

SSN 774 *Virginia* Class Submarine

Executive Summary

- The Navy conducted two *Virginia* class FOT&E events that began in FY11 and extended into FY12. The first test event examined the *Virginia* class submarine's ability to operate under-ice and to conduct Anti-Submarine Warfare (ASW) in the Arctic. The second test event examined the modernized *Virginia* class submarine's performance with the Navy's latest combat system and sonar suite.
- DOT&E issued a classified report on the modernized *Virginia* FOT&E in November 2012, and concluded that the modernization of the combat system and sonar suite did not change the performance of the *Virginia* class for the missions tested.
- The Navy completed an update to the Test and Evaluation Master Plan (TEMP) and DOT&E approved the revision on July 24, 2012. The revision outlines plans to test deferred capabilities, electronic systems upgrades, and affordability changes included in the third increment of submarines (Block III).

System

- The *Virginia* class submarine is the replacement for the aging fleet of *Los Angeles* class submarines. The *Virginia* class:
 - Is capable of targeting, controlling, and launching Mk 48 Advanced Capability torpedoes, Tomahawk cruise missiles, and future mines
 - Has mission capability similar to the *Seawolf* submarine class with improvements to the electronic support suite, sonar, and combat control systems
 - Has a new-design propulsion plant incorporating components from previous submarine classes
 - Uses a modular design and significant commercial off-the-shelf computer technologies and hardware intended to allow for rapid and cost-effective technology refresh cycles
- The Navy is procuring and upgrading *Virginia* class submarines incrementally in a series of blocks.
 - Block I (hulls 1-4) and Block II (hulls 5-10) ships incorporated the initial design of the *Virginia* class.
 - Block III (hulls 11-18) ships will include the following affordability enhancements:
 - A Large Aperture Bow array will replace the spherical array in the front of the ship.



- Two *Virginia* payload tubes will replace the 12 vertical launch tubes. Each payload tube is capable of storing and launching six Tomahawk land attack missiles used in strike warfare.
- The Navy has not finalized the design for Block IV and beyond ships.

Mission

The Operational Commander will employ the *Virginia* class submarine to conduct open ocean and littoral covert operations in support of the following submarine mission areas:

- Strike Warfare (STW)
- Anti-Submarine Warfare (ASW)
- Intelligence, Surveillance, and Reconnaissance (ISR); Indications and Warnings (I&W); and Electronic Warfare (EW)
- Anti-Surface Ship Warfare (ASUW)
- Naval Special Warfare (NSW)
- Mine Warfare (MIW)
- Battle Group Operations (BGO)

Major Contractors

- General Dynamics Electric Boat – Groton, Connecticut
- Huntington Ingalls Industries, Newport News Shipbuilding – Newport News, Virginia

Activity

- In accordance with DOT&E-approved test plans, two *Virginia* class submarine FOT&E events started in FY11 and extended into FY12 due to data processing, data analysis, and reporting delays.
- The Navy conducted the first FOT&E period in conjunction with a bi-annual Ice Exercise (ICEX-11). This event allowed testers to examine the *Virginia* class submarine's ability to transit to and operate under-ice and

in the Arctic. This test period also assessed the *Virginia* class's ASW mission performance against a modern threat SSN surrogate under-ice in the Arctic. As part of the transit to northern latitudes, testers examined the *Virginia* class' susceptibility to fixed passive sonar arrays. DOT&E plans to issue a report on this testing in 2QFY13.

- The second FOT&E period was a series of test events to examine the mission performance changes as a result of the modernization of the *Virginia* class submarines' sonar and combat control system. These tests were combined with the operational evaluations of the latest variants of the Acoustic Rapid Commercial Off-the-Shelf Insertion (A-RCI) Sonar System, the AN/BYG-1 Combat Control System, and the Mk 48 Advanced Capability torpedo. DOT&E issued a combined operational test report on this testing in November 2012.
- The *Virginia* TEMP also required FOT&E in order to complete testing of the Naval Special Warfare mission support capabilities for the Dry Deck Shelter (DDS) and for a diver emergency recompression capability in the *Virginia* class submarine's Lock-Out Trunk (LOT). The Navy completed LOT and DDS system design changes and began test planning for the LOT diver oxygen recompression system certification and for operations with a DDS in FY12. The Navy plans to complete these test events in early FY13.
- DOT&E approved Revision G to the TEMP on July 24, 2012. The revision outlines plans to test the mission performance of the *Virginia* class affordability changes (new bow array and vertical payload tubes) with the electronic systems upgrades planned for the third increment submarines (Block III) and to complete the testing of deferred mission capabilities.
- Because Navy security rules prevent collection of useful operational test data from *Virginia* when conducting exercises with foreign ASW capable platforms, the Navy finished IOT&E and recent FOT&E without testing the *Virginia* class submarine against one of its primary threats, the foreign diesel electric submarine (SSK). The Navy investigated alternative test strategies as part of the TEMP update process. The approved strategy asserts that the primary data for assessing this capability will come from three sources: related sonar system testing on *Los Angeles* class submarines, the use of an onboard training system that injects simulated acoustic targets into the combat system, and the possibility for future testing against real allied-nations' SSKs when security rules are relaxed.
- The Block III design will require shock testing of the Common Weapons Launcher and the *Virginia* Payload Tube (VPT) hatch. The Navy plans to complete VPT hatch shock qualification testing in April 2013 to support the first Block III delivery in August 2014.
- The Navy is performing verification and validation of the Transient Shock Analysis (TSA) modeling method used for the design of *Virginia* class Block III items. The Navy plans to accredit the TSA modeling method in March 2013.
- The Navy plans to update the Vulnerability Assessment Report to include the Block III modifications in July 2014.

Assessment

- The Navy achieved test efficiencies by combining the operational testing of several programs into a series of test events. Since submarine platform and mission systems testing are interdependent, the consolidation of the *Virginia* class testing with A-RCI sonar, acoustic arrays, Mk 48 torpedoes, and the AN/BYG-1 testing increased test efficiency and enabled a more complete end-to-end evaluation of the *Virginia* class submarine's mission performance. This testing also provided insights into the effectiveness and suitability of each individual system and weapon the Navy uses on other classes of submarines.
- The FOT&E event in the Arctic was adequate; however, the transfer and analysis of the data were significantly delayed and the Navy did not retain some test data. DOT&E's assessment of *Virginia*'s effectiveness in the Arctic environment and *Virginia*'s susceptibility to low-frequency fixed passive sonar arrays will be contained in an early FY13 classified report.
- DOT&E's classified report on *Virginia*'s modernization FOT&E, issued in November 2012, concluded the following:
 - *Virginia*'s operational effectiveness is dependent on the mission conducted. The modernization of the sonar and fire control systems (A-RCI and AN/BYG-1) with the Advanced Processor Build 09 software did not change (improve or degrade) the performance of the *Virginia* class for the missions tested. DOT&E's assessment of mission effectiveness remains the same for ASW, ISR, High Contact Management, Situational Awareness, and Mine Avoidance. DOT&E's overall assessment of Information Assurance remains unchanged from IOT&E, although the new software represents an improvement in Information Assurance over previous systems.
 - Although *Virginia* was not effective for some of the missions tested, it remains an effective replacement for the *Los Angeles* class submarine, providing similar mission performance and improved covertness.
 - Testing to examine ASW-Attack and situational awareness in a high-surface-ship density environment was adequate for the system software tested, but not adequate for the software version fielded. After completion of operational testing, the Navy issued software changes intended to address the severe performance problems observed with the Wide Aperture Array. The Navy has not completed operational testing on the new software, which is fielded on deployed submarines. DOT&E assesses that the late fix of the array's deficiencies is a result of the Navy's schedule-driven development processes, which fields new increments without completing adequate developmental testing.
 - The Navy collected adequate data to assess the suitability of the sonar and fire control systems. Insufficient data were collected to reassess the suitability of *Virginia*'s hull, mechanical, electrical, or electronic systems; however, these data were not expected to demonstrate significantly different reliability compared to what was

NAVY PROGRAMS

observed in IOT&E. Of note, the installation of the new Advanced Processor Build 09 of the A-RCI sonar system on *Virginia* class submarines will degrade the reliability of the sonar system on these submarines relative to what was demonstrated in the IOT&E.

Recommendations

- Status of Previous Recommendations. The Navy has made progress in addressing 22 of the 30 recommendations contained in the November 2009 classified BLRIP report and the October 2011 classified FOT&E report. Of the outstanding recommendations, the significant unclassified ones are:
 1. Test against an SSK threat surrogate in order to evaluate *Virginia's* capability, detectability, and survivability against modern diesel-electric submarines.
 2. Conduct FOT&E to examine *Virginia's* susceptibility to airborne ASW threats such as Maritime Patrol Aircraft and helicopters.
- FY12 Recommendations. The Navy should:
 1. Coordinate the *Virginia*, A-RCI, and AN/BYG-1 TEMPs and utilize Undersea Enterprise Capstone documents to facilitate testing efficiencies.
 2. Complete the verification, validation, and accreditation of the TSA method used for *Virginia* class Block III items.
 3. Repeat the FOT&E event to determine *Virginia's* susceptibility to low-frequency active sonar and *Virginia's* ability to conduct ASUW in a low-frequency active environment. This testing should include a *Los Angeles* class submarine operating in the same environment to enable comparison with the *Virginia* class.
 4. Address the 21 recommendations that are included in the November 2012 DOT&E-published FOT&E report on *Virginia's* modernization and the associated sonar and combat control systems. In particular, the Navy should re-evaluate operational effectiveness on a submarine with a repaired Wide Aperture Array.

NAVY PROGRAMS