

## Acoustic Rapid Commercial Off-the-Shelf (COTS) Insertion (A-RCI) and AN/BYG-1 Combat Control System

### Executive Summary

- DOT&E issued a classified FOT&E report on the Advanced Processor Build 2009 (APB-09) variants of the Acoustic Rapid Commercial Off-the-Shelf (COTS) Insertion (A-RCI) sonar system and AN/BYG-1 combat control system on November 15, 2012. In the report, DOT&E concluded that performance in the mission areas tested remain unchanged from previous versions of the A-RCI and AN/BYG-1 systems.
- DOT&E approved a Test and Evaluation Master Plan (TEMP) covering APB-11 and APB-13 variants.
- Operational testing of the APB-11 variants began in early FY13 and is expected to conclude in FY14. The Navy completed the first at-sea portion of operational testing in accordance with the DOT&E-approved test plan but testing was limited due to equipment failures:
  - During the Anti-Submarine Warfare (ASW) test in May 2013, the TB-29 towed array failed. As a result, data for the TB-29-specific modifications of the APB-11 system are to be captured in future testing.
  - The active operating mode of the Low Cost Conformal Array (LCCA) was unable to be evaluated due to a failure of the system's software to detect contacts. The system performed adequately in earlier developmental testing but a previously unknown software deficiency caused the system to not function properly in the operational test environment. Although the Navy developed a software update to address this deficiency, future testing will need to be conducted to verify its performance.

### System

#### A-RCI

- The A-RCI sonar system is intended to maintain an advantage in acoustic detection of threat submarines.
- A-RCI processes data from the submarine's acoustic arrays (i.e., spherical array, hull array, wide aperture array, conformal array, and high-frequency array) along with the submarine's two towed arrays (i.e., the fat line array consisting of the TB-16 or TB-34, and the thin line array consisting of the TB-23 or TB-29).

#### AN/BYG-1

- The AN/BYG-1 combat control system provides operators with information to support appropriate tactical positioning and a means to employ weapons (i.e., torpedoes and missiles).
- AN/BYG-1 is used for analyzing and tracking submarine and surface ship contacts, providing situational awareness with the capability to target and employ torpedoes and missiles.



- Both systems use commercial off-the-shelf computer technology and software to provide:
  - Sonar and combat control for the *Virginia* class submarine
  - Replacement sonar and combat control retrofitted into *Los Angeles*, *Ohio*, and *Seawolf* class submarines
- The Navy updates the hardware and software every two years for these systems to take advantage of improved processing with new technology. Testing for the A-RCI sonar system and AN/BYG-1 combat control system occurs concurrently.

### Mission

- Submarine crews use the A-RCI to:
  - Search, detect, and track submarine and surface vessels in open-ocean and littoral sea environments without being counter-detected
  - Search, detect, and avoid mines and other submerged objects
  - Covertly conduct Intelligence, Surveillance, and Reconnaissance
  - Covertly execute Naval Special Warfare missions
  - Perform under-ice operations
- Operators use the AN/BYG-1 to:
  - 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

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## Major Contractors

- A-RCI: Lockheed Martin Maritime Systems and Sensors – Washington, District of Columbia
- AN/BYG-1: General Dynamics Advanced Information Systems – Fairfax, Virginia, and Pittsfield, Massachusetts

## Activity

- DOT&E issued an FOT&E report on the APB-09 variants of the A-RCI sonar system and the AN/BYG-1 combat control system on November 15, 2012.
- DOT&E approved a TEMP covering APB-11 and APB-13 variants. APB-11 operational testing will include at-sea evaluations focusing on ASW and situational awareness in High-Density Contact Management situations. In addition, testing will include Information Assurance evaluations and an at-sea event against a high-end diesel submarine, which has not been evaluated since 2007.
- Operational testing of the APB-11 variants began in early FY13 and is expected to conclude in FY14. The Navy completed the first at-sea portion of testing in accordance with the DOT&E-approved TEMP and test plan but testing suffered from limitations due to equipment failures:
  - During the ASW test in May 2013, the TB-29 towed array failed. As a result, data could not be collected to characterize the performance of the TB-29 specific modifications of the APB-11 system that provided algorithms for determining range and a new range-azimuth display to aid in resolving bearing ambiguity. The Navy expects to capture these data in future testing.
  - The Navy was unable to evaluate the active operating mode of the LCCA due to a limitation of the system software. The system performed adequately in earlier developmental testing as the software problem was not readily apparent in a more benign developmental testing environment. The Navy developed a software update to correct this problem and verified proper functionality with in-lab testing by playing back and analyzing recorded data. Operational testing of the active operating mode of the LCCA, to include the software update, is not complete. The Navy incorporated the software update in a revision to the APB-11 variant.
- The A-RCI high-frequency mine performance is not effective for some types of minefields but meets threshold requirements against some mine types under certain environmental conditions.
- The AN/BYG-1 system 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, AN/BYG-1 remains not effective in ASW scenarios.
- Information Assurance is not effective and remains unchanged from the APB-07 variant, although APB-09 represents an improvement in Information Assurance over previous systems.
- The AN-BYG-1 APB-09 system is operationally suitable and continues to exhibit excellent reliability and availability; however, the Navy needs to improve APB training.
- Due to the biennial software and hardware development cycle, the Navy generates and approves the requirements documents and TEMPs in parallel with APB development and installation. As a result, the fleet assumes additional risk, since most operational testing is not completed before the system is initially deployed.
- The Navy's schedule-driven process prevents operational test results from directly supporting development of the follow-on APBs. For example, the Navy completed operational testing of the A-RCI APB-09 system in early FY12. Due to the combination of the late completion of testing and the Navy's practice of issuing an updated version every two years, data from the test could not be included in the development of APB-11.

## Assessment

- The final assessment of APB-11 is not completed, as testing is expected to continue through FY14. As a result, DOT&E's overall assessment remains unchanged from previous assessments. The DOT&E classified FOT&E report from November 2012 concluded the following regarding performance:
  - For ASW, A-RCI passive sonar capability is effective against older classes of submarines in some environments but is not effective in all environments or against modern threats.
  - The A-RCI and the AN/BYG-1 systems are not effective in supporting operator situational awareness and contact management in areas of high-contact density.

## Recommendations

- Status of Previous Recommendations.
  - The Navy made progress in addressing 23 of the 39 previous recommendations outlined in the classified APB-09 DOT&E report. Of the 16 remaining outstanding recommendations, the significant unclassified recommendations are:
    1. Conduct additional testing in shallow water to examine the ship's ASW capabilities in those conditions.
    2. 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.

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3. Improve operator training such that operators understand and effectively employ new APB functionality when fielded.
  4. Evaluate the covertness of the high-frequency sonar during a future submarine-on-submarine test.
  5. Determine the performance of the A-RCI system in detecting near surface mines.
- The following recommendations from the FY12 Annual Report remain open. In the upcoming fiscal year, the Navy should:
1. Consolidate the A-RCI and AN/BYG-1 TEMPs and test plans into an Undersea Enterprise Capstone document to permit efficiencies in testing.
  2. 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.
  3. Evaluate its metrics to improve their robustness under varying environmental conditions and to focus on earlier and longer range operator detections.
  4. Conduct a minefield video survey to evaluate the condition and location of the mines prior to the decision to use the minefield for testing, if future minefield testing requires use of existing fleet training minefields.
- FY13 Recommendations. None.

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