYP contract); the potential industrial-base challenges of building both Columbia-class boats and Virginia-class attack submarines (SSNs) at the same time; and technical risk in the design for the latest (i.e., Block V) version of the Virginia-class submarine.

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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 FY2021 budget requests $4,235.9 million (i.e., about $4.2 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 is discussed in another CRS report—CRS Report R41129, *Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress*, by Ronald O'Rourke.

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 Ronald O'Rourke.

Background

U.S. Navy Submarines[1]

The U.S. Navy operates three types of submarines—nuclear-powered ballistic missile submarines (SSBNs),[2] nuclear-powered cruise missile and special operations forces (SOF) submarines (SSGNs),[3] 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] 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.

[2] 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 inCRS Report R41129, *Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress*, by Ronald O'Rourke, and CRS Report RL31623, *U.S. Nuclear Weapons: Changes in Policy and Force Structure*, by Amy F. Woolf.

[3] 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 Ronald O'Rourke.

- 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.[4] In the post-Cold War era, although ASW remained a mission, the SSN force focused more on performing the first three other missions listed above. With the shift in the strategic environment in recent years from the post-Cold War era to a new situation featuring renewed great power competition,[5] ASW against Russian and Chinese submarines has once again become a more prominent mission for U.S. Navy SSNs.

U.S. SSN Force Levels

Force-Level Goal

The Navy's force-level goal, released in December 2016, is to achieve and maintain a 355-ship fleet, including 66 SSNs.[6] For a review of SSN force-level goals since the Reagan Administration, see **Appendix A**.

Force Level at End of FY2019

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 50 SSNs in service at the end of FY2018 included the following:

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

Projected Force Levels

Table 1 shows the Navy's projection of the number of SSNs over time if the Navy's FY2020 30-year shipbuilding plan were fully implemented. As can be seen in the table, the FY2020 30-year shipbuilding plan would achieve the Navy's 66-boat SSN force-level goal by FY2048.

[4] 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).

[5] For more on this shift, see CRS Report R43838, *A Shift in the International Security Environment: Potential Implications for Defense—Issues for Congress*, by Ronald O'Rourke.

[6] For additional information on Navy force-level goals, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

Table 1. Projected SSN Force Levels

As shown in Navy's FY2020 30-Year (FY2020-FY2049) Shipbuilding Plan

Fiscal year	Annual procurement quantity	Projected number of SSNs	Force level relative to current 66-boat goal	
			Number of ships	Percent
20	3	52	-14	-21%
21	2	53	-13	-20%
22	2	52	-14	-21%
23	2	51	-15	-23%
24	2	47	-19	-29%
25	2	44	-22	-33%
26	2	44	-22	-33%
27	2	42	-24	-36%
28	2	42	-24	-36%
29	2	44	-22	-33%
30	2	46	-20	-30%
31	2	48	-18	-27%
32	2	49	-17	-26%
33	2	51	-15	-23%
34	2	53	-13	-20%
35	2	54	-12	-18%
36	2	56	-10	-15%
37	2	58	-8	-12%
38	2	57	-9	-14%
39	2	58	-8	-12%
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	—	—
49	2	67	+1	+2%

Source: Table prepared by CRS based on Navy's FY2020 30-year shipbuilding plan. Percent figures rounded to nearest percent.

As also shown in the table, the number of SSNs is projected to experience (relative to a previous Navy SSN force-level goal of 48 boats) a valley or trough from the mid-2020s through the early 2030s, reaching a minimum of 42 boats (i.e., 24 boats, or about 36%, less than the current 66-boat force-level goal) in FY2027-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 a period of weakened conventional deterrence against potential adversaries such as China.[7] The projected SSN valley

[7] 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

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 FY2020 budget submission proposes to refuel and extend the service life of two older Los Angeles (SSN-688) class submarines. The Navy states that this could be followed by refuelings and service life extensions for up to five more Los Angeles-class SSNs that would be funded in fiscal years beyond the FY2020-FY2024 Future Year Defense Plan (FYDP).[8]

U.S. SSN Classes

Los Angeles (SSN-688) Class

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 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 FY2019, 32 of the 62 boats in the class had been retired.

Seawolf (SSN-21) Class

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.[9] 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.[10]

Virginia (SSN-774) Class

The Navy has been procuring Virginia-class SSNs (see **Figure 1**) since FY1998; the first entered service in October 2004. The Virginia-class design was developed to be less expensive and better optimized for post-Cold War submarine missions than the Seawolf-class design. The baseline

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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.)

[8] U.S. Navy, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, February 2018, p. 6. For 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, see **Appendix C**.

[9] 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.

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

Virginia-class design is slightly larger than the Los Angeles-class design[11] but incorporates newer technologies, including technologies used in the Seawolf-class design.

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.

Virginia-Class Procurement Program

Unit Procurement Cost

Most Virginia-class boats to be procured in FY2019 and subsequent years are to be built to a lengthened configuration that includes the Virginia Payload Module (see discussion below) and generally have an estimated unit procurement cost in the Navy's FY2020 budget submission of roughly $3.4 billion.

Annual Procurement Quantities

Table 2 shows annual numbers of Virginia-class boats procured from FY1998 (the lead boat) through FY2020, the number requested for procurement in FY2021, and the numbers projected for procurement in FY2022-FY2025 under the FY2022-FY2025 Future Years Defense Plan (FYDP).

[11] The baseline Virginia-class design has a beam of 34 feet and a submerged displacement of 7,800 tons.

Table 2. Annual Numbers of Virginia-Class Boats Procured or Projected for Procurement

FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
1	1	0	1	1	1	1	1	1	1	1	1	1	2
FY12	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	***FY21***	***FY22***	***FY23***	***FY24***	***FY25***
2	2	2	2	2	2	2	2	2	*1*	*2*	*2*	*2*	*2*

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

Multiyear Contracting

With the exception of a single Virginia-class boat procured in FY2003, all Virginia-class boats have been procured or are to be procured under multiyear contracting, meaning either a block buy contract or multiyear procurement (MYP) contract:[12]

- The first four Virginia-class boats, known as the Block I boats, were procured in FY1998-FY2002 under a block buy contract covering those years.[13] This was the first instance of block buy contracting—the mechanism of a block buy contract was essentially created for procuring the first four Virginia-class boats.
- The Virginia-class boat procured in FY2003 fell between the FY1998-FY2002 block buy contract noted above and the FY2004-FY2008 MYP contract noted below, and was contracted for separately.
- The five Virginia-class boats procured FY2004-FY2008, known as the Block II boats, were procured under an MYP contract covering those years.
- The eight Virginia-class boats procured in FY2009-FY2013, known as the Block III boats, were procured under an MYP contract covering those years.
- The 10 Virginia-class boats procured in FY2014-FY2018, known as the Block IV boats, were procured under an MYP contract covering those years.
- The Virginia-class boats being procured in FY2019-FY2023, known as the Block V boats, are to be procured under an MYP contract covering those years.

FY2019-FY2023 MYP Contract

Table 2 shows a total of nine Virginia-class boats scheduled for procurement under the FY2019-FY2023 MYP contract. The Navy's FY2020 budget submission had stated that the Navy was negotiating an MYP contract for 10 Virginia-class boats during these years. On this basis, observers anticipated that the FY2019-FY2023 Virginia-class MYP contract would include a total of 10 or perhaps even 11 boats.

In early November 2019, however, the Navy confirmed to reporters that, after lengthy negotiations with the program's prime contractor, General Dynamics, the two sides had reached an agreement for an MYP contract including nine Virginia-class boats with an option for a 10th.

The Navy awarded the contract—a fixed-price incentive fee (FPIF) MYP contract—on December 2, 2019. The contract includes nine Virginia-class boats (eight of which are to be built with the

[12] For more on block buy contracting and MYP contracting, see CRS Report R41909, *Multiyear Procurement (MYP) and Block Buy Contracting in Defense Acquisition: Background and Issues for Congress*, by Ronald O'Rourke.

[13] 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 Ronald O'Rourke and Moshe Schwartz. 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.

Virginia Payload Module, or VPM (see discussion below), plus an option for a 10th boat that would also be built with the VPM. The contract also includes a 10th shipset of supplier-made components, so that if the option for the 10th boat is exercised, the ship can be constructed in a timely manner. The option for the 10th boat can be awarded any time during the contract's five-year period. Of the nine firm boats in the contract, six are to have their final assembly done at HII/NNS and three at GD/EB. The 10th boat, if awarded, would have its final assembly done at GD/EB.[14]

Joint Production Arrangement

Virginia-class boats are built jointly by General Dynamics' Electric Boat Division (GD/EB) of Groton, CT, and Quonset Point, RI—the program's prime contractor—and Huntington Ingalls Industries' Newport News Shipbuilding (HII/NNS), of Newport News, VA. 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.[15] A primary aim of the arrangement was 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.[16]

Integrated Enterprise Plan (IEP)

Under a plan it calls the Integrated Enterprise Plan (IEP), the Navy plans to build Columbia-class ballistic missile submarines jointly at GD/EB and HII/NNS, with most of the work going to GD/EB. (The IEP was previously called the Submarine Unified Build Strategy, or SUBS.) 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 final-assembly work for that program than it has received in the past.[17]

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[14] For press reports about the contract, see, for example, Megan Eckstein, "Navy Awards $22B Contract to Electric Boat, Newport News Shipbuilding for 9 Block V Virginia Subs," *USNI News*, December 2, 2019; David B. Larter, "US Navy Awards Largest-Ever Shipbuilding Contract to Electric Boat for New Attack Submarines," *Defense News*, December 2, 2019; Rich Abott, "Navy Awards Largest Contract Ever, $22.2 Billion For 9 Block V Virginia Subs," *Defense Daily*, December 2, 2019.

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

[16] 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.

[17] Key elements of IEP include the following:

Schedule and Cost Performance

Earlier Record

As noted in CRS testimony in 2014,[18] the Virginia (SSN-774) class attack program was cited as an example of a successful acquisition program. The program received a David Packard Excellence in Acquisition Award from the Department of Defense (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 until recently, ships had been delivered largely on cost and ahead of schedule.[20]

- 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;
- 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.

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

[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 discussions of recent exceptions, see Christopher P. Cavas, "US Navy Submarine Program Loses Some of Its Shine," *Defense News*, March 13, 2017; David B. Larter, "Virginia-Class Attack Sub Delivers late As US Navy Aims to Get Program Back on Course," *Defense News*, June 26, 2018.

More-Recent Reported Delays Relative to Targeted Delivery Dates

Beginning in March and April 2019, it was reported that GD/EB, HII/NNS, and their supplier firms were experiencing challenges in meeting scheduled delivery times as the Virginia-class program transitions over time from production of two "regular" Virginia-class boats per year to two VPM-equipped boats per year. As a result of these challenges, it was reported, the program has experienced months-long delays in efforts to build boats relative to their targeted delivery dates.[21] A November 4, 2019, press report stated that "the most recent Virginia-class boat, the Delaware, was delivered by Huntington Ingalls Newport News nearly nine months behind schedule, which is later than the four-to-seven month delays the Navy predicted earlier in the year."[22]

Virginia Payload Module (VPM)

The Navy plans to build most Virginia-class boats procured in FY2019 and subsequent years with the Virginia Payload Module (VPM), an additional, 84-foot-long, mid-body section equipped with four large-diameter, vertical launch tubes for storing and launching additional Tomahawk missiles or other payloads. The VPM's vertical launch tubes are to be used to store and fire additional Tomahawk cruise missiles or other payloads, such as large-diameter unmanned underwater vehicles (UUVs).[23] The four additional launch tubes in the VPM could carry a total of 28 additional Tomahawk cruise missiles (7 per tube),[24] 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%.[25]

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).[26] 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.

The Navy's FY2021 budget submission shows that Virginia-class boats with the VPM generally have estimated recurring unit procurement costs of roughly $3.4 billion. The joint explanatory statement for the FY2014 DOD Appropriations Act (Division C of H.R. 3547/P.L. 113-76 of

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[21] See, for example, Government Accountability Office, *Columbia Class Submarine[:] Overly Optimistic Cost Estimate Will Likely Lead to Budget Increases*, GAO-19-497, April 2019, pp. 20-23; David B. Larter, "Late Is the New Normal for Virginia-Class Attack Boats," *Defense News*, March 20, 2019; Megan Eckstein, "Navy: Lack of Submarine Parts Slowing Down Maintenance, New Construction," *USNI News*, March 26, 2019. See also David B. Larter, "The US Navy, Seeking Savings, Shakes Up Its Plans for More Lethal Attack Submarines," *Defense News*, April 3, 2019.

[22] David B. Larter, "US Navy to Slash the Number of Virginia-Class Attack Subs in Long-Delayed Block V Contract," *Defense News*, November 4, 2019.

[23] 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.

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

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

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

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.[27]

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.[28]

FY2021 Funding Request

The Navy's FY2021 budget submission estimates the procurement cost of the Virginia-class boat requested for procurement in FY2021 at $3,539.4 million (i.e., about $3.5 billion). The boat has received $915.7 million in prior-year "regular" advance procurement (AP) funding, and $289.0 million in prior-year Economic Order Quantity (EOQ) AP funding for components of boats being procured under the FY2019-FY2023 MYP contract. The Navy's proposed FY2021 budget requests the remaining $2,334.7 million needed to complete the boat's estimated procurement cost, as well as $1,473.8 million in "regular" AP funding for Virginia-class boats to be procured in future fiscal years and $427.4 million in EOQ AP funding for components of boats being procured under the FY2019-FY2023 MYP contract, bringing the total amount of procurement and AP funding requested for the program in FY2021 to $4,235.9 million (i.e., about $4.2 billion), excluding outfitting and post-delivery costs.

Second Boat Included in Navy's FY2021 Unfunded Priorities List

The Navy's FY2021 unfunded priorities list (UPL) reportedly lists a second Virginia-class boat (which would be the 10th boat under the FY2019-FY2023 Virginia-class MYP contract) as the Navy's top unfunded priority for FY2021, and states that fully funding this additional boat in FY2021 would require an additional $2.76 billion in funding.[29] The Navy believes the industrial base has the capacity to take on the additional work associated with building the 10th boat.[30]

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

[28] For press reports discussing these improvements, see Kris Osborn, "The Navy Wants to Turn ITs Nuclear Attack Submarines Into 'Spy' Ships," *National Interest*, May 28, 2018; 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.

[29] See, for example, David B. Larter, "Here's the $5.4 Billion of Stuff the US Navy Says It Wants But Didn't Fit in Its FY21 Budget Request," *Defense News*, February 21, 2020; Ben Werner, "Second Virginia Attack Boat Tops Navy's Fiscal Year 2021 Unfunded Priorities List," *USNI News*, February 20, 2020.

[30] Source: Navy briefing on its proposed FY2021 budget, February 11, 2020.

Submarine Construction Industrial Base

U.S. Navy submarines are built by GD/EB and HII/NNS. These 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.

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 sole-source suppliers. For nuclear-propulsion component suppliers, an additional source of stabilizing work is the Navy's nuclear-powered aircraft carrier construction program.[31] 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; additional portions are resident at HII/NNS and some of the component makers.

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 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. A November 2018 Government Accountability Office (GAO) report on the issue stated the following:

> The Navy has been unable to begin or complete the vast majority of its attack submarine maintenance periods on time resulting in significant maintenance delays and operating and support cost expenditures. GAO's analysis of Navy maintenance data shows that between fiscal year 2008 and 2018, attack submarines have incurred 10,363 days of idle time and maintenance delays as a result of delays in getting into and out of the shipyards. For example, the Navy originally scheduled the USS Boise to enter a shipyard for an extended maintenance period in 2013 but, due to heavy shipyard workload, the Navy delayed the start of the maintenance period. In June 2016, the USS Boise could no longer conduct normal operations and the boat has remained idle, pierside for over two years since then waiting to enter a shipyard…. GAO estimated that since fiscal year 2008 the Navy has spent more than $1.5 billion in fiscal year 2018 constant dollars to support attack submarines that provide no operational capability—those sitting idle while waiting to enter the shipyards, and those delayed in completing their maintenance at the shipyards.
>
> The Navy has started to address challenges related to workforce shortages and facilities needs at the public shipyards. However, it has not effectively allocated maintenance periods among public shipyards and private shipyards that may also be available to help minimize attack submarine idle time. GAO's analysis found that while the public shipyards have operated above capacity for the past several years, attack submarine maintenance delays are getting longer and idle time is increasing. The Navy may have options to mitigate this idle time and maintenance delays by leveraging private shipyard capacity for repair work. But the Navy has not completed a comprehensive business case analysis as recommended by Department of Defense guidelines to inform maintenance workload allocation across public and private shipyards. Navy leadership has acknowledged that they need to be more proactive in leveraging potential private shipyard repair capacity. Without

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

> addressing this challenge, the Navy risks continued expenditure of operating and support funding to crew, maintain, and support attack submarines that provide no operational capability because they are delayed in getting into and out of maintenance.[32]

The House Appropriations Committee, in its report (H.Rept. 115-769 of June 20, 2018) on the FY2019 DOD Appropriations Act (H.R. 6157) stated the following:

> SUBMARINE MAINTENANCE SHORTFALLS
>
> The Committee recognizes that the nuclear-capable public naval shipyards are backlogged with submarine maintenance work, while private nuclear-capable shipyards have underutilized capacity. The Los Angeles (SSN–688) class submarines are especially impacted by this backlog, which significantly reduces their operational availability for missions in support of combatant commanders. The Committee directs the Secretary of the Navy to submit a report to the congressional defense committees not later than 90 days after the enactment of this Act that outlines a comprehensive, five-year submarine maintenance plan that restores submarine operational availability and fully utilizes both public and private nuclear-capable shipyards in accordance with all applicable laws. The plan should strive to provide both private and public shipyards with predictable frequency of maintenance availabilities and estimate any potential cost savings that distributing the workload may deliver. (Page 71)

A March 2019 Navy report to Congress states that in response to the above committee report language

> The Navy submitted an initial [submarine maintenance] plan in December 2018, that reflected FY 2019 budget information. The Navy has [now] updated this plan to incorporate data from the President's FY 2020 budget submitted on March 11, 2019….
>
> … In the post-Cold War and post 9/11 era, there have been decades of decision making associated with the re-posturing of defense strategies, such as: the reduction in maintenance capacity and flexibility though Baes Realignment and Closures (BRAC), increased Operational Tempo (OPTEMPO), evolution of submarine life cycle maintenance plans, budget reductions, and budget uncertainties that have contributed to the current challenges facing the submarine fleet.
>
> The root cause of submarine idle time and associated loss of operational availability, as discussed in the recent Government Accountability Office (GAO) report 19-229, "Actions Needed to Address Costly Maintenance Delays Facing the Attack Submarine Fleet" (issued November 2018), is largely due to public shipyard capacity not keeping pace with growing maintenance requirements that have been building for a number of years prior to the USS BOISE (SSN 764) FY 2016 Engineered Overhaul (EOH). The workload to capacity mismatch resulted in lower priority attack submarine (SSN) availabilities (as compared to ballistic missile submarines and nuclear-powered aircraft carriers) being delivered late and a bow-waving of workload from one fiscal year to the next that could not be executed. The workload backlog exacerbated the public shipyard workload-to-capacity mismatch and contributed to an increasing trend in late SSN [maintenance] deliveries.
>
> The Navy has taken several actions to improve the workload-to-capacity balance at the public shipyards. Notably, over 20,600 workers were hired from FY 2013 through FY 2018, which after accounting for attrition, increased total end strength from 29,400 to 36,700. However, the accelerated hiring resulted in 56 percent of the production workforce having less than five years of experience. The less experienced workforce requires a greater investment in training, as described in the Navy's Report to Congress on the Naval Shipyard Development Plan (issued March 2018), which offers some near term

[32] Government Accountability Office, *Navy Readiness[:] Actions Needed to Address Costly Maintenance Delays Facing the Attack Submarine Fleet*, GAO-19-229, November 2018, summary page.

> productivity gains. The Navy has also taken additional actions to balance workload at our public shipyards by outsourcing four submarine maintenance availabilities to the private sector and plans to outsource another two submarine availabilities to the private shipyards starting in FY 2020 and FY 2021. Additionally, to ensure on-time delivery from maintenance availabilities, availability inductions have been rescheduled to occur when the shipyards have the capacity to accomplish the availability(s) within programmed schedule durations. This necessary action to improve the on-time delivery of current maintenance availabilities has resulted in some additional submarine maintenance backlog and some accumulation of idle time. Based on actions and initiatives the Navy is currently pursuing to improve submarine operational availability and the outsourcing of two additional submarine availabilities to the private sector, the Navy assesses that the submarine idle time will be eliminated by the end of FY 2023 and the submarine maintenance backlog will be worked off by the end of FY 2023.[33]

Issues for Congress

Funding for Second Boat in FY2021

One issue for Congress is whether to provide funding for procuring a second Virginia-class boat in FY2021 (which would be the 10th boat under the MYP contract).

Supporters of adding funding for the procurement of a second Virginia-class boat in FY2021 could argue that it is the top item on the Navy's FY2021 Unfunded Priorities List (UPL), that some observers have identified attack submarines as particularly important for countering China's improving naval capabilities,[34] that procuring a second Virginia-class boat in FY2021 could help the Navy to more quickly recover from the projected valley or trough in SSN force levels and achieve the Navy's 66-boat SSN force-level objective, that the Navy believes the industrial base has the capacity to take on the additional work associated with a 10th boat, and that adding a second Virginia-class boat in FY2021 could improve production economies of scale in the Virginia-class program and provide better support for supplier firms, including firms involved in making nuclear propulsion components for Navy ships.[35]

Opponents of adding funding for the procurement of a second Virginia-class boat in FY2021 could argue that adding a 10th boat to the FY2019-FY2023 Virginia-class MYP contract could stress the submarine industrial base, particularly in the context of FY2021 being the year that the Navy wants to also start building the first Columbia-class ballistic missile submarine (see next section), that there may be more cost-effective uses for the additional $2.76 billion that would be needed to fully fund the second boat, including other items on the unfunded lists of the Navy and the other services, and that the FY2019-FY2023 MYP contract already contains funding for a 10th shipset of Virginia-class supplier-made components, the purpose of which is to help provide stability for key component makers.

[33] U.S. Navy, *President's FY 2020 Budget Update to Report to Congress on Submarine Depot Maintenance Prepared by Secretary of the Navy*, generated March 12, 2019, with cover letters dated March 21, 2019, provided to CRS by Navy Office of Legislative Affairs on March 27, 2019, pp. 3-4.

[34] For discussion of China's naval modernization effort and U.S. Navy responses to that effort, see CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by Ronald O'Rourke.

[35] For a news report discussing the final point, see Ben Werner, "Nuclear Reactor Builder Warns of Loss if Navy Buys Single Virginia Attack Boat in FY '21," *USNI News*, February 25, 2020.

Industrial-Base Challenges of Building Both Virginia- and Columbia-Class Boats

Another potential issue for Congress concerns the potential industrial-base challenges of building both Virginia- and Columbia-class boats at the same time. Along with continued production of Virginia-class SSNs, the Navy in FY2021 is to also begin building Columbia-class ballistic missile submarines (SSBNs). Observers have expressed concern about the industrial base's capacity for building both Virginia- and Columbia-class boats without encountering bottlenecks or other production problems in one or both of these programs. Concerns about the ability of the submarine construction industrial base to execute an eventual procurement rate of two VPM-equipped Virginia-class boats and one Columbia-class boat per year have been heightened by recent reports of challenges faced by the two submarine-construction shipyards (GD/EB and HII/NNS), as well as submarine component supplier firms in meeting scheduled delivery times for Virginia-class boats as the Virginia-class program transitions over time from production of two "regular" Virginia-class boats per year to two VPM-equipped boats per year.[36] Potential oversight questions for Congress include the following:

- Do the Navy and the submarine builders agree on the question of the capacity of the industrial base to support various potential Virginia- and Columbia-class workloads?
- What steps are the Navy, the submarine builders, and submarine supplier firms taking to bring the capacity of the industrial base more into alignment with desired submarine procurement rates? What are the costs of these steps, and what portion of these costs will be borne by the government?

Regarding the second bullet point above, a November 7, 2019, press report states:

> The Navy and submarine builders General Dynamics Electric Boat and Newport News Shipbuilding are executing a recovery plan to get Block IV Virginia-class submarine production back on track, after the last five submarines in Block III delivered late.
>
> The Virginia-class program had previously been held up as a model of efficient procurement, as the boats were delivering on-cost and on-schedule—or at times beating cost and schedule—and former Navy Secretary Ray Mabus grew to joke about the program as having a punch-card rewards program to get 10 subs for the price of nine. Delivery times also dropped from 84 months to 72 and then to 66, on their way down to 60 months for Block IV.
>
> But as the program moved from building one a year to two a year, the subs stopped delivering on time.

[36] See, for example, Government Accountability Office, *Columbia Class Submarine[:] Overly Optimistic Cost Estimate Will Likely Lead to Budget Increases*, GAO-19-497, April 2019, pp. 20-23; David B. Larter, "Late Is the New Normal for Virginia-Class Attack Boats," *Defense News*, March 20, 2019; Megan Eckstein, "Navy: Lack of Submarine Parts Slowing Down Maintenance, New Construction," *USNI News*, March 26, 2019; David B. Larter, "The US Navy, Seeking Savings, Shakes Up Its Plans for More Lethal Attack Submarines," *Defense News*, April 3, 2019; Anthony Capaccio, "U.S. Navy Sub Firepower Upgrade Delayed by Welding Flaws," *Bloomberg*, August 13, 2019; Paul McLeary, "Weld Problems Spread To Second Navy Sub Program," *Breaking Defense*, August 14, 2019; David B. Larter, "Questions About US Navy Attack Sub Program Linger as Contract Negotiations Drag," *Defense News*, August 16, 2019; Emma Watkins, "Will the U.S. Navy Soon Have a Missile-Tube Problem?" *National Interest*, August 19, 2019; David B. Larter, "As CNO Richardson Departs, US Submarine Builders Face Pressure," *Defense News*, August 22, 2019; David B. Larter, "After a Leadership Shakeup at General Dynamics, a Murky Future for Submarine Building," *Defense News*, October 28, 2019; Rich Abott, "Navy Says Virginia Sub Delays Due To Faster Production Rate," *Defense Daily*, November 6, 2019.

"The way we build our submarines, there's four super modules [that make up each boat]: two built at EB, two built at Newport News. From their module perspective, they have to deliver a module (one of each kind) every six months. And you look the entire fabrication, from the pipe shop to pre-fab to sub-modules to modules, when you're at that cadence of two per year, every part of that assembly line must be on cadence. At the pre-fab, at the sub-module, the footprint, the people, the tools, the procedures. So what we learned is, if you get out of cadence in any part of that step, you're going to impact final assembly and test. So that's what happened," Rear Adm. David Goggins, the program executive officer for submarines, said in response to a USNI News question during a question-and-answer session at the Naval Submarine League's annual symposium.

"So the companies have put together a recovery plan. We have the metrics. And the key thing is getting back to cadence across the entire production line, from the pipe shop, pre-fab, sub-modules, modules and final assembly and test. Our plan has us getting back to cadence by the end of next year," he said.

Speaking to USNI News after the event, Goggins said that Newport News Shipbuilding had expanded its footprint at its Virginia shipyard to try to keep up with the higher workload, which wouldn't be sustainable in the long-run as the shipyard also begins work on the upcoming Columbia-class ballistic missile submarine program.

"At Newport News they expanded to additional footprint, and now the key thing is, over the next year and a half, through the end of next year, is getting those modules completed on schedule," Goggins told USNI News.

"So by the end of next year, we're back to cadence and using the planned footprint with the planned resources to go execute module deliveries."

He said metrics are in place to ensure the company is on track to meet this goal. Asked if any significant hurdles remain, he said, "they need to go execute the plan. They have the people, they have the footprint, they have the tooling; they just have to go execute, which they're doing today."

Tom Plante, the director of strategic planning for Electric Boat, told USNI News during a September visit to the Connecticut shipyard that some of the vendors were unable to keep up with the faster pace of shipbuilding, either sending parts late or sending parts with deficiencies that had to be later ripped out of modules and replaced.

"We were challenged to meet our schedules in Block IV, and some of that is program execution, some of that is ripples caused by [continuing resolutions] and funding and plus-ups," Plante said.

"If we get off that rhythm, if we get off that cadence, that causes these ripples, and it takes multiple ships to work through that. If you have a supply problem—non-conforming material comes in and I've got to stop, I've got to go assess, I've got to rip things out, I've got to re-do things—then that all adds time and cost to construction execution by shipbuilders."

Goggins said Wednesday [November 6] that it would be important to keep the recovery plan on track and get the Virginia production line under control so problems don't spill over and affect the Columbia class of SSBNs.

"The key thing is getting back to cadence across the entire production line, and that is needed to ensure the success of the Columbia program, which is key," the rear admiral said.

Despite the challenge keeping up with the faster delivery schedule, Goggins said the Virginia-class submarines have been delivering at ever-higher quality. The future Delaware (SSN-791) completed its sea trials on Oct. 10 and delivered on Oct. 25 and was the highest-

quality sub delivered to date, according to the Board of Inspection and Survey (INSURV) report, Goggins said.[37]

Technical Risk in Virginia-Class Block V Design

Another potential issue for Congress concerns technical risk in the design for Block V version of the Virginia-class submarine—the version to be procured during the FY2019-FY2023 Virginia-class MYP contract. A May 2019 GAO report—the 2019 edition of GAO's annual report surveying DOD major acquisition programs—stated the following regarding the Block V version of the Virginia-class design:

> **Current Status**
>
> In 2019, the Navy plans to award a multibillion dollar, multiyear contract for construction of 10 Block V submarines. Under the Navy's plan, all Block V ships will include acoustic superiority improvements, while the VPM will be added starting with the second Block V submarine.
>
> According to program officials, the design of Block V submarines will differ from Block IV by approximately 20 percent. Of this 20 percent, the program office considers 70 percent to constitute major changes. The program office plans to complete basic and functional designs for VPM by construction start—an approach consistent with best practices. However, the shipbuilder is currently behind schedule in completing detail design work, where (1) the design advances to the highest level of fidelity, (2) specific fabrication and installation instructions for the shipyard are developed, and (3) required production materials are identified. The program now plans to complete 76 percent of this work by construction start, compared to the 86 percent it initially planned, in part due to the shipbuilder's challenges in using a new design tool. Going forward, the Navy and shipbuilder will need to balance staffing levels for the remaining Block V design work with design efforts for the new Columbia class ballistic missile submarine. Construction of Block V and the Columbia class will coincide beginning in fiscal year 2021.This will require the Navy and its shipbuilder to manage staffing demands and other resources across both programs. In addition, program officials said vendor quality issues with welding on VPM have caused a 3.5-month delay in the schedule for the payload tubes for the first two submarines with VPM. The Navy plans to recover some time by accelerating tube manufacturing with a second vendor, but this approach may increase program costs.
>
> The Block V effort is subsumed under the SSN 774 major defense acquisition program, and is not managed as a separate program. In 2015, the Office of the Secretary of Defense shifted the program's oversight to the Navy. SSN 774 had already completed its required defense acquisition system milestone reviews before Block V started, but program officials said the Navy continues to conduct regular oversight of the Block V.
>
> **Program Office Comments**
>
> In commenting on a draft of this assessment, the program office provided technical comments, which we incorporated where appropriate.[38]

[37] Megan Eckstein, "Navy, Sub Builders Have Recovery Plan to Get Virginia Attack Boat deliveries Back on Schedule," *USNI News*, November 7, 2019. See also Megan Eckstein, "Sub Builders Confident Young Workforce Can Keep Virginia Attack Boats On track," *USNI News*, December 3, 2019.

[38] Government Accountability Office, *Weapon Systems Annual Assessment[:] Limited Use of Knowledge-Based Practices Continues to Undercut DOD's Investments*, GAO-19-336SP, May 2019, p. 137.

Additional Issues

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.[39]

Problem with Hull Coating

Another issue for Congress concerns a problem with the hull coating used on Virginia-class boats that was first reported years ago, and then again 2017[40] and 2019.[41]

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.[42]

Legislative Activity for FY2021

Congressional Action on FY2021 Funding Request

Table 3 summarizes congressional action on the Navy's FY2021 funding request for the Virginia-class program.

Table 3. Congressional Action on FY2021 Funding

(Millions of dollars, rounded to nearest tenth)

		Authorization			Appropriation		
	Request	HASC	SASC	Conf.	HAC	SAC	Conf.
Virginia class procurement	2,334.7						
Virginia class advance procurement (AP)	1,901.2						
(Quantity)	*(1)*						
TOTAL	**4,235.9**						

Source: Table prepared by CRS based on Navy's FY2021 budget submission, committee and conference reports, and explanatory statements on FY2021 National Defense Authorization Act and FY2021 DOD Appropriations Act.

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

[40] See William Cole, "Navy Subs Still Show Issue with Stealth Coating," *Military.com*, March 6, 2017.

[41] See James Clark, "Whistleblower Accuses Largest US Military Shipbuilder of Putting 'American Lives at Risk' by Falsifying Tests on Submarine Stealth Coating," *Task & Purpose*, October 3, 2019.

[42] 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.

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.

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.[43] 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.[44]

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.[45] 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."[46] 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

[43] 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.

[44] 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.

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

[46] 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."[47]

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."[48]

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.[49]

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.[50]

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.[51]

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.

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

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

[49] 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.

[50] 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.

[51] 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.[52]

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.[53] 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

[52] For additional discussion of these funding approaches, see CRS Report RL32776, *Navy Ship Procurement: Alternative Funding Approaches—Background and Options for Congress*, by Ronald O'Rourke.

[53] 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.[54]

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 two or three years of advance work on long-leadtime components, and an additional five or 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.

[54] 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.[55] 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.[56]
- 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.[57]
- 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.[58]
- 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.[59] The total cost of

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

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

[57] 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.

[58] 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.

[59] 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.[60]

- 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,

[60] 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.[61]
- Seven-month deployments might affect retention rates for submarine personnel.

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[61] 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.)