

## Mk 48 Advanced Capability (ADCAP) Torpedo Modifications

### Executive Summary

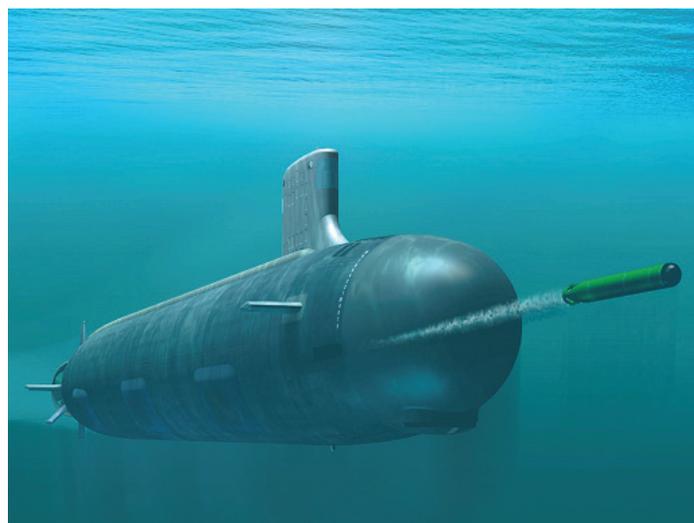
- In FY12, the Navy continued operational testing of the Advanced Processor Build (APB) Spiral 4 operational software for the Mk 48 Advanced Capability (ADCAP) Modification (Mod) 7 Common Broadband Advanced Sonar System (CBASS) torpedo and Mk 48 ADCAP Mod 6 Advanced Common Torpedo (ACOT). OT&E, which began in FY11, is expected to continue into early FY13.
- Since the commencement of operational testing in FY11, the Navy has fired approximately 330 torpedoes equipped with Spiral 4 tactical software for training and testing at both surface and submerged targets in a variety of different environmental and tactical scenarios. These scenarios have included targets deploying multiple static countermeasures, targets deploying the mobile countermeasure, and targets designed to emulate the threat identified in the Navy's Urgent Operational Needs Statement (UONS) of March 19, 2010.
- Because the Navy did not complete developmental testing before early fielding and before commencing operational testing of the Mk 48 Spiral 4 torpedo, operational testers, the Navy's laboratories, and fleet users identified several performance deficiencies during operational testing. The Navy interrupted the operational testing and issued new Mk 48 Spiral 4 torpedo operational software with the intention of fixing identified deficiencies.

### System

- The Mk 48 ADCAP torpedo is the only Anti-Submarine Warfare and Anti-Surface Ship Warfare weapon used by U.S. submarines. Mk 48 ADCAP torpedo modifications are a series of hardware and software upgrades to the weapon.
- Mk 48 Mod 6, Mod 6 Spiral 1, Mod 6 ACOT – Guidance and Control Box, and Mod 7 CBASS Phase I are fielded torpedoes.
- Mk 48 Mod 7 CBASS upgrades the Mk 48 ACOT with a new sonar designed to improve torpedo effectiveness through future software upgrades. Phase 1 torpedoes deliver the initial hardware and software; Phase 2 torpedoes are required to deliver full capability.

### Activity

- In FY12, the Navy continued operational testing of the APB Spiral 4 operational software for the Mk 48 ADCAP Mod 7 (CBASS) torpedo and Mk 48 ADCAP Mod 6 (ACOT). OT&E, which began in FY11, is expected to continue into early FY13.
- Since the commencement of operational testing in FY11, the Navy has fired approximately 330 torpedoes equipped



- The software developed for CBASS Phase 2 is designated APB Spiral 4. The Navy subsequently determined that Spiral 4 software can run on ACOT weapons as well. As a result, the Navy is testing Spiral 4 on both CBASS and ACOT weapons. The Navy has authorized the limited fielding of Mk 48 Spiral 4 torpedoes.
- CBASS is a co-development program with the Royal Australian Navy.

### Mission

The Submarine Force employs the Mk 48 ADCAP torpedo as a long-range, heavy-weight weapon:

- For destroying surface ships or submarines
- In both deep-water open ocean and shallow-water littoral environments

### Major Contractor

Lockheed Martin Sippican Inc. – Marion, Massachusetts

with Spiral 4 tactical software for training and testing at both surface and submerged targets in a variety of different environmental and tactical scenarios. These scenarios have included targets deploying multiple static countermeasures, targets deploying the mobile countermeasure, and targets designed to emulate the threat identified in the Navy's UONS of March 19, 2010.

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- Relevant prior activity includes:
    - The Navy's Commander, Operational Test and Evaluation Force (COTF) observed and analyzed the results of the in-water Mk 48 Spiral 4 exercises and developmental testing from January to February 2011. COTF also conducted modeling and simulation assessments using the Weapons Analysis Facility (WAF) located at the Naval Undersea Warfare Center, Newport, Rhode Island, to examine Mk 48 Spiral 4 performance in baseline warfare scenarios.
    - The Navy released the Mk 48 Spiral 4 torpedo for limited operational use in March 2011.
    - DOT&E delivered an Early Fielding report to Congressional defense committees in March 2011.
    - The Navy has shifted to a Technical Insertion (TI) and APB model for torpedo development. The Navy intends the hardware modernizations (TIs) to address component obsolescence and to enable future capability. The Navy intends the new operational software (APBs) to use the new TI hardware and to improve the torpedo's capability.
  - The Navy updated the Joint Test and Evaluation Master Plan to cover the Spiral 4 with Mk 48 ADCAP CBASS and Mk 48 ADCAP ACOT, and to address the UONS threat. DOT&E approved the updated Test and Evaluation Master Plan on January 13, 2012.
  - The Navy completed development of a Submarine-Launched Countermeasure Emulator (SLACE) to support Mk 48 Spiral 4 testing. The SLACE emulator enables the Navy to conduct more realistic torpedo operational testing against threat submarine surrogates that can employ mobile countermeasures. The Navy also developed a Steel Diesel Electric Submarine surrogate to evaluate torpedo performance against submarine threats in limited operational scenarios.
  - DOT&E approved the OT&E initial test plan for Mk 48 Spiral 4 on July 14, 2011, to support the initial operational test events. Because the Navy was unable to identify future test locations and test resources, and provide the execution details of the operational scenarios, DOT&E required the Navy to update the test plan once the follow-on testing was planned and before conducting the remainder of the operational testing. DOT&E approved updated test plans on June 15, 2012, and August 24, 2012. DOT&E also required the Navy to submit a final update to the test plan once the details of the remainder of the Mk 48 Spiral 4 testing were known.
  - The Navy conducted the first phase of Spiral 4 operational testing in conjunction with FOT&E on the *Virginia* class submarine in March 2011 off Maui and at the Pacific Missile Range Facility off Kauai, Hawaii. Submarines fired 17 Spiral 4 weapons with software versions 3x.4.3 and 3x.4.4.
  - In June 2011, the Navy conducted 10 firings, with Spiral 4 software version 3x.4.4, off southern California.
  - In September 2011, the Navy conducted 10 additional Mk 48 Spiral 4 torpedo developmental test events using the Steel Diesel Electric Submarine target surrogate at a shallow-water site off the Virginia coast. The purpose was to gain additional torpedo performance information against the UONS threat.
  - In December 2011, the Navy issued Mk 48 Spiral 4 torpedo software version 3x.4.6 to correct problems identified in the completed testing and by fleet operators. In order to avoid the costly repetition of all completed operational testing, the Navy's testers evaluated the effects of these changes on the torpedo's performance. Test events where performance would likely be affected by the new software change were invalidated from the operational test database and retesting was incorporated into future test periods.
  - The Navy conducted 13 firings with the new Spiral 4 software, version 3x.4.6, in June 2012 in the Narragansett Bay Operating Area. This test was held in conjunction with a Tactical Development Exercise that featured another 12 torpedo firings.
  - In September 2012, the Navy conducted 11 Spiral 4 shots with software version 3x.4.6 at two sites off Maui, Hawaii. An Australian *Collins* class diesel submarine served as the target and four of the runs featured the SLACE mobile countermeasure emulator.
  - During FY12, the Navy employed Spiral 4 weapons during four Submarine Command Course exercises at the Atlantic Undersea Test and Evaluation Center and the Pacific Missile Range Facility. To conserve test resources, DOT&E agreed to utilize these torpedo events as regression testing to evaluate the performance of the Mk 48 Spiral 4 in some deep-water scenarios.
  - In October 2012, the Navy conducted an additional three Spiral 4 shots with software version 3x.4.6 off Cape Cod, Massachusetts.
  - The Navy accredited the WAF, located at the Navy Undersea Warfare Center, in August 2012 to compare the performance of the two hardware versions of the Mk 48 torpedo that use the Spiral 4 software.
  - The Navy conducted two Mk 48 Sink Exercise (SINKEX) events in FY12, using war-shot torpedoes. Both SINKEXs were executed by allied submarine forces. A Canadian submarine fired an Mk 48 Mod 4M (Mk 48 version sold to allies), while an Australian submarine fired a Mk 48 Mod 7. These test events confirmed the warhead performance of in-service and stored Mk 48 torpedoes.
- ### Assessment
- The Navy's Quick Reaction Assessment and WAF testing of the Mk 48 Spiral 4 torpedo enabled a limited assessment of its performance. DOT&E's report on the early fielding assessed that testing indicated the Mk 48 Spiral 4 has a limited capability, under certain operational conditions, against the threat identified in the UONS; however, the Navy did not have adequate threat surrogates for the evaluation. DOT&E's assessment also reported that the Spiral 4 torpedo did not demonstrate expected improvements over the legacy torpedo, and may degrade current capability in certain warfare scenarios.
  - Additional information on Mk 48 Spiral 4 performance can be found in DOT&E's classified Mk 48 ACOT and CBASS Spiral 4 Early Fielding Report dated March 18, 2011.

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- During operational testing, the Navy's testers and laboratories discovered several torpedo deficiencies not identified during developmental testing that resulted in the Navy developing software corrections intended to fix the identified deficiencies. The Navy used the WAF for assessing the software changes, issued a new software version, and continued with the operational testing. As the WAF consistently overestimates performance and was not accredited for evaluating torpedo effectiveness or for operational testing of the Mk 48 Spiral 4, DOT&E assesses this development approach as high risk for adequately predicting satisfactory torpedo in-water performance.
- The Navy and DOT&E are assessing the completed Mk 48 Spiral 4 test events for operational realism and validity incrementally as the fleet training and test events are completed. Most fleet training events have been too structured or lacked the necessary post firing operational conditions to meet required torpedo test conditions. Navy testers are working with fleet trainers to improve the post torpedo firing operational realism.
- Due to delays in completing the development of the SLACE mobile countermeasure surrogate and the Navy's focus on the UONS threat, the Navy did not conduct adequate developmental testing against SLACE-like countermeasures. DOT&E assessed that Mk 48 Spiral 4 performance against SLACE-like threats is high risk because the Program Office completed little in-water developmental testing. Assessment of the Mk 48 Spiral 4 operational testing with SLACE, conducted in September 2012, is in progress.
- Due to the shortage of available test submarine shooters and targets, the Navy continues to have difficulty scheduling and planning adequate torpedo operational test events. Thus, Navy testers have been unable to provide the execution details for completing operationally realistic events for all required Mk 48 Spiral 4 test events. As a result, DOT&E has required

the Navy to submit updates to the test plan once the event details are known and approved the testing event by event.

- Initial regression and operational testing results indicate Mk 48 performance in deep-water and shallow-water areas has not substantially changed; however, insufficient testing has been completed to allow a statistically significant assessment.

## Recommendations

- Status of Previous Recommendations. The Navy has addressed six of the nine previous Annual Report recommendations. The three outstanding recommendations are as follows:
  1. While some improvements have been made by conducting regression testing in conjunction with scheduled fleet training events and by using WAF simulations, the Navy should continue to address reducing in-water test delays and improve the WAF simulations.
  2. As the Navy continues to conduct only limited torpedo training and testing in shallow waters, they should develop shallow-water test and training areas and modernize the exercise torpedo locating and recovery systems.
  3. The Navy should complete development of threat representative target and countermeasure surrogates for torpedo testing. In addition to representing the physical and signature characteristics of the threat, the surrogate should be capable of emulating appropriate operational profiles of the threat.
- FY12 Recommendations. The Navy should:
  1. Plan and conduct adequate developmental testing before starting operational testing.
  2. Continue conducting the Mk 48 Spiral 4 torpedo testing in FY13. Testing should include the evaluation of torpedo performance against submarine surrogates for the small diesel-electric threat.

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