

AN/BYG-1 Combat Control System

Executive Summary

- The Navy completed FOT&E of AN/BYG-1 Advanced Processor Build 09 (APB-09) in early FY12.
- DOT&E issued a classified FOT&E report for the AN/BYG-1 APB-09 system in November 2012 and found the APB-09 system provides performance similar to previous APBs (not improved or degraded).
- The processing and display for the Wide Aperture Array (WAA) suffered from significant technical problems that were discovered during operational testing. The WAA is a sonar input to the BYG-1 intended to provide bearing and ranges data to the system. The Navy developed new software intended to fix the WAA problems, conducted limited development testing, and issued the new software to the fleet without further operational testing.
- The Navy is completing development of the APB-11 version and operational testing is planned to begin in FY13.

System

- AN/BYG-1 is an open-architecture submarine combat control system for analyzing and tracking submarine and surface ship contacts, providing situational awareness, as well as the capability to target and employ torpedoes and missiles.
- AN/BYG-1 replaces central processors with commercial off-the-shelf (COTS) computer technology. The Navy installs improvements to the system via an incremental development program. The program includes the following:
 - A combat control system for the *Virginia* class submarine
 - A replacement combat control system back-fit into *Los Angeles*, *Ohio*, and *Seawolf* class submarines
 - Biannual software upgrades (called Advanced Processor Builds (APBs)) and hardware upgrades (called Technology Insertions (TIs)). While using the same process and nomenclature, these APBs and TIs are distinct from those used in the Acoustic Rapid COTS Insertion (A-RCI) program.
- The Navy intends improvements to provide expanded capabilities for Anti-Submarine (ASW) and Anti-Surface



- Warfare (ASUW), high-density contact management, and the targeting and control of submarine weapons.
- The Navy is also developing AN/BYG-1 for use on the Royal Australian Navy *Collins* class diesel electric submarines.

Mission

Submarine crews equipped with the AN/BYG-1 combat control system are able to complete the following submarine force missions:

- Analyze submarine sensor contact information to track submarine and surface vessels in open ocean and littoral sea environments
- Employ heavyweight torpedoes against submarine and surface ship targets
- Receive strike warfare tasking, plan strike missions, and employ Tomahawk land-attack cruise missiles
- Receive and synthesize all organic sensor data and external tactical intelligence to produce an integrated tactical picture

Major Contractors

- General Dynamics Advanced Information Systems – Fairfax, Virginia
- General Dynamics Advanced Information Systems – Pittsfield, Massachusetts

Activity

- The Navy completed FOT&E of AN/BYG-1 APB-09 in early FY12 in accordance with a DOT&E-approved test plan. The Navy combined testing with the AN/BQQ-10 A-RCI Sonar System, the *Virginia* class submarine, and the Mk 48 Mod 6 Advanced Common Torpedo (ACOT) and Mk 48 Advanced Capability (ADCAP) Mod 7 Common Broadband Advanced Sonar System (CBASS) programs. Coordinating these tests provided testing efficiencies and enabled an end-to-end evaluation of mission performance.
- DOT&E issued a classified combined operational test report in November 2012 that evaluates the effectiveness and suitability of the AN/BYG-1 APB-09 system.
- The Navy began drafting a Test and Evaluation Master Plan (TEMP) for the APB-11 and APB-13 variants of AN/BYG-1, and expects to issue it by early FY13. Operational testing of the APB-11 variant of AN/BYG-1 is expected to begin in FY13.

Assessment

- The Navy's schedule-driven process prevents operational test results from directly supporting development of the follow-on APBs. The Navy completed operational testing of the AN/BYG-1 APB-09 system in 2011. Due to the combination of late completion of testing and the Navy's practice of issuing an updated software and hardware version every two years, data from APB-09 operational testing have not been included in the development of APB-11, which is nearing completion.
- The DOT&E classified combined report to Congress for the *Virginia* class submarine, A-RCI APB-09, and AN/BYG-1 APB-09 systems concluded the following regarding AN/BYG-1 test adequacy and system performance:
 - Given the data available, no evidence exists to change the conclusions about mission performance from previous reports on AN/BYG-1 (not improved or degraded). Specifically,
 - APB-09 is not effective in supporting operator situational awareness and contact management in areas of high-contact density.
 - APB-09 did not meet the Navy's requirements for target localization; however, the targeting solutions were often sufficient for a trained crew to provide the torpedo an opportunity to detect the target. Nevertheless, the APB-09 variant remains not effective in ASW scenarios.
 - DOT&E's overall assessment of Information Assurance was unchanged from the APB-07 variant (not effective), although the new software represents an improvement in Information Assurance over previous systems.
 - APB-09 is operationally suitable and continues to exhibit excellent reliability and availability; however, the Navy needs to improve APB training.
 - Testing to examine missions involving ASW-Attack, situational awareness, and contact management in areas of high-contact density was adequate for the system tested but not adequate for the software version fielded on *Virginia* class submarines. The AN/BQQ-10 A-RCI processing for the WAA suffered from system development problems, which led to poor performance during the operational testing. AN/BYG-1's contribution to the ASW mission performance and submarine mission operations in areas of high-contact density was hindered due to these problems. The Navy investigated the WAA issues after operational testing was completed and subsequently issued software fixes intended to correct the problems. The Navy conducted some limited developmental testing to confirm functionality; however, the Navy has not completed

operational testing to evaluate the updated WAA software effects on BYG-1 performance. DOT&E assesses that the completed operational testing allows for an adequate assessment of the performance on *Los Angeles* class and *Ohio* class submarines that do not have a WAA.

- The new BYG-1 route planning tools were unable to be fully evaluated due to the lack of required databases and crew training.

Recommendations

- Status of Previous Recommendations. The Navy has made progress in addressing four of the seven outstanding recommendations contained in previous annual reports and test reports. The remaining significant unclassified recommendations are:
 1. Improve the detection and localization performance for submarines operating in high-density surface ship environments. Consider investing in automation that will assist the operator in processing the large amount of constantly changing contact data and determining which contacts pose an immediate collision or counter-detection threat.
 2. Improve operator training such that operators understand and effectively employ new APB functionality when fielded.
 3. Conduct future ASW testing against high-end targets simulating modern threat diesel-electric submarines (SSK) to enable a more complete assessment of A-RCI and BYG-1 performance. Since acoustic sensors and environmental conditions effect the system's performance, testing should be conducted using the Navy's tactical sensor combinations and in a variety of threat-like environments.
- FY12 Recommendations.
 1. DOT&E published a classified APB-09 FOT&E report in November 2012. That report identifies 21 recommendations that the Navy should address for the A-RCI sonar system and the AN/BYG-1 combat control systems. In particular, the Navy should re-evaluate operational effectiveness on a submarine with a repaired WAA.
 2. The Navy should consolidate the A-RCI and AN/BYG-1 TEMPs and test plans into an Undersea Enterprise Capstone document to permit efficiencies in testing.
 3. The Navy should improve its developmental testing processes and metrics used to determine if a system potentially improves effectiveness and suitability and to ensure that the system is ready for operational testing and subsequent fielding.