VIRGINIA (SSN 774) CLASS ATTACK SUBMARINE

Navy ACAT ID Program		**Prime Contractor**
Total Number of Systems:	30	General Dynamics Electric Boat Division
Total Program Cost (TY$):	$65,151M	Newport News Shipbuilding
Average Unit Cost (TY$):	$1,995M	Lockheed Martin Federal Systems (Combat System)
Full-rate production:	1QFY07	

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

VIRGINIA will replace the aging fleet of LOS ANGELES (SSN 688) Class submarines and is intended to maintain the U.S. technological lead in undersea warfare well into the 21st century. VIRGINIA is intended to be a submarine comparable in most respects to its immediate predecessor, the SEAWOLF, but in a more affordable configuration. It is designed to rapidly deploy to militarily important hostile ocean areas and deny their use to the enemy, clear the way for strikes by other friendly forces, and engage and destroy enemy submarines, surface forces and land targets, supporting ***dominant maneuver*** as well as ***full-dimensional protection*** for forces afloat. VIRGINIA will have a broad range of missions packaged in a quiet, heavily armed, shock resistant, survivable submarine. These include Covert Strike Warfare, Anti-Submarine Warfare, Covert Intelligence Collection/Surveillance, Covert Indication and Warning and Electronic Warfare, Anti-Surface Ship Warfare, Special Warfare, Covert Mine Warfare, and Battle Group Support. VIRGINIA includes systems that incorporate technological advancements enabling greater ship quieting, improved acoustic sensors (with potential for subsequent growth), a flexible weapon load and ability to more quietly launch weapons, an advanced nuclear reactor, improved propulsion machinery, an advanced propulsor, improved ship control, and enhanced

survivability. VIRGINIA will use advanced technology and commercial off-the-shelf (COTS) equipment to reduce acquisition and life-cycle costs while retaining mission effectiveness.

VIRGINIA is required to be capable of targeting, controlling and launching MK 48 ADCAP torpedoes, mines, and Tomahawk missiles from anywhere in the ocean. Its sonar capability is expected to be similar to SEAWOLF's, and its electronic support suite and combat control system represent improvements over legacy systems. The external communications system is required to be an improvement over SEAWOLF and legacy systems, providing full, high data rate interoperability with U.S. and allied forces. These characteristics provide intelligence and strike capabilities to support the Joint Force Commander in ***precision engagement***. VIRGINIA is required to maintain a level of stealth equivalent to the requirements of the SEAWOLF (SSN 21) class submarines.

More details are provided in the classified version of this report.

BACKGROUND INFORMATION

The Milestone I DAB approved VIRGINIA to enter Phase I in August 1994. For Milestone II, a very aggressive and thorough EOA of VIRGINIA was conducted in accordance with a DOT&E approved test plan, concluding that VIRGINIA was potentially operationally effective. More details are provided in the classified version of this report. The Program Office and Navy sponsor fully supported this EOA and generally agreed with the findings.

DOT&E recommended and the Secretary of Defense approved a statutorily allowed waiver to full-up, system-level live fire testing of VIRGINIA because such tests were considered unreasonably expensive and impractical. DOT&E approved the alternative LFT&E plan submitted in lieu of full-up, system-level testing in June 1995. This plan includes shock qualification tests and analysis of components, surrogate underwater shock tests, a Total Ship Survivability Trial (TSST), a Ship Shock Test, as well as a series of vulnerability assessments. The Milestone II DAB approved VIRGINIA to enter Phase II on June 30, 1995.

An OA, which supported a DAB Program Review in FY97, concluded that the VIRGINIA design should lead to a potentially operationally effective submarine. The OA identified three high and six moderate risk areas. More details are provided in the classified version of this report. Many of the issues identified during the FY97 OA were the results of programmatic decisions to scope back efforts or eliminated capabilities factored into the original estimates of the VIRGINIA performance baseline.

On September 30, 1998, the Navy and Electric Boat signed the construction contract for the first four NSSN hulls. The $4.2 billion contract has Electric Boat as the prime contractor and Newport News Shipbuilding as a major subcontractor. On October 2, 1998, the first hull of the NSSN class officially became the USS VIRGINIA (SSN 774).

The Submarine Combat Systems program office is conducting VIRGINIA sonar development. Its leading sonar program, known as AN/BQQ-10 Acoustic Rapid COTS Insertion (A-RCI), uses COTS technology to upgrade submarine sonars. Current upgrades are for the SSN 688 class submarines, and will later include TRIDENT SSBNs, SEAWOLF, and VIRGINIA. The SSN 688 series consists of four phases: Phase I upgraded the towed array narrow band and spatial vernier processing on two 688 class submarines which have since been upgraded to Phase II; Phase II significantly upgrades all aspects of towed array processing; Phase III upgrades spherical array and hull array processing and an enhanced

onboard training capability; and Phase IV upgrades high frequency sonar processing. Phase II is currently being operated on many SSN 688 class submarines. In response to fleet demands, a planned software/hardware upgrade (Advanced Processing Build (APB)) for the Phase II sonar known as Phase II+ was introduced five months in advance of schedule. Early shipboard installation of Phases III and IV occurred in late FY00, and development continues. After Phases III and IV operational tests are completed in FY01, the A-RCI program will continue to upgrade its sonars through the APB sequence, which is a periodic (approximately annual) software and/or hardware upgrade plan. The AN/BQQ-10 series sonar is planned to progress to a common COTS architecture for all U.S. submarine sonars by 2005-2007.

TEST & EVALUATION ACTIVITY

As of December 2000, DOT&E was awaiting receipt of Revision C to the TEMP, which was in final Navy approval routing. This TEMP revision includes a move of the Full Ship Shock Test and Total Ship Survivability Trial from Hull 1 to Hull 2, which DOT&E agreed to based on the Navy's input that this move would improve overall scheduling stability without impacting the Milestone III decision date

In May 2000, COMOPTEVFOR issued an Interim Operational Assessment Report on VIRGINIA.

In May 2000, the SSN 688 submarine variant of the AN/BLQ-10 Electronics Support Measures (ESM) system passed its Operational Evaluation.

Extensive early integration testing of the VIRGINIA Non-propulsion Electronic System (NPES) occurred throughout the year. NPES is the name given to the 26 sub-systems outside the propulsion plant, and the local area network that ties these systems together on an asynchronous transfer modem (ATM), fiber optic computer network.

Technical testing to improve the acoustic performance of VIRGINIA propulsor development continued throughout the year. More details are provided in the classified version of this report.

The Naval Security Group assisted COMOPTEVFOR in evaluating the vulnerability of VIRGINIA's combat and ship control systems local area network. This assessment included looks at outside attack, internal attack, and inadvertent error. The initial evaluation was included in COMOPTEVFOR's Interim Operational Assessment Report. Evaluation will continue in FY01.

A-RCI/BQQ-10 Activity. (1) A-RCI Phase II+ was installed on an SSN-688 class submarine in April 2000. From April to June 2000 fleet training teams and the developer conducted installation testing, software development, system performance observation, and crew training. With no operational test of the Phase II+ sonar, this submarine then deployed. (2) An operational assessment of A-RCI Phase II+ was scheduled to occur in the Pacific in September 2000, but was not performed due to platform problems unrelated to the sonar. The test was reschedule for January 2001. (3) Developmental testing of A-RCI Phases III and IV occurred in the Atlantic during September and November 2000. (4) Technical evaluation of A-RCI Phase IV occurred in the Pacific in October and November 2000. More details are provided in the classified version of this report.

Other testing included: (1) Lightweight Wide Aperture Array sonar performance and environmental testing; (2) TB-29A Risk Reduction Array self-noise, telemetry, and durability testing; (3)

Weapon Stowage and Handling System (WSHS) hardware and software integration testing; (4) AN/BLQ-10 Photonics Mast engineering developmental model at-sea testing; (5) UNDEX component shock testing; (6) Reverse Osmosis Unit prototype at-sea testing; (7) High Speed Emergency Diesel Generator electrical load testing (unsatisfactory); and (8) Integrated Low Pressure Electrolyzer endurance testing.

In FY 99, DOT&E reviewed and twice commented on the Navy's September 1998 Update I of the VIRGINIA detail design vulnerability assessment report (VAR) and the Navy's actions to resolve DOT&E's VAR comments. In FY00, the Navy continued its vulnerability assessment work to support the next VAR Update, which is due in June 2001. DOT&E continued to participate in VIRGINIA LFT&E working group meetings to reach resolution of VAR comments, and provided insight as well as oversight on Navy planning for future LFT&E activities. DOT&E also witnessed component shock qualification tests, and reviewed with the Navy the results of Live Fire component and surrogate tests including extensive underwater shock tests of the A/B-1 test vehicle, completed in 1999.

The Navy announced its intention to develop electric drive in future VIRGINIA Class submarines, starting in about 2010. DOT&E will evaluate the potential impact on the survivability of this major product improvement program.

TEST & EVALUATION ASSESSMENT

Due to post-delivery schedule conflicts with other high priority tests required for ship safety, susceptibility, and weapons systems performance, DOT&E agreed with a Navy proposal to move the Full Ship Shock Test (FSST) to Hull 2, contingent on the Navy's agreement to not seek any further moves of the FSST to a later hull. This move also requires revision of the TEMP Life Fire Test & Evaluation Strategy, which DOT&E has tasked the Navy to provide in FY01.

COMOPTEVFOR's Interim Early Operational Assessment (EOA) recomputed Virginia Anti-submarine Warfare (ASW) performance predictions using Naval Undersea Warfare Center (NUWC), Newport, computer models, and by changing several key inputs, based on more up-to-date information than was available in 1994. COMOPTEVFOR's intent was to assess VIRGINIA against the most challenging foreseen future threats. The revised inputs included upgrading the nuclear attack submarine Threat of Record, upgrading the threat diesel submarine, updating threat and own-ship tactics, refining VIRGINIA performance characteristics, and changing to NUWC's more recent and sophisticated ocean environment computer model. Results are found in the classified version of this report. In addition, the Interim OA Report cited the NPES (slow software development), the radio room (equipment space to support functionality), and the TB-29A towed array (interoperability with the combat system) as medium to high risks. The report also cited inadequate ship manning for information systems technicians and immature concepts of operations for the photonics mast as current concerns. The report also cited other concerns that are discussed in the classified version of this report. DOT&E agrees with COMOPTEVFOR's assessment, but notes that added emphases are needed in at least two more areas, one of which is discussed in the classified version of this report. The other area needing further examination is TB-29 series towed array reliability, which has been an historical problem. COMOPTEVFOR has indicated that the next and final EOA Report, due in late FY01, will include these additional two areas.

A-RCI operational testing quality continued to be sub-par. To date, Submarine Force training teams have performed much of the A-RCI sonar assessment, with feedback going directly to Submarine Force leadership and not being provided to the operational test community. This practice has ignored the

approved Chief of Naval Operations channel for conducting operational tests and reporting results, although about 25 submarines are now using A-RCI sonars. More details are provided in the classified version of this report.

The Navy has evaluated six damage scenarios for the detail design VAR using linear extrapolation from physics-based design-level shock analyses in local environments to 10 percent above the design level. The assessment at this level of shock intensity resulted in very limited damage and few lessons learned. The Navy is proposing a "Meaningful Drill Concept" for the post-delivery Total Ship Survivability Trial (TSST) with damage scenarios that are to be tied back to the six shot lines. However, the damage scenarios for these shot lines have not been developed to reflect the effects of secondary damage (e.g., fire, flooding, hydraulic leak, loss of control circuits, etc.). Another concern is how or to what degree the Navy will simulate realistic propulsion plant damage in the TSST scenarios. DOT&E is continuing to work with the Navy to resolve these issues.

There are other LFT&E concerns. (1) The Navy has not described its approach for Verification, Validation, and Accreditation (VV&A) of LFT&E computer models. (2) The Navy has not described how it will extrapolate Ship Shock Test results to higher shock intensity levels for use in the assessment of VIRGINIA's vulnerability to underwater shock. (3) The Navy has not shown how (or if) it will assess VIRGINIA's ability to surface after exposure to an underwater burst at the hull integrity shock factor level. (4) Because of funding shortfalls, the Weapons Handling Module (WHM) shock test on A/B-1 has been moved from FY01 to FY03. Funding shortfalls may also result in revised and potentially less stringent shock qualifications of the WHM and other components that were originally planned for testing on A/B-1. These risks for later deficiency identification and lower standards concern DOT&E, who continues to work with the Navy to reach understandings and resolve differences.

CONCLUSIONS, RECOMMENDATIONS AND LESSONS LEARNED

The Navy appears to be initially successful in developing usable Commercial-Off-the-Shelf computer systems for submarine sonars in the A-RCI program. The extent of this success, however, has yet to be independently assessed, and history has shown that ample, robust, and independent operational testing is essential for ultimate success. Short-changing TEMP agreed-to operational testing periods, often cited as necessary to maintain fleet operating tempo, needs to be less frequent, and a higher priority needs to be given to operational testing. The A-RCI Phase III Operational Evaluation, scheduled for March 2001, is an opportunity to conduct meaningful operational testing, and needs to be completed as planned.

The Navy needs to develop realistic TSST scenarios that stress the submarine and include the effects of secondary damage. DOT&E will work with the Navy to ensure that scenarios developed for TSST are appropriate, include the effects of secondary damage, and meet LFT&E statutory requirements.

The Navy's recent trend of deleting funding from previously agreed-to ship shock testing, as evidenced by USS SEAWOLF and DDG-51 Flight Two, needs to be stopped, and Congressional support is needed to make this happen.