AN/BYG-1 Combat Control System

Executive Summary

The Navy deployed AN/BYG-1 with the latest upgrades before completing OT&E during 2008. This is a change for the program, which had a record of completing OT&E before fielding upgrades. Additionally, the limited test and evaluation completed is not sufficient to confirm expected performance improvements. The overall OT&E strategy needs attention to provide the right information to decision-makers before the Navy fields and deploys the system upgrades.

System

- AN/BYG-1 is an open architecture submarine combat control system for analyzing and tracking submarine and surface ship contacts, enabling crew situational awareness, and for targeting and employing tactical torpedoes and missiles.
- AN/BYG-1 replaces central processors with commercial off-the shelf (COTS) computer technology and software. The Navy installs improvements to the system via a spiral development program. It includes:
  - A combat control system for the *Virginia* class submarine
  - A replacement combat control system backfit into *Los Angeles*, *Ohio*, and *Seawolf* class submarines
  - Schedule-driven annual software upgrades (Advanced Processor Builds (APBs)) and biannual hardware upgrades called Technology Insertions (TI)
- The Navy intends improvements to provide expanded capabilities for anti-submarine and anti-surface warfare, 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 or 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

Prime Contractors

- General Dynamics
- Raytheon

Activity

- DOT&E conditionally approved the AN/BYG-1 TI-06/APB-06 Test and Evaluation Master Plan (TEMP) on June 26, 2008. The Navy approved the TI-06/APB-06 Capabilities Development Document (CDD) in July 2008. Due to delays in developing and approving the TI-06/APB-06 CDD and TEMP, DOT&E conditionally approved the Navy's TI-06/APB-06 test plan on April 1, 2008, based on the draft requirements. This enabled the Navy to utilize available test assets to conduct the first APB-06 operational test.
- The Navy deployed the AN/BYG-1 TI-06/APB-06 system on an operational submarine in June 2008. This is a reversal of previous acquisition trends, where the Navy successfully completed operational testing before fielding AN/BYG-1 systems.
- The Navy conducted three OT&E events for the AN/BYG-1 TI-06/APB-06 system to evaluate performance in mission areas for *Los Angeles* class submarines. During the planning for these tests, DOT&E urged the Navy to combine sonar, combat control, and weapons tests into single "end-to-end" tests wherever possible. As discussed below, the Navy combined the Acoustic Rapid COTS Insertion (A-RCI) and BYG-1 testing. In addition to reducing costs and test assets, this provided a total mission performance evaluation.
  - The Navy tested TI-06/APB-06 target motion analysis performance in an exercise with a cooperative Italian diesel-electric submarine (SSK) in September 2008. This was a combined test with the AN/BQQ-10 A-RCI sonar system.
  - The Navy tested TI-06/APB-06 in a high-density shipping area to assess the crew's situational awareness in a difficult littoral environment in April 2008. This was a combined test with the A-RCI sonar system.

  - The Navy successfully conducted two Tomahawk missile launches with the AN/BYG-1 TI-06/APB06 system in May 2008.
- The Navy conducted an initial AN/BYG-1 information assurance vulnerability assessment in July 2008. The Navy is planning information assurance penetration (Red Team) testing in early 2009.
- The Navy's Commander, Operational Test and Evaluation Force is evaluating data from the 2008 tests and plans to issue a report on the APB-06 system in 2QFY09, provided all required testing is complete.

Assessment

- Navy operational testers evaluated previous versions of AN/BYG-1, prior to the fielding or deployment of the system. However, Navy operational commanders deployed the submarine with the APB-06 upgrade installed before operational testing could be completed – this is due in part to the effort to combine testing with the A-RCI submarine sonar program and the related testing delays of that program. Additionally, the limited test and evaluation completed is not sufficient to confirm expected performance improvements. The overall OT&E strategy needs attention to provide the right information to decision-makers before the Navy fields and deploys the system upgrades.
- Two of the APB-06 test events were inadequate for fully evaluating AN/BYG-1 APB-06 performance. A material problem on the test submarine and bad weather in the test area prevented execution of the complete test plan during the April 2008 crew situational awareness in a high-contact density environment test. Due to test limitations and acoustic conditions in the test area, the target motion analysis performance test with the Italian SSK did not provide sufficient data to fully evaluate the system. Testers are analyzing event data to determine the extent of the additional testing needed.
- AN/BYG-1 is a technological improvement over the legacy combat control systems; however, insufficient test data exists to conclude that AN/BYG-1 APB upgrades improve mission capability between APBs. DOT&E believes the new functionality in each APB should enable a trained operator's performance to improve at sea; however, the Navy has not substantiated or measured significant performance improvements in realistic operational environments.
- AN/BYG-1 continues to demonstrate above-threshold reliability, maintainability, and availability. This is due in part to the separation of tactical software development and the weapons-control interface and hardware.
- AN/BYG-1 TI-06/APB-06 is effective in employing Tomahawk missiles.

Recommendations

- Status of Previous Recommendations: This is the first annual report for this program.
- FY08 Recommendations: The Navy should:
  1. Continue to conduct combined testing of A-RCI and AN/BYG-1 to enable a full end-to-end evaluation of submarine capability in the applicable mission areas.
  2. Develop platform-level metrics with thresholds for the entire combat system (segregated requirements result in inadequate evaluations of the system).
  3. Implement an event-based vice schedule-based methodology for developing and testing AN/BYG-1 upgrades, to ensure adequate testing before fielding.