

## Acoustic Rapid Commercial Off-the-Shelf (COTS) Insertion (A-RCI) for Sonar AN/BQQ-10 (V)

### Executive Summary

- The Navy completed IOT&E of a new high-frequency array called the Low Cost Conformal Array (LCCA) in FY10. DOT&E issued a classified Beyond Low-Rate Initial Production (BLRIP) report for the array in FY11 and concluded that the system is effective and suitable.
- The Navy completed FOT&E of the Acoustic Rapid Commercial Off-the-Shelf (COTS) Insertion for Sonar (A-RCI) Advanced Processor Build 2007 version (APB-07) system in FY10. DOT&E issued a classified report combined with an assessment of the APB-07 version of the AN/BYG-1 Combat Control System in FY11.
- The Navy commenced FOT&E of A-RCI APB-09 in March 2011. Testing is scheduled to be completed in early FY12.

### System

- A-RCI is an open architecture sonar system intended to maintain an advantage in acoustic detection of threat submarines.
- A-RCI uses legacy sensors and replaces central processors with COTS computer technology and software. The program includes the following:
  - A sonar system for the *Virginia* class submarine
  - A replacement sonar system retrofitted into *Los Angeles*, *Ohio*, and *Seawolf* class submarines
  - Biannual software upgrades (called 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 AN/BYG-1 Combat Control System program.
- The Navy intends the A-RCI upgrades to provide expanded capabilities for anti-submarine warfare (ASW), high-density contact management, and mine warfare, particularly in littoral waters and against diesel submarines.
- A-RCI processes data from the submarine's acoustic arrays (i.e., spherical array, hull array, wide aperture array, and high-frequency arrays) 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).



- A-RCI processes and displays the data from the LCCA. Combined with the legacy high-frequency sail array mounted in the front of the sail, LCCA provides the submarine crew with a near 360-degree high-frequency passive sonar capability. The LCCA is used to increase tactical control and situational awareness when operating in areas that are heavily populated with surface vessels.

### Mission

The Navy's intent for submarine crews equipped with the A-RCI sonar is to complete the following submarine force missions:

- 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

### Major Contractor

Lockheed Martin Maritime Systems and Sensors – Washington, District of Columbia

### Activity

- The Navy completed FOT&E of A-RCI APB-07 in late 2010 in accordance with a DOT&E-approved test plan. Testing was conducted on four submarines, included two hardware variants, and was combined with the IOT&E periods of two new sonar arrays: the TB-34 and the LCCA. Some of the testing periods were also combined with the operational

testing of the APB-07 variant of the AN/BYG-1 Combat Control System. Coordinating these tests provided testing efficiencies and enabled an end-to-end evaluation of mission performance. DOT&E issued a classified combined A-RCI and AN/BYG-1 APB-07 test report in July 2011.

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- The Navy completed IOT&E of the LCCA in 2010. DOT&E issued a classified BLRIP report in May 2011.
- DOT&E approved the A-RCI APB-09 Test and Evaluation Master Plan (TEMP) in September 2010. Operational testing of the APB-09 variant commenced in March 2011 and will continue into early FY12.
- The Navy began drafting a TEMP for the APB-11 and APB-13 A-RCI variants, and expects to issue it by mid 2012. As part of these efforts, DOT&E requested the Navy investigate new methods of land-based testing and onboard simulated target injection methods to augment at-sea operational tests.

## Assessment

- The Navy's schedule-driven process prevents operational test results from directly supporting development of the follow-on APBs. The Navy is scheduled to complete operational testing of the A-RCI APB-09 system in early FY12. Due to the combination of late completion of testing and the Navy's practice of issuing an updated version every two years, data from APB-09 operational testing will not be included in the development of APB-11.
- The DOT&E classified BLRIP report for the LCCA concluded the following:
  - LCCA is operationally effective and operationally suitable.
  - The Navy conducted adequate in-water testing to provide an initial assessment of the operational utility of the LCCA and associated A-RCI processing and displays. Additional testing is recommended to examine LCCA's ability to contribute to ASW missions.
- The DOT&E classified FOT&E report for the A-RCI APB-07 and BYG-1 APB-07 systems concluded the following regarding A-RCI testing adequacy and system performance:
  - The Navy did not conduct adequate testing to assess the A-RCI APB-07 system's capability to support Mine Detection and Avoidance and ASW operations.
    - There were three significant problems with the Mine Detection and Avoidance tests: the targets and minefield condition were not operationally representative, the Navy did not execute the test in accordance with the approved test plan, and hardware limitations aboard the test ship preclude a full examination of the functionality under test.
    - There were two significant problems with the ASW test event: an accurate and meaningful measurement of search time could not be determined due to the tactics employed by the test ships, and the test was not executed as planned with regard to the repositioning times between events and the starting distances between the two submarines at the beginning of each test run.
  - Testing of the APB-07 system to examine situational awareness in areas of high contact density and testing of precision underwater mapping and navigation were adequate.
  - A-RCI is not effective in supporting operator situational awareness and contact management in areas of high contact density.

- The newly introduced Precision Underwater Mapping and Ping-to-Ping Matching algorithms are effective. However, additional testing is recommended to confirm effectiveness in other underwater environments and aboard submarines with different hardware variants.
- Testing was not adequate to make a determination of the APB-07 system's ASW effectiveness. Given the data available and the limitations of the test, DOT&E concluded that no evidence existed to change the conclusions from its previous reports on A-RCI. Specifically, A-RCI passive sonar capability is effective against older classes of submarines in most environments, but is not effective in some environments against modern threats.
- The A-RCI APB-07 system demonstrated significantly different reliability and availability performance between the two hardware variants on which it was hosted. The TI-06 APB-07 system was not operationally suitable, but the TI-08 APB-07 system was operationally suitable.
- The A-RCI bi-annual upgrades to software and hardware results in the requirements documents and TEMPs being developed and approved 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.

## Recommendations

- Status of Previous Recommendations. The Navy has made progress in addressing most of the recommendations contained in the October 2009 BLRIP report. The remaining recommendations are:
  1. Evaluate the covertness of the high-frequency sonar during a future submarine-on-submarine test.
  2. Investigate the software reliability problems and institute measures to improve system software and recording devices' reliability.
  3. Evaluate the ability of A-RCI to detect and classify a snorkeling diesel submarine operating in littoral waters containing several diesel-powered vessels.
  4. Consider investing in improvements to the Onboard Trainer to improve trainer reliability and target realism.
  5. Develop operationally relevant metrics to evaluate A-RCI performance to allow for comparison testing between APBs and an assessment of the system's planned improvements, as well as overall performance.
- FY11 Recommendations.
  1. The Navy should consolidate the A-RCI and AN/BYG-1 TEMPs into an Undersea Enterprise Capstone document.
  2. DOT&E's BLRIP report on the LCCA contained five classified recommendations.
  3. DOT&E's FOT&E report on A-RCI APB-07 contained 17 recommendations. The most significant unclassified recommendations are:
    - Improve the detection and localization performance for submarines operating in high density surface ship environments. Consider investing in automation that

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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.

- Improve operator training such that operators understand and effectively employ new APB functionality when fielded. Many of the newly introduced features in APB-07 that were designed to improve mission performance were not used consistently during the test.
- Investigate the software reliability problems observed during testing and determine whether the TI-06 hardware or the hosting of the A-RCI APB-07 on TI-06 is the primary cause of the failures that occurred.
- Implement a reliability growth program for A-RCI APB development and conduct sufficient testing to ensure that reliable systems are fielded to the submarine fleet.

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