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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 since FY1998. The two Virginia-class boats requested for procurement in FY2017 are to be the 25th and 26th boats in the class. The 10 Virginia-class boats programmed for procurement in FY2014-FY2018 (two per year for five years) are being procured under a multiyear-procurement (MYP) contract.

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2017 at $5,408.9 million, or an average of $2,704.5 million each. The boats have received a total of $1,623.3 million in prior-year advance procurement (AP) funding and $597.6 million in prior-year Economic Order Quantity (EOQ) funding. The Navy's proposed FY2017 budget requests the remaining $3,188.0 million needed to complete the boats' estimated combined procurement cost. The Navy's proposed FY2017 budget also requests $1,767.2 million in AP funding for Virginia-class boats to be procured in future fiscal years, bringing the total FY2017 funding request for the program (excluding outfitting and post-delivery costs) to $4,955.2 million.

The Navy's proposed FY2017 budget also requests $97.9 million in research and development funding for the Virginia Payload Module (VPM). The funding is contained in Program Element (PE) 0604580N, entitled Virginia Payload Module (VPM), which is line 128 in the Navy's FY2017 research and development account.

The Navy plans to build some of the Virginia-class boats procured in FY2019 and subsequent years with an additional mid-body section, called the Virginia Payload Module (VPM), that contains four large-diameter, vertical launch tubes that the boats would use to store and fire additional Tomahawk cruise missiles or other payloads, such as large-diameter unmanned underwater vehicles (UUVs).

The Navy's FY2017 30-year SSN procurement plan, if implemented, would not be sufficient to maintain a force of 48 SSNs consistently over the long run. The Navy projects under that plan the SSN force would fall below 48 boats starting in FY2025, reach a minimum of 41 boats in FY2029, and remain below 48 boats through FY2036.

Potential issues for Congress regarding the Virginia-class program include whether to procure an additional Virginia-class boat in FY2021 and, more generally, the Virginia-class procurement rate in coming years.

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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 FY2017 budget requests $4,955.2 million 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 Ohio Replacement (SSBN[X]) ballistic missile submarine program is discussed in another CRS report.[1]

Background

Strategic and Budgetary Context

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) .

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;

[1] See CRS Report R41129, *Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine 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 Ohio Replacement (SSBN[X]) Ballistic Missile Submarine 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 Ronald O'Rourke.

- covert insertion and recovery of SOF (on a smaller scale than possible with the SSGNs);
- 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 wants to achieve and maintain a fleet in coming years of 308 ships, including 48 SSNs.[7] For a review of SSN force level goals since the Reagan Administration, see **Appendix A**.

Force Level at End of FY2015

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 has declined since then in a manner that has roughly paralleled the decline in the total size of the Navy over the same time period. The 54 SSNs in service at the end of FY2015 included the following:

- 39 Los Angeles (SSN-688) class boats;
- 3 Seawolf (SSN-21) class boats; and
- 12 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) are equipped 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 FY2015, 23 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. 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 currently cost about $2.7 billion each to procure. 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 FY2016, and numbers scheduled for procurement under the FY2017-FY2021 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
1	1	0	1	1	1	1	1	1	1	1	1
FY10	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	***FY17***	***FY18***	***FY19***	***FY20***	***FY21***
1	2	2	2	2	2	2	*2*	*2*	*2*	*2*	*1*

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 FY2014-FY2018 (referred to as the Block IV boats) are being procured under a multiyear procurement (MYP) contract[11] that was approved by Congress as part of its action on the FY2013 budget, and awarded by the Navy on April 28, 2014. The eight Virginia-class boats procured in FY2009-FY2013 (the Block III boats) were procured under a previous MYP contract, and the five Virginia-class boats procured in FY2004-FY2008 (the Block II boats) were procured under a still-earlier MYP contract. The four boats procured in 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 arrangement, 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) .

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, at the outset of Virginia-class procurement.[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. GD/EB has built the reactor compartments and performing final assembly on boats 1, 3, and so on, while HII/NNS has done so on boats 2, 4, and so on. 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), is proposing to build Ohio replacement 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 is also proposing 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 of the Navy's proposed plan include the following:

- GD/EB is to be the prime contractor for designing and building Ohio replacement boats;
- HII/NNS is to be a subcontractor for designing and building Ohio replacement boats;
- GD/EB is to build certain parts of each Ohio replacement 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 Ohio replacement 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 Ohio replacement 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 Ohio replacement 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 that:

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

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]

Virginia Payload Module (VPM)

The Navy plans to build one of the two Virginia-class boats procured in FY2019, and all Virginia-class boats procured in FY2020 and subsequent years, with an additional mid-body section, called the Virginia Payload Module (VPM). The VPM, reportedly about 70 feet in length[18] (earlier design concepts for the VPM were reportedly about 94 feet in length),[19] contains four large-diameter, vertical launch tubes that would be used to store and fire additional Tomahawk cruise missiles or other payloads, such as large-diameter unmanned underwater vehicles (UUVs).[20]

The four additional launch tubes in the VPM could carry a total of 28 additional Tomahawk cruise missiles (7 per tube),[21] 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%.[22] The Navy wants to start building Virginia-class boats with the VPM in FY2019.

In constant FY2010 dollars, the Navy in January 2015 estimated the non-recurring engineering (i.e., design) cost of the VPM as $725 million, the production cost for the first VPM-equipped boat as $409 million, and the production cost for subsequent VPM-equipped boats as $305

[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] "Navy Selects Virginia Payload Module Design Concept," *USNI News (*http://news.usni.org*)*, November 4, 2013.

[19] Christopher P. Cavas, "Innovations, No-Shows At Sea-Air-Space Exhibition," *Defense News*, April 18, 2011: 4. See also Christopher P. Cavas, "U.S. Navy Eyes Dual-Mission Sub," *Defense News*, October 17, 2011; and Lee Hudson, "New Virginia-Class Payload Module May Replace SSGN Capability," *Inside the Navy*, October 24, 2011.

[20] 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.

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

[22] 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 mid-body vertical tubes would increase that total by about 76%.

million. Using DOD's deflator for procurement costs other than pay fuel and medical, the figure of $305 million in constant FY2010 dollars equates to about $340 million in FY2017 dollars. Given the current Virginia-class unit procurement cost of about $2.7 billion, an additional cost of $340 million would represent an increase of roughly 13% in unit procurement cost.

Building Virginia-class boats with the VPM would 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).[23] 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.

A November 18, 2015, press report states:

> The Virginia-class submarine program is finalizing the Virginia Payload Module design and will start prototyping soon to reduce risk and cost as much as possible ahead of the 2019 construction start, according to a Navy report to Congress.
>
> According to the "Virginia Class Submarine Cost Containment Strategy for Block V Virginia Payload Module Design" report, dated Aug. 31 but not received by the Senate until mid-October, the Navy says late Fiscal Year 2015 and early FY 2016 is a "critical" time period for the program....
>
> The Naval Sea Systems Command's (NAVSEA) engineering directorate will update cost estimates soon based on the final concept design, but so far the program has been successful in sticking to its cost goals. The program had a threshold requirement of $994 million and an objective requirement of $931 million in non-recurring engineering costs, and as of January 2015 the program estimated it would end up spending $936 million. The first VPM module is required to cost $633 million with an objective cost of $567 million, and the most recent estimate puts the lead ship VPM at $563 million. Follow-on VPMs would be required to cost $567 million each with an objective cost of $527 million, and the January estimate puts them at an even lower $508 million.[24]

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.[25] The first such report, dated July 2014, is reprinted in **Appendix C**.[26]

FY2017 Funding Request

The Navy estimates the combined procurement cost of the two Virginia-class boats requested for procurement in FY2017 at $5,408.9 million, or an average of $2,704.5 million each. The boats have received a total of $1,623.3 million in prior-year advance procurement (AP) funding and $597.6 million in prior-year Economic Order Quantity (EOQ) funding. The Navy's proposed FY2017 budget requests the remaining $3,188.0 million needed to complete the boats' estimated

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

[24] Megan Eckstein, "Navy Finalizing Virginia Payload Module Design, Will Begin Prototyping To Reduce Risk," *USNI News*, November 18, 2015.

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

[26] For an article discussing the navy's report, see Lee Hudson, "Stackley Outlines Virginia Payload Module Cost Strategy For Congress," *Inside the Navy*, November 3, 2014.

combined procurement cost. The Navy's proposed FY2017 budget also requests $1,767.2 million in AP funding for Virginia-class boats to be procured in future fiscal years, bringing the total FY2017 funding request for the program (excluding outfitting and post-delivery costs) to $4,955.2 million.

The Navy's proposed FY2017 budget also requests $97.9 million in research and development funding for the Virginia Payload Module (VPM). The funding is contained in Program Element (PE) 0604580N, entitled Virginia Payload Module (VPM), which is line 128 in the Navy's FY2017 research and development account.

Submarine Construction Industrial Base

In addition to GD/EB and HII/NNS, the submarine construction industrial base includes scores 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. Observers in recent years have expressed concern for the continued survival of many of these firms. For nuclear-propulsion component suppliers, an additional source of stabilizing work is the Navy's nuclear-powered aircraft carrier construction program.[27] 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. Several years ago, some observers expressed concern about the Navy's plans for sustaining the design and engineering portion of the submarine construction industrial base. These concerns appear to have receded, in large part because of the Navy's plan to design and procure a next-generation ballistic missile submarine called the Ohio Replacement Program or SSBN(X).[28]

Projected SSN Shortfall

Size and Timing of Shortfall

The Navy's FY2017 30-year SSN procurement plan, if implemented, would not be sufficient to maintain a force of 48 SSNs consistently over the long run. As shown in **Table 2**, the Navy projects under the plan that the SSN force would fall below 48 boats starting in FY2025, reach a minimum of 41 boats in FY2029, and remain below 48 boats through FY2036. Since the Navy plans to retire the four SSGNs by 2028 without procuring any replacements for them, no SSGNs would be available in 2028 and subsequent years to help compensate for a drop in SSN force level below 48 boats. The projected SSN shortfall was first identified by CRS in 1995 and has been discussed in CRS reports and testimony every year since then.

[27] 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.

[28] For more on the SBN(X) program, see CRS Report R41129, *Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress*, by (name redacted) .

Table 2. Projected SSN Shortfall

As shown in Navy's FY2017 30-Year (FY2017-FY2046) Shipbuilding Plan

Fiscal year	Annual procurement quantity	Projected number of SSNs	Shortfall relative to 48-boat goal	
			Number of ships	Percent
17	2	52		
18	2	53		
19	2	52		
20	2	52		
21	1	51		
22	2	48		
23	2	49		
24	1	48		
25	2	47	1	-2%
26	1	45	3	-6%
27	1	44	4	-8%
28	1	42	6	-13%
29	1	41	7	-15%
30	1	42	6	-13%
31	1	43	5	-10%
32	1	43	5	-10%
33	1	44	4	-8%
34	1	45	3	-6%
35	1	46	2	-4%
36	2	47	1	-2%
37	2	48		
38	2	47	1	-2%
39	2	47	1	-2%
40	1	47	1	-2%
41	2	47	1	-2%
42	1	49		
43	2	49		
44	1	50		
45	2	50		
46	1	51		

Source: Table prepared by CRS based on Navy's FY2017 30-year shipbuilding plan. Percent figures rounded to nearest percent.

2006 Navy Study on Options for Mitigating Projected Shortfall

The Navy in 2006 initiated a study on options for mitigating the projected SSN shortfall. The study was completed in early 2007 and briefed to CRS and the Congressional Budget Office (CBO) on May 22, 2007.[29] 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.[30]

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

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

- 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.[31]
- 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.[32]
- 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.[33] The total cost of extending the lives of the 16 boats would be roughly $500 million in constant FY2005 dollars.[34]
- 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.

[31] 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.

[32] 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.

[33] 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.

[34] 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.

- 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, 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.[35]
- Seven-month deployments might affect retention rates for submarine personnel.

March 2016 Press Report on Options for Mitigating Projected Shortfall

A March 8, 2016, press report discussed options the Navy is currently considering for mitigating the projected SSN shortfall, including the option of finding a way to procure a second Virginia-class boat in FY2021. The press report stated:

[35] 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.)

A spike in demand for the Navy's attacks submarines, just ahead of a spate of decommissionings and a dip in new SSN construction, is leading the Navy to look at some previously unthinkable measures to mitigate the upcoming shortfall in the fleet.

Those measures include extending the life of some legacy boats and increasing submarine production despite the cost and workforce strain the Ohio Replacement Program will put on the Navy and industry....

Even though the Navy's Fiscal Year 2017 budget request released in early February called for just one attack submarine to be built in 2021 – a deviation from the current two-a-year build rate to accommodate the construction of the first Ohio Replacement Program ballistic missile submarine – just two weeks later officials floated the idea of trying to find money to buy back that second attack sub....

Seeing this situation approaching, the Navy devised a three-pronged approach in the mid-2000s to try to mitigate the upcoming strain on the attack sub fleet.

First, the Navy would consider extending the life of the Los Angeles-class boats – something almost unheard of with the carefully managed nuclear-powered subs. Schedules, and therefore nuclear fuel consumption, for these boats are rigidly managed throughout the life of the sub, and conventional wisdom dictates that a sub's service life cannot be lengthened.

However, Jabaley said, the Navy has found some exceptions to the rule. A couple years before each Los Angeles-class sub hits the end of its life, the Navy has begun an engineering analysis process. First, will there be enough nuclear fuel to support a six-month deployment tacked on to the end of the boat's life? If yes, proceed to the next question: will the submarine still be structurally sound enough to support submerging and operating for an additional six months? Jabaley said the Navy would not pay for additional work to extend the life of the boats, but if the answer to both questions happens to be yes then the Navy will deploy the Los-Angeles class boat once more, providing a bit of extra overseas presence to fill combatant commander needs, before retiring the boat.

Second, Jabaley said the Navy began lengthening some Los Angeles-class deployments – also considered taboo.

"By deploying for eight months instead of six, you're using incrementally more fuel than you would otherwise in a normal operating cycle, so that can actually be counterproductive to the ability to extend that same submarine when you get to the end of life," Jabaley said, explaining that submarines consume nuclear fuel more rapidly during overseas deployments than during in-port training or maintenance availabilities.

"It requires a very close management of fuel usage so we're sure that the submarine has the ability to operate to the end of its life, and if you have more fuel remaining then you can consider the extension."

Despite the complications it presented, Jabaley said the lengthened deployments were worth the extra overseas presence they provided as well.

Third in the mitigation strategy, the Navy would try to build the new Virginia-class submarines faster. Whereas the first Virginia-class boats took about 84 months to build, General Dynamics Electric Boat and Newport News Shipbuilding now can deliver a sub to the fleet in about 61 months.

"We have a goal to get down to 55 months, the shipbuilders have a plan they call 'Drive for 55,'" Jabaley said. That plan revolves around "productivity improvements, changes to the manufacturing and assembly plan to be able to deliver a submarine in as short a time as 55 months." The faster the industrial base can deliver each submarine, the faster those boats can get through training and get out to sea.

"That was all well and good in 2006: we had a problem, we knew we were facing it," Jabaley said.

"But things have changed since then. In particular, the resurgence of Russia and the ascendance of China, both of which are producing numerous submarines, and in particular in Russia's part, extremely capable submarines. So we're facing challenges of both quantity and quality from our competitors....

Though attack submarine requirements can be hard to talk about publicly due to classification, the combatant commanders have, as Jabaley said, "started to proclaim quite clearly that they are not getting enough submarines on deployment." During FY 2017 budget hearings, both U.S. Pacific Command commander Adm. Harry Harris and U.S. European Command commander Gen. Philip Breedlove made clear to lawmakers they are only getting about 60 percent of the submarines they request, and they need more to keep up with evolving Russian and Chinese threats.

"All of that put together has made the urgency even greater," Jabaley said....

or Navy acquisition chief Sean Stackley, the entire situation presents challenges and opportunities. The challenge is maintaining the efficient two-a-year Virginia construction rate, while also moving into the larger Block V configuration in 2019 which includes a Virginia Payload Module section, while also keeping the Ohio Replacement Program on track – while grappling with other Navy shipbuilding needs, and while adhering to spending caps from Congress.

The opportunity, he explained March 3 at the American Society of Naval Engineers' annual ASNE Day, is leveraging authorities given by Congress in the 2015 and 2016 National Defense Authorization Act to get creative. Not only did Congress give incremental funding and advanced construction authority for the Ohio Replacement Program to help keep costs down, lawmakers also passed a key provision "that allows us to look across programs, across years in terms of procuring material to buy it as efficiently as possible and drive cost down," Stackley said.

"Quietly in the background we've been working with industry to figure out, given this significant amount of submarine workload coming, how can we best accomplish it in terms of not just efficiency but looking at facility investments that have to be made at our two boatyards, EB and Newport News," Stackley said.

"We laid that all out, and in doing that we identified where we have risk and also where we have opportunity – opportunity in terms of capacity and also opportunity in terms of driving down cost."

"What we see is opportunity, and if we don't nail that opportunity down, if we let 2021 pass, we are not going to get that boat back in the future and it just deepens the valley we're looking at," he concluded.

Jabaley explained that the 2021 submarine is the most important for shaping the submarine shortfall. The shortfall would begin in 2025 or 2026, depending on the success of the effort to extend the life of the Los Angeles boats. A Virginia-class boat procured in 2021 would deliver in 2026, possibly staving off the start of the shortfall another year. Then, that boat would decrease the depth of the shortfall each year, slightly decreasing the impact felt by the fleet. And it would negate the one-sub shortfall expected in the last year of the trough, in 2036, and from 2038 to 2041.

Put another way, Jabaley said there is currently a 51 SSN-year shortfall over 17 years. The addition of the second 2021 boat — and its subsequent effects — could reduce the attack boat shortfall to 35.

Stackley tasked Jabaley and the rest of PEO Subs with making it happen, and he made clear last week how serious he was about buying back the second boat in 2021.

> "That's frankly our requirement this year inside our shipbuilding program to figure out how to get there because that is our asymmetrical advantage: we own the undersea domain, we cannot give it up and 2021 is our next big opportunity to deepen, frankly, deepen our hold on that," Stackley said....
>
> The first thing to figure out was if industry could handle the workload, and Jabaley said "we are convinced that it can."...
>
> With industry on board and ready for the workload, the next question is how to pay for the second 2021 attack sub.
>
> First, "there are some savings just by adding it in," Jabaley said, due to the savings that buying more units creates throughout the supply chain.
>
> Second, as the Navy analyzes the Block V contract – it owes the Secretary of Defense a cost estimate for the addition of the Virginia Payload Module – "we're aggressively looking for ways we can reduce cost, so the Virginia program has their work to do in lowering cost."
>
> And lastly, as Stackley alluded to in his comments about the contracting authorities provided in the NDAA, there are savings to be had if the Navy can find creative ways to move away from stovepiped contracting for each ship class and look more holistically at its overall shipbuilding needs.
>
> "I need to bring [the Virginia class and Ohio Replacement Program] together, and I need to employ innovative contracting and acquisition strategies to find synergy and cost savings," Jabaley said."[36]

Issues for Congress

Funding an Additional Virginia-Class Boat in FY2021

As discussed in the previous section (see "March 2016 Press Report on Options for Mitigating Projected Shortfall"), the Navy wants to find a way to procure a second Virginia-class boat in FY2021 as a way to help mitigate the projected SSN shortfall. The issue for Congress is whether to support this effort, and if so, whether to provide any advance procurement (AP) funding in FY2017 to begin paying for that boat. In assessing this question, Congress may consider various factors, including the amount of funding that would be needed to procure the boat, the operational value the boat would have, and the potential impact, in a situation of constrained defense funding, on other Navy or DOD programs of funding the additional boat.

At an April 6, 2016, hearing on Navy shipbuilding programs before the Seapower subcommittee of the Senate Armed Services Committee, the following exchange occurred:

> SENATOR KELLY AYOTTE (continuing):
>
> I wanted to follow up, Admiral Mulloy on—you were talking about the requirements overall for the size of our fleet. Well, one of the issues that I'm concerned about, as we look at all the threats that we're facing and all the challenges that were certainly outlined well by Senator King is the Navy's requirement for the attack submarine fleet was actually established, as I understand it, in I think it was around 2006.

[36] Megan Eckstein, "Navy Finds Urgency In Staving Off A Sub Shortfall Decades In The Making," *USNI News*, March 8, 2016. See also Kris Osborn, "Navy Wants More Attack Submarines Faster," Scout, February 26, 2016.

And given all the things that have changed since 2006 and the challenges that we face and in particular, obviously, that in the Asia Pacific region, is the Navy going to undertake establishing a new requirement for the attack submarine fleet as well? We already know that 50 percent to 60 percent of our combatant commander's request[s] [f]or the attack submarine is not being met.

VICE ADMIRAL JOSEPH P. MULLOY, USN, DEPUTY CHIEF OF NAVAL OPERATIONS FOR INTEGRATION OF CAPABILITIES AND RESOURCES:

Yes, ma'am. As part of that four (ph)-structure assessment [sic: Force Structure Assessment], there's actually nine analysis [sic: analyses:] of carriers, large service combatants [and other ship types] and one of those is SSNs and SSBNs as well and clearly, the [SSN] number is 48, it has been since the 2006 study.

Unfortunately, and we're probably above it right now, but based upon the decommissioning rate of the Virginia Class—[correction:] of the 688 (ph) Class submarines, we built them at four or five a year with the tremendous support of Congress back in the '80s. We will go down to a number of 41 [SSNs] in 2009 [sic: 2029] and we'll stable it [sic: stay] at 48 for over 10 more years.

So, it's important to get—actually, that multiyear [contact], [and] one item that we've been asked by the host [sic: House] Arms Services Committee and we're looking at now in next year's budget is, there's—in FY21, we got to one Virginia because we started [procuring] the first Ohio Replacement [boat in FY2021].

AYOTTE:

You're reading my mind. We love this.

MULLOY:

That is clearly—that is—clearly, we are now looking at what are the disadvantages [sic] that would come from the authorization of more of those ships in the multiyear. Could we get further savings out of the halls [sic: hulls?] that—that we'll ask them and we'll have to come back next year?

But clearly, the first submarine that fills in that activities (ph) is buying the [FY]'21 submarine. Mr. Stackley had commissioned a group and he'll probably talk—they'll talk more about it, the Submarine Bill Unified Strategy that looked at Virginia Class, Virginia payload, and Ohio Replacement. And we think we'd be able to do that.

AYOTTE:

Well, Secretary Stackley, I certainly love your comment on that of what Admiral Mulloy just said because this is also something that has been raised by both the Chief and the Vice Chief have expressed a real interest in not going down to one Virginia Class submarine in 2021 and our ability to keep it at two. Even with two, you know, we have a gap. But with one, it's just—it's not sensible.

SEAN J. STACKLEY, ASSISTANT SECRETARY OF THE NAVY RESEARCH, DEVELOPMENT, AND ACQUISITION:

Yes, ma'am. We've been building two [Virginia class] submarines a year since 2011 and this year is actually the first year. [that] We start delivering at two per year.

So, we've got stability in a [production] line. Admiral Mulloy referred to the Submarine Unified Build Strategy. [FY]'21 is a challenge year because of the Ohio Replacement [lead ship]. We spent a lot of time this past year working with industry taking a look at how can we best build the Ohio Replacement program so that we can leverage the best of our two submarine builders, Electric Boat and Newport News.

> And as we work through that, what we're uncovering is opportunity and capacity across the two builders. So, one of the challenges was capacity and imposing a potential risk on the Ohio Replacement. We think we have the capacity to address that.
>
> The second challenge is design associated with the Ohio Replacement [program]. We have that on track today. A third challenge then becomes cost. And so, as we look at building the Virginia multiyear and as we look at driving down cost frankly in the Ohio Replacement program, we're finding more opportunities.
>
> So, we're working—this is a top priority in our [FY]2018 budget build, to be able to come back and fill in that [second] [FY]2021 [Virginia-class] submarine because of all the decisions going forward to mitigate the [SSN] shortfall that Admiral Mulloy described. That vote [sic: boat, i.e., a second Virginia-class boat in FY2021] is the first and best mitigation effort that we can have.
>
> So, it's a priority. We think we have tools available to address it as opposed to just bring it back to large bill and a lot of risk associated with it and we look forward to continue to work with you all in the course of this year and with next year's budget to do so.
>
> AYOTTE:
>
> Well, I think that's excellent and I look forward to working with you both on that issue.[37]

Navy Plans for Building VPM-Equipped Virginia-Class Boats

As discussed earlier (see "Virginia Payload Module (VPM)"), the Navy plans to build one of the two Virginia-class boats procured in FY2019, and all Virginia-class boats procured in FY2020 and subsequent years, with the Virginia Payload Module (VPM). An issue for Congress is whether to approve, modify, or reject the Navy's plans for building VPM-equipped Virginia-class boats. In assessing this question, Congress may consider various factors, including the cost and operational value of the VPM, the impact on the submarine construction industrial base and the Virginia-class construction effort of building Virginia-class boats with VPMs, and the potential impact, in a situation of constrained defense funding, on other Navy or DOD programs of funding VPMs for Virginia-class boats.

Virginia-Class Procurement Rate More Generally in Coming Years

Another potential issue for Congress concerns the Virginia-class procurement rate more generally in coming years (i.e., beyond the question of whether to procure an additional boat in FY2021), particularly in the context of the SSN shortfall projected for FY2025-FY2036 shown in **Table 2** and the larger debate over future U.S. defense strategy and defense spending.

Mitigating Projected SSN Shortfall

In addition to lengthening SSN deployments to 7 months and extending the service lives of existing SSNs by periods ranging from 3 months to 24 months (see "2006 Navy Study on Options for Mitigating Projected Shortfall" above), options for more fully mitigating the projected SSN shortfall include

- refueling a small number of (perhaps one to five) existing SSNs and extending their service lives by 10 years or more, and
- putting additional Virginia-class boats into the 30-year shipbuilding plan.

[37] Transcript of hearing.

It is not clear whether it would be feasible or cost-effective to refuel existing SSNs and extend their service lives by 10 or more years, given factors such as limits on submarine pressure hull life.

Larger Debate on Defense Strategy and Defense Spending

Some observers—particularly those who propose reducing U.S. defense spending as part of an effort to reduce the federal budget deficit—have recommended that the SSN force-level goal be reduced to something less than 48 boats, and/or that Virginia-class procurement be reduced. A June 2010 report from a group called the Sustainable Defense Task Force recommends a Navy of 230 ships, including 37 SSNs,[38] and a September 2010 report from the Cato Institute recommends a Navy of 241 ships, including 40 SSNs.[39] Both reports recommend limiting Virginia-class procurement to one boat per year, as does a September 2010 report from the Center for American Progress.[40] A November 2010 report from a group called the Debt Reduction Task Force recommends "deferring" Virginia-class procurement.[41] The November 2010 draft recommendations of the co-chairs of the Fiscal Commission include recommendations for reducing procurement of certain weapon systems; the Virginia-class program is not among them.

Other observers have recommended that the SSN force-level goal should be increased to something higher than 48 boats, particularly in light of Chinese naval modernization.[42] The July 2010 report of an independent panel that assessed the 2010 Quadrennial Defense Review (QDR)—an assessment that is required by the law governing QDRs (10 U.S.C. 118)—recommends a Navy of 346 ships, including 55 SSNs.[43] An April 2010 report from the Heritage Foundation recommends a Navy of 309 ships, including 55 SSNs.[44]

Factors to consider in assessing whether to maintain, increase, or reduce the SSN force-level goal and/or planned Virginia-class procurement include but are not limited to the federal budget and debt situation, the value of SSNs in defending U.S. interests and implementing U.S. national security strategy, and potential effects on the submarine industrial base.

As discussed earlier, Virginia-class boats scheduled for procurement in FY2014 are covered under an MYP contract for the period FY2014-FY2018. This MYP contract includes the procurement of two Virginia-class boats in FY2017. If fewer than two boats were procured in FY2017, the Navy might need to terminate the MYP contract and pay a cancellation penalty to the contractor.

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[38] *Debt, Deficits, and Defense, A Way Forward[:] Report of the Sustainable Defense Task Force*, June 11, 2010, pp. 19-20, 31.

[39] Benjamin H. Friedman and Christopher Preble, *Budgetary Savings from Military Restraint*, Washington, Cato Institute, September 23, 2010 (Policy Analysis No. 667), p. 9.

[40] Lawrence J. Korb and Laura Conley, *Strong and Sustainable[:] How to Reduce Military Spending While Keeping Our Nation Safe*, Center for American Progress, September 2010, pp. 19-20.

[41] Debt Reduction Task Force, *Restoring America's Future[:] Reviving the Economy, Cutting Spending and Debt, and Creating a Simple, Pro-Growth Tax System*, November 2010, p. 103.

[42] For further discussion of China's naval modernization effort, see CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by (name redacted) .

[43] Stephen J. Hadley and William J. Perry, co-chairmen, et al., *The QDR in Perspective: Meeting America's National Security Needs In the 21st Century, The Final Report of the Quadrennial Defense Review Independent Panel*, Washington, 2010, Figure 3-2 on page 58.

[44] A *Strong National Defense[:] The Armed Forces America Needs and What They Will Cost*, Heritage Foundation, April 5, 2011, pp. 25-26.

Three Virginia-Class Boats Built with Defective Parts

Another issue for Congress concerns three Virginia-class boats that were discovered to have been built with defective parts, and the operational and cost implications of this situation. A March 28, 2016, press report states:

> In early 2015 engineers on a brand-new submarine made a troubling find: A pipe joint near the innermost chamber of its nuclear-powered engine showed signs of tampering.
>
> The defective elbow pipe, used to funnel steam from the reactor to the sub's propulsion turbines and generators, showed evidence of jury-rigged welding that could've been designed to make it appear satisfactory. But the part was already installed, the sub already commissioned.
>
> These defective parts, each probably valued on the order of $10,000 or less, have kept the $2.7 billion attack submarine Minnesota languishing in an overhaul for two years, while engineers attempt to cut out and replace a difficult to reach part near the nuclear reactor. Meanwhile, Navy engineers are scouring aircraft carriers and other submarines for problems and criminal investigators are gathering evidence.
>
> The unauthorized parts are impacting three new Virginia-class attack submarines, likely extending the post-shakedown overhauls for the other two subs and adding greatly to the final tab at a time these fearsome vessels are needed around the globe to defend carrier groups and strike America's adversaries. It's also trapped its crew in limbo as repair deadlines come and go, while other subs must take their place.
>
> The Minnesota, the 10th Virginia-class attack boat, was delivered 11 months ahead of schedule. But it has been in the shipyards at Electric Boat in Groton, Connecticut for two years — more than twice as long as a normal post-shakedown availability. It still has months to go. The plankowner crew has spent only a handful of days at sea since joining the fleet and experts say they're likely to forfeit their whole deployment cycle, forcing fleet bosses to make tough decisions about whether to extend deployments or withhold forces from missions overseas.
>
> News of the lousy parts first emerged in August, a month after the Minnesota was to have finished its overhaul. Since then, a Justice Department-led investigation is examining the quality control issues that led the shoddy part to be installed in the $2.7-billion sub.
>
> The same shoddy elbow joints were installed aboard attack subs North Dakota and John Warner, forcing the Navy to spend millions of dollars and many more months to repair them. If these pipes ruptured, they would leak steam and force the submarine to take emergency measures that would impair its combat effectiveness....
>
> At the center of the debacle is pipe-maker Nuflo Inc., a Jacksonville, Florida-based manufacturer that is the focus of the investigation into quality control issues, according to two Navy sources familiar with the inquiry. The investigation has delayed the repairs so that agents can recover evidence, sources said....
>
> Making matters worse are concerns that the flawed pipe fittings may extend well beyond the three identified attack submarines. In a statement, NAVSEA, which oversees ship construction and maintenance, said it has sent inspectors across the fleet to test Nuflo-made fittings on other ships.
>
> "As part of an ongoing investigation into a quality control issue with a supplier, General Dynamics Electric Boat and Huntington Ingalls Incorporated, Newport News, determined that fittings supplied by the vendor in question required additional testing and repair due to incorrect test documentation, incorrect testing, or unauthorized and undocumented weld repairs performed on these fittings," a NAVSEA spokeswoman said in the statement. "The fittings, which are used in various piping applications aboard new

> construction submarines, are also installed on other ships. Therefore, out of an abundance of caution, the Navy, in coordination with its industry partners, has been performing additional inspections and surveys throughout the fleet to fully bound the issue."
>
> The full scope of the problem remains unclear. NAVSEA declined to comment on whether any other shoddy parts had been found on other ships, citing the ongoing investigation....
>
> Spokespeople for the Navy and NAVSEA declined to provide an estimated cost for Minnesota's extra year in the shipyards or to say how much it will likely cost to fix the John Warner and North Dakota. The Navy spokesman acknowledged that maintenance delays affect what ships are sent on deployment, but declined to go into any specifics about how other crews were affected.
>
> "Generally speaking, delays in maintenance periods will impact the overall operational availability of the submarine force," Lt. Cmdr. Tim Hawkins said. "Leaders regularly review operational schedules and adjust them based on force availability and presence requirements. Attack submarines, which are always in high demand, will continue to be deployed when and where they are needed most."
>
> No subs have been recalled from deployment for related repairs, NAVSEA said. But the parts must be replaced within a few years of its commissioning to reduce the risk that the joint will leak or even burst in a combat scenario.
>
> It the pipe joint were to rupture, it would not cause a radioactive incident. But it could effectively render the submarine unable to operate for weeks or months until fixed. The crew of the attack submarine Jefferson City discovered a water leak in the propulsion plant; finding and fixing that kept the sub stuck in Guam for five months in 2014....
>
> What's not clear is how long the repairs of John Warner and North Dakota will take, how many other ships have these deficient fittings, and what the total cost will be in terms of money and lost operational time.
>
> The Navy refuses to comment while the investigation grinds on.[45]

Potential oversight questions for Congress include the following:

- How did this problem of defective parts occur in the Virginia-class program, which has been in production since FY1998? Was there a breakdown in the following of procedures, and if so, what was the nature of the breakdown, and why did it happen?
- How many Virginia-class boats (or other Navy ships) are affected?
- How much time and money will it cost to fix the affected ships? How much of this cost will be borne by the government, and how much by private industry?
- What is the operational impact of affected ships being unavailable for deployment due to the need to fix problems with these defective parts?
- When does the Navy anticipate completing its investigation into the matter?
- What steps has the Navy taken, or what steps does it plan to take, to ensure that this does not happen again in the Virginia-class program or other Navy shipbuilding programs?

[45] David Larter, "Secret Weld: How Shoddy Parts Disabled A $2.7 Billion Submarine," *Navy Times*, March 28, 2016.

Legislative Activity for FY2017

Congressional Action on FY2017 Funding Request

Table 3 summarizes congressional action on the Navy's FY2017 funding request for the Virginia-class program.

Table 3. Congressional Action on FY2017 Funding

(Millions of dollars, rounded to nearest tenth)

		Authorization			Appropriation		
	Request	HASC	SASC	Conf.	HAC	SAC	Conf.
Virginia class procurement	3,188.0	3,188					
Virginia class advance procurement (AP)	1,767.2	1,852.2					
Virginia Payload Module (VPM) research and development (PE 0604580N, line 128)	97.9	97.9					

Source: Table prepared by CRS based on Navy's FY2017 budget submission and committee and conference reports.

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.

FY2017 National Defense Authorization Act (H.R. 4909)

House

The House Armed Services Committee, in its report (H.Rept. 114-537 of May 4, 2016) on H.R. 4909, recommends the funding levels shown in the HASC column of **Table 3**.

H.Rept. 114-537 states:

> *Virginia Class Submarine*
>
> The budget request included $1.77 billion for the Virginia Class Submarine Advance Procurement.
>
> In fiscal year 2017, advance procurement is necessary to support procurement of long lead time materials and advanced manufacturing efforts for a total of four ships: the SSN800 and SSN801 (from the existing Block IV multiyear procurement contract) and the SSN802 and SSN803 (from the anticipated Block V multiyear procurement contract). It is anticipated that the Block V contract will include, for the first time, the Virginia Payload Module, a new hull section which contains four large-diameter payload tubes for increased Tomahawk missile capacity. The committee believes that additional funding is necessary to support advanced construction for the Virginia-class submarine program in fiscal year 2017 to maintain cost, schedule, and contractual requirements.
>
> Therefore, the committee recommends $1.85 billion, an increase of $85.0 million, for the Virginia Class Submarine Advance Procurement.
>
> *Virginia class submarine industrial base capacity*
>
> The committee notes that since the end of the Cold War, the United States has produced an average of less than one attack submarine (SSN) per year. Over the next 20 years, submarine production is planned to average two submarines per year, and, for most of

those years, one of the two submarines will be an Ohio Replacement ballistic missile submarine (SSBN), which is roughly two and a half times larger than the attack submarines currently under construction. The committee believes that this sustained annual submarine production workload at the nation's two nuclear shipbuilders and their vendor base will double from what it has been in the recent past. Managing this increase in production to be both affordable and executable in delivering critically needed capabilities to the fleet will require careful planning and attention, as well as continued coordination with the carrier programs.

While SSBN requirements will be met under current shipbuilding plans, attack submarine force levels will fall below the Navy requirement of 48 SSNs in 2025, and reach a nadir of 41 attack submarines in 2030. The committee is concerned that this unprecedented shrinkage in undersea force structure will come at a time of growing demand for naval forces, particularly for the assured access and capabilities provided by submarines. The committee has received testimony from a wide range of military leaders and experts about the strain that the submarine force is under today, and the need to mitigate the projected reduction in the fleet. Given the increasing demand on undersea capabilities, the committee firmly supports the sustainment of the current two a year production rate of new attack submarines to include during the procurement years of Ohio Replacement submarines which begins in 2021.

Therefore, the committee directs the Secretary of the Navy to submit a report to the congressional defense committees by March 1, 2017, as to the submarine industrial base and the viability of producing additional attack submarines beyond the fiscal year 2017 shipbuilding plan in the 2017–2030 timeframe. This report should address the following specific elements:

(1) The capacity of the submarine shipyards and vendor base and factors limiting submarine production;

(2) The viability of adding SSNs to Navy shipbuilding plans;

(3) The impact of increasing attack submarine production during the 2017–2030 timeframe on Navy undersea force levels;

(4) The impact of increasing attack submarine production on overall Virginia and Ohio Replacement program costs and workload profiles; and

(5) Potential efficiencies and economies that might be achieved in increasing SSN production. (Pages 25-26)

FY2017 DOD Appropriations Act (H.R. XXXX)

House

The House Appropriations Committee, in its report (H.Rept. 114-XXX of May XX, 2016) on H.R. XXXX, recommends the funding levels shown in the HAC column of **Table 3**.

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.[46] 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.[47]

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.[48] 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."[49] 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

[46] 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.

[47] 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.

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

[49] 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."[50]

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."[51]

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.[52]

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.[53]

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.[54]

In February 2006, the Navy proposed to maintain in coming years a fleet of 313 ships, including 48 SSNs. Some of the Navy's ship force-level goals have changed since 2006, and the goals now add up to a desired fleet of 308 ships. The figure of 48 SSNs, however, remains unchanged from 2006.

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

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

[52] 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.

[53] 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.

[54] 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 alternatives for funding SSNs that was originally incorporated into this report during discussions in earlier years on potential options for Virginia-class procurement.

Alternative methods of funding the procurement of SSNs include but are not necessarily limited to the following:

- **two years of advance procurement funding followed by full funding**—the traditional approach, under which there are two years of advance procurement 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 advance procurement funding followed by full funding**—one year of advance procurement 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 advance procurement funding (single-year full funding)**—full funding of the SSN in the year of procurement, with no advance procurement 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.[55]

Navy testimony to Congress in early 2007, when Congress was considering the FY2008 budget, suggested that two years of advance procurement funding are required to fund the procurement of an SSN, and consequently that additional SSNs could not be procured until FY2010 at the earliest.[56] 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 advance procurement funding (which is used primarily for financing long-leadtime nuclear propulsion components), Congress can procure an SSN without prior-year advance procurement funding, or with only one year of advance procurement 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 advance procurement 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,

[55] 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.

[56] 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.

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 advance procurement payment for CVN-74. Congress, in acting on the FY1988 budget, decided to accelerate the procurement of both ships to 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.[57]

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 advance procurement funding or no advance procurement 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.

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.

[57] 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. July 2014 Navy Report to Congress on Virginia Payload Module (VPM)

The joint explanatory statement for the FY2014 DOD Appropriations Act (Division C of H.R. 3547/P.L. 113-76 of January 17, 2014) requires the Navy to submit biannual reports to the congressional defense committees describing the actions the Navy is taking to minimize costs for the VPM.[58] This appendix reprints the first of these reports, which is dated July 2014.[59]

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

[59] The report was posted at *InsideDefense.com* (subscription required) on November 13, 2014.

REPORT TO CONGRESS

VIRGINIA (SSN774) ATTACK CLASS SUBMARINE

Cost Containment Strategy for the Block V VIRGINIA Payload Module (VPM) Design

July 2014

IN COMPLIANCE WITH THE JOINT EXPLANATORY STATEMENT ACCOMPANYING
THE
CONSOLIDATED APPROPRIATIONS ACT, 2014

PREPARED BY
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The estimated cost of this report or study for the
Department of Defense is approximately $10,000 for the 2014 Fiscal Year.
This includes $0 in expenses and $10,000 in DoD labor.
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Reporting Requirement

Division C of the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2014 (Public Law 113-76), directs the Secretary of the Navy to create a separate budget line item to enable additional congressional oversight and increase transparency into the costs of the VIRGINIA Payload Module (VPM). Furthermore, Congress directed the Secretary to submit a bi-annual report to the congressional defense committees describing the actions the Navy is taking to minimize costs. The agreement fences $20 million until the first bi-annual report is provided to the congressional defense committees.

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Executive Summary

In the mid-2020s, the Navy's four guided missile submarines (SSGNs) will begin to decommission. These SSGNs provide the Navy and the Nation with unmatched undersea conventional strike capability and capacity, with each SSGN carrying up to 154 Tomahawk land attack cruise missiles. The Navy's current fleet of attack submarines (SSNs) can carry 12 Tomahawks each. The loss of the SSGNs will result in an over 60 percent drop in undersea strike capacity.

The Department of Defense's Office of Cost and Program Evaluation (CAPE) conducted a review of the potential undersea strike alternatives to determine the optimal materiel solution to recapitalize the SSGNs' strike capacity. CAPE certified to the Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) (AT&L) that the Navy studies in conjunction with CAPE's independent review and the Naval Sea Systems Command's (NAVSEA) Cost Engineering and Industrial Analysis's (05C) cost estimate met the requirements of an Analysis of Alternatives (AoA), and CAPE did not recommend performing an AoA for undersea strike. The review determined that the VIRGINIA Payload Module (VPM), a hull insert with four large-diameter tubes inserted aft of the sail, each tube capable of carrying seven Tomahawks, represented the best materiel solution to mitigate the loss of undersea strike capacity given near-term budget constraints. To minimize cost, schedule, and technical risks, VPM will reuse operationally proven systems and will not require the development of any new technology. For example, the missile tubes that will be used in VPM are nearly identical to the multiple all-up-round canister (MAC) tubes that are currently deployed on the SSGNs.

In December 2013, the Joint Requirement Oversight Council (JROC) approved the Capability Development Document (CDD) establishing the requirements and Key Performance Parameters (KPPs) for VPM. The CDD set clear KPPs for cost, schedule, and strike capacity. By placing cost on equal footing as capability, the CDD ensures the Navy will leverage its best practices and lessons learned from previous submarine research and development, acquisition, and modernization efforts to deliver the required capability within the strict cost targets.

Alteration to the design of any weapon system in full rate production has the potential to introduce justifiable concern associated with the possible erosion of program cost performance and production. The Navy recognizes these risks as they apply to implementation of VPM during Block V construction and intends to employ a full range of management techniques to mitigate them, commencing early in the design phase. The Navy has a proven record of developing and executing similarly scaled efforts such as the Block III design for affordability effort including the redesigned bow. These techniques are well established and embedded in the current submarine acquisition community culture, developed during "NSSN" [the New Attack Submarine Program – the precursor to the VIRGINIA Class] program inception and evolved through the successful VIRGINIA Class Block IV construction contract award.

The Navy's disciplined engineering and acquisition management approach for VPM, in conjunction with treating cost and capability as equally important requirements, will minimize the potential for cost performance degradation and program disruption. The key actions the Navy is taking to minimize costs are: continue proven management techniques used from program inception through Block IV award; implementation of Integrated Product and Process Development (IPPD) in conjunction with execution of existing build plans; ensure stable requirements; high design completion at construction start; risk mitigation; and cost reporting.

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1. Background

The VIRGINIA Class Submarine Program was the first major defense program to implement the tenets of the October 1994 Under Secretary of Defense for Acquisition and Technology memorandum, "Implementation of Integrated Product and Process Development (IPPD) in DoD Acquisition Programs." The VIRGINIA Class program has continuously implemented the use of Commercial Off-the-Shelf (COTS) components, open systems standards, acquisition streamlining, total ownership cost (TOC) driven decision making, Lean 6 Sigma assessments of all processes, and recent should cost/will cost and Better Buying Power initiatives to improve the program as it has matured.

1.1 Block I – IPPD Design/Build Genesis (SSNs 774–777)

From inception, the VIRGINIA Class Submarine Program was strikingly different from past fast attack programs, in part due to advances in technology, but mostly due to revolutionary changes in the design/build, business, and acquisition processes. The Navy, General Dynamics Electric Boat (GDEB) and their major subcontractor, Huntington Ingalls Industries – Newport News Shipbuilding (HII-NNS), embraced the IPPD concept and established multi-disciplined teams to collaboratively design and build the submarine. Inherent in the definition of IPPD, both products and processes derived benefit from structured and hierarchical integration of the cross-functional teams. The IPPD approach holistically linked operational performance, construction techniques, test methods, and life-cycle supportability into an up-front "single-pass" design effort. IPPD enabled the shipbuilder to expand the use of modular construction and off-hull module assembly techniques beyond that of previous submarine programs and erect the entire submarine from 10 major sections. While the IPPD approach was exceedingly effective, the introduction of a new, sophisticated Computer Aided Three-dimensional Interactive Application (CATIA) also greatly enhanced the design/build process and programmatic business efficiency. The CATIA software design tool replaced traditional drawings and hand crafted wooden models with 3-D manipulative color graphics dispersed to Integrated Product Team members to facilitate timely and efficient, visual design collaboration. CATIA also established the single shipbuilding construction and procurement database, linking design with production and business operations. CATIA also provided a higher fidelity design release forecast which in turn supported the establishment of a more accurate budget baseline from which to conduct cost analysis.

1.2 Block II – Continuous Improvement via Capital Expenditure (SSNs 778–783)

As the program began construction on the Block II submarines, the Navy set about to improve construction efficiencies beginning with USS *New Hampshire* (SSN 778), the first submarine in the Block II contract. Recognizing construction span time reduction held the most immediate promise for lowering cost and accelerating delivery of the warships, focus was directed at determining what could be done to improve industrial efficiency without compromise to quality or performance. Teaming for success, the Navy and shipbuilders agreed that facility investment was needed, and a strategy to incorporate an innovative Capital Expenditure (CAPEX) incentive clause was devised and incorporated in the Block II contract. Of the 10 Block II CAPEX funded projects, the transportation system upgrades provided the most visible evidence of reduced span time by allowing a shift from the Block I 10 module build plan to a plan entailing only four "super" modules to undergo final assembly at the delivery shipyard. Block II CAPEX projects have produced a seven to one return on investment.

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1.3 Block III – Design for Affordability (DFA) (SSNs 784–791)

The VIRGINIA Class cost reduction program began in earnest in late 2005, when the Chief of Naval Operations (CNO) issued a challenge to the VIRGINIA Class Program to reduce the acquisition cost of each submarine to $2 billion (in FY 2005 dollars) by 2012 as a condition of increasing the procurement rate from one to two submarines per year. This challenge represented a 20 percent decrease in unit cost. The CNO issued the challenge to support the acquisition of VIRGINIA Class submarines within the Navy shipbuilding budget, and make the necessary increase in attack submarine production to support national force levels. At the time, cutting 20 percent of the unit cost of a submarine with a mature design in serial production, without removing capability, was an unprecedented task.

General Dynamics Electric Boat and the Navy developed an integrated cost reduction strategy focusing on three areas – Design for Affordability (DFA), construction performance, and acquisition/procurement strategy. Implementation of all three elements resulted in a savings of $400 million per ship and a reduction in construction span by 30 percent (from 84 to 60 months). In recognition of these collaborative achievements, the VIRGINIA Class Program received the 2008 David Packard Excellence in Acquisition Award for "embracing the principles of acquisition reform since its initiation," and for having significantly reduced total program costs.

1.4 Block IV – Reduced Total Ownership Cost (RTOC) (SSNs 792–801)

Having optimized the construction process via targeted capital investment and DFA, the program concentrated on creating more operational value from each submarine by increasing the time between major maintenance availabilities. The goal was to alter the established life cycle maintenance plan from 72-month operating cycles, with 14 deployments and four major depot availabilities, to 96-month operating cycles, with 15 deployments and only three major depot availabilities. The challenge once again was to identify which design changes offered the highest Reduction of Total Ownership Cost (RTOC) return on investment from a limited design budget – assessing maintenance drivers and factors that determine the aggregate operating cycle. By eliminating one depot availability per hull, the program will avoid approximately $120 million (FY 2010 dollars) in Operating and Support costs per submarine. By enabling an additional deployment from each subsequent Block IV and beyond hull, an operational availability equivalent to one submarine will be realized following delivery of SSN 805.

2.0 Block V –VPM Concept Origination

The VPM concept was introduced to address the eventual loss of submarine guided missile (SSGN) strike capabilities in the mid-2020s when the Navy's four SSGNs retire, reducing Navy-wide undersea strike volume by almost two-thirds. The SSGNs' retirement also coincides with a historically low attack class submarine force structure.

In a 2013 review of undersea strike alternatives conducted by CAPE, VPM was identified to be the optimal materiel solution to recapitalize undersea strike without substantially changing a mature and stable submarine design. CAPE certified to AT&L that the review met the requirements of an AoA, and an AoA was not required. VIRGINIA Class submarines with VPM would retain all existing mission capability, while providing approximately 94 percent of the current undersea strike volume.

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In December 2013, the JROC approved the CDD establishing the requirements and KPPs for VPM. The CDD sets clear KPPs for strike capacity, schedule, and cost. The strike KPP increases the missile capacity from 12 to 40. For schedule, the VPM's Initial Operating Capability (IOC) threshold and objective dates are no later than 2nd quarter FY 2028 and no later than 4th quarter FY 2026, respectively.

The cost KPP includes criteria for design, lead ship, and follow ship thresholds and objectives requiring a disciplined approach to balance capabilities within the established cost parameters. Based on the NAVSEA 05C current estimate, the VPM cost estimate is below the CDD's cost objectives.

Cost - CY10$ ($M)

	Threshold	Objective	Current Est.
NRE:	800	750	744
Lead Ship:	475	425	423
Follow on Ships	350	325	318

Cost - TY$ ($M)

	Threshold	Objective	Current Est.
NRE:	994	931	924
Lead Ship:	633	567	564
Follow on Ships	567	527	515

Note: CDD Cost values are for 20 VPM modules and start of construction in FY19

The Navy/Industry team is focused on controlling VPM program costs, while minimizing baseline ship impacts, and maintaining the established VIRGINIA Class build plan cadence. As a result of the VIRGINIA Class modular design, inherent design features make the insertion of a hull section less of an impact on the build plan. The VPM design is modeled after other successful VIRGINIA Class programs, which have lowered costs through a proven cost reduction framework.

3.0 FY 2014 VPM Design Funding and Cost Control Management Requirements

The Consolidated Appropriations Act, 2014 (Public Law 113-76) appropriated $59.1 million for the development of VPM. Division C of the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2014, directed the creation of a separate budget line item to enable additional congressional oversight and increase transparency into the costs of the VPM. The Navy established *Navy PE: 0604580N VIRGINIA Payload Module (VPM)* to fulfill this requirement. The Joint Explanatory Statement also stipulated the withholding of $20 million in funding until the first submission of a bi-annual report to the congressional defense committees describing the actions the Navy plans to take to minimize costs. The following sections of this report are intended to fulfill this requirement.

4.0 Cost Containment Strategy for the Block V VPM Design

The strategy to design and seamlessly insert VPM into the construction sequence within the established budget is to employ the full spectrum of proven management techniques used from program inception through Block IV contract award. Specifically:

- Incorporate key tenets of the USD(AT&L) Better Buying Power 2.0 approach to defense acquisition such as affordability targets and innovative contract incentives.
- Apply overarching IPPD practices and implement design/build teams (Block I and III lessons learned).

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- Identify capital investment opportunities with high return on investment potential (Block II and III lessons learned).
- Develop design focused on affordability (Block III lessons learned) and life cycle maintenance costs (Block IV lessons learned).
- Explore and establish ship and component level acquisition strategies to yield a higher confidence/lower cost construction cost (Block III and IV lessons learned).
- Utilize an incentive structure that specifically details required cost reductions in design, construction, and operations and support.

These techniques have guided the VIRGINIA Class Program and will be used throughout the VPM effort.

4.1 Implementation of IPPD in conjunction with execution of existing build plan

The IPPD approach that was utilized as part of the successful Block III bow redesign effort provided the program with the experience and the strategy that can be leveraged for VPM during ongoing production. This will ensure the VPM design is strategically coordinated with construction and will not disrupt the established four-module build plan or construction cadence. This, in turn, requires an increase in the Advance Procurement funding profile for Block V to enable the completion of VPM during the fabrication and assembly phase at the same time as the other module components. A detailed Integrated Master Schedule (IMS) and Module Build Plan will be completed in December 2014, providing the comprehensive IPPD roadmap to minimize baseline ship impacts and maintain the established VIRGINIA Class construction cadence. In addition, the design team will evaluate capital investment opportunities to lower construction costs.

4.2 Stable requirements

The CDD sets clear KPPs for cost, strike capacity, and schedule based on stable requirements. These KPPs promote stability in the Program, providing the Navy and Shipbuilders with fixed, tangible, and measurable objectives. By placing cost on equal footing as capability, the CDD ensures the Navy will leverage its best practices and lessons learned from previous submarine research and development, acquisition, and modernization efforts to deliver the required capability within the strict cost targets. The ship specification process will further define the requirements in strict accordance with the KPPs.

4.3 Design completion

The current VPM design concept does not require the development of any new technology to satisfy the CDD requirements. By relying on proven operational systems, the Navy avoids the unnecessary risk new technology poses. Similarly, "like" systems and components already utilized or proven elsewhere in the submarine enterprise will be leveraged, scaled, or reused to an extensive degree. The most obvious example of this strategy pertains to replication of the tubes and scaling of the launch control electronics from the bow of the Block III design. The collective sum of the re-use strategy tied to the VIRGINIA Payload Tubes (VPTs), Submarine Warfare Federated Tactical System (SWFTS) combat system, Ship Service Hydraulic Plant, Electronic Auxiliary Fresh Water Plant, and other Hull, Mechanical and Electrical subsystems results in a high Technology Readiness Level (TRL) for the VPM effort. This equates to an achievable goal of having the VPM design 80 percent complete prior to

construction start, adding confidence to completing the design within budget and minimizing construction costs.

4.4 Risk mitigation

The VPM cost reduction program will employ a low-risk technical approach, with a goal of having the VPM design 80 percent complete prior to construction start. This will ensure that design errors do not create issues during the construction phase, thereby avoiding unforeseen costs later in the program. With no new technology and significant design and component reuse, the VPM design has a high TRL, thus low risk to the shipbuilder. The program will continue to evaluate and mitigate construction and design risk. For example, the program will benefit when the land based VPT test site is completed at Naval Undersea Warfare Center (NUWC) Newport this fall. Manufactured at Quonset Point and installed by Electric Boat, this collaborative Navy/shipbuilder test facility will support early electronic testing to mitigate VPM risk, and lower shipbuilding construction risk.

The shipbuilding industrial base is well positioned to simultaneously design both VPM and OHIO Replacement as the completion of the VIRGINIA Block III and Moored Training Ship design efforts allow for sufficient General Dynamics Electric Boat (GDEB) resources to support both designs.

The VIRGINIA Program is collaborating with the OHIO Replacement Program to ensure commonality among select ship components and design features which will benefit the acquisition and life-cycle costs for both programs. Where possible, the programs will utilize common equipment designs such as Ship Control System hardware, and Command, Control, Communications, and Intelligence (C3I) systems. The two programs will utilize best manufacturing processes and practices to ensure cost savings across both classes.

4.5 Cost reporting

The VPM program will continue to use the established best practices that enabled previous cost reduction. The program has an effective and established metrics/performance measurement system to manage cost, schedule and risk. A key and essential factor governing effectiveness is the accuracy of the underlying work scope comprising the budget baseline being tracked. The CATIA design application has remained in use since Block I and provides this essential fidelity. Cost analysis data, combined shipbuilder and Navy estimates at completion (EACs), formal risk management program outputs, and quarterly design reviews will all be utilized to assess the VPM program health. To promote specific transparency into cost, as directed, a separate Research, Development, Test and Evaluation (RDT&E) Program Element (PE: 0604580N) was developed for VPM funding. This new PE is reflected in the 2015 budget submission to Congress and ensures VPM costs are separate and distinct from the program's overall RDT&E budget. Consistent with the program's history of monitoring cost, cost estimates for VPM design will be reviewed quarterly and refined by the VPM design team and the program has developed action plans (based on estimates of cost-at-completion) to track cost reporting.

5.0 Conclusion

This report provides a baseline understanding of VPM and the cost reduction and containment strategies employed by the Navy throughout the VIRGINIA Class Program to include the early efforts on VPM.

Subsequent bi-annual reports will provide additional specific metrics for VPM as its acquisition, design, and construction strategies are developed and refined. Products such as design curves, manning ramp-up plans, design drawings, and progress on ship specifications will be provided with future reports as they become available.

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