REPORT TO CONGRESS

VIRGINIA (SSN774) ATTACK CLASS SUBMARINE

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

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

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Table of Contents

2

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.

3

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.

4

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.

5

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.

6

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).

7

- 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

8

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.

10