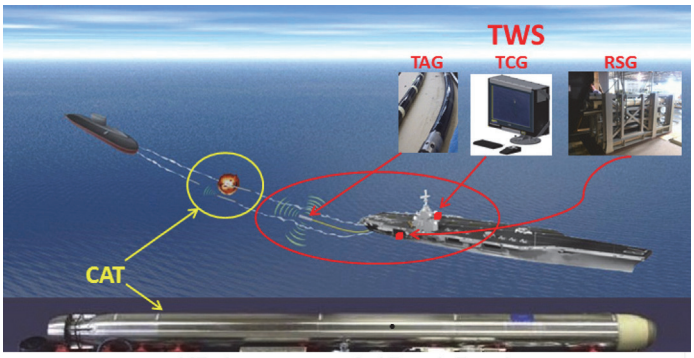
Surface Ship Torpedo Defense (SSTD) System: Torpedo Warning System and Countermeasure Anti-torpedo Torpedo

Executive Summary

- The Navy installed a prototype Torpedo Warning System (TWS) and early engineering development model of the Countermeasure Anti-torpedo Torpedo (CAT) aboard USS *George H. W. Bush* (CVN-77) in March 2013. It demonstrated some capability to detect certain types of threat torpedoes. However, the system has not been fully tested and most TWS and CAT testing to date have been conducted in areas with benign acoustic conditions when compared to the expected threat operating areas.
- The Navy's decision to add an acoustic operator to monitor TWS displays and supplement the automated detection and alerting functions of TWS improved threat detection performance during the November 2013 Quick Reaction Assessment (QRA). However, the test area did not offer the same number of opportunities for false alerts as expected in the threat area, it is not known if the presence of the operator could also reduce the false alert rate.
- When properly targeted, the CAT demonstrated a capability to detect and home on some threat surrogates. However, because of safety requirements, the surrogate threat torpedoes and CATs used were operated at depths that were deeper than most threat torpedoes are expected to operate. The Navy's CAT developmental testing before the QRA focused on predicting the performance in scenarios planned for the QRA. Shallower torpedo scenarios that would force the CAT to track and attack the surrogate threat torpedoes in challenging areas of the water column were not investigated. Therefore, CAT's ability to neutralize these threats cannot be fully assessed.
- The Navy intends to field the prototype TWS and early engineering development model of the CAT in FY14. Additional information on the TWS and CAT performance will be provided in DOT&E's classified Early Fielding Report in 2QFY14.

System

- The Surface Ship Torpedo Defense (SSTD) is a system-of-systems that includes two new sub-programs: the TWS program (an Acquisition Category III program) and CAT (not an acquisition program until FY16).
- TWS is being built as an early warning system to alert on and localize incoming threat torpedoes and consists of three major subsystems:
  - The Target Acquisition Group consists of a towed acoustic array, tow cable, winch, power supply, and signal processing equipment. Data from the array and the ship's radar system are processed into contact tracks and alerts to be forwarded to the Tactical Control Group. The array will eventually be capable of both passive and active sonar operations.
  - The Tactical Control Group consists of duplicate consoles on the bridge and Combat Direction Center (on CVNs) that displays contacts, issues torpedo alerts to the crew, and automatically develops CAT placement presets using information sent from the Target Acquisition Group. The operator will use this console to manage the threat engagement sequence and command CAT launches.
  - The Ready Stow Group will consist of the steel cradles housing the CATs.
- CAT is a hard-kill countermeasure intended to neutralize threat torpedoes and consists of the following:
  - The Anti-torpedo Torpedo (ATT) is a 6.75-inch diameter interceptor designed for high-speed and maneuverability to support rapid engagement of the threat torpedo.
  - The All-Up Round Equipment consists of a nose sabot, ram plate, launch tube, muzzle cover, and breech mechanism to encapsulate and launch the ATT.



CAT - Countermeasure Anti-Torpedo Torpedo
RSG - Ready Stow Group
TAG - Target Acquisition Group
TCG - Tactical Control Group
TWS - Torpedo Warning System

Mission

Commanders of nuclear-powered aircraft carriers and Combat Logistic Force ships will use SSTD to defend against incoming threat torpedoes.

Major Contractors

TWS
- 3Phoenix – Wake Forest, North Carolina
- In-Depth Engineering – Fairfax, Virginia
- Pacific Engineering Inc. (PEI) – Lincoln, Nebraska

CAT
- Pennsylvania State University Applied Research Laboratory – State College, Pennsylvania
- Pacific Engineering Inc. (PEI) – Lincoln, Nebraska

Activity
- The Navy has been working on a hard-kill torpedo defensive system for surface ships for over 10 years, but accelerated the development of TWS and CAT as a result of the March 2010 sinking of the South Korean ship, ROKS Cheonan, and a Navy Fifth Fleet Urgent Operational Needs Statement. The Navy also decided to have the systems protect high-value ships (aircraft carriers and combat logistic ships) rather than destroyers as originally planned.
- The Navy conducted early ATT (a previous version of the CAT) warhead testing against select representative torpedo threats in 2002 and 2008. These tests were conducted to gain early insights into the lethality of the ATT and to begin development of a lethality prediction model.
- In March 2013, the Navy installed a prototype TWS aboard USS *George H. W. Bush* (CVN-77). The Navy conducted the following five sea tests of this TWS configuration:
  - Approximately 24 hours of TWS operations in the Virginia Capes Fleet Operating Areas (VCOAs) during March 2013. During this test, the Navy completed the TWS installation checkouts including functional system operation of the Target Acquisition Group and TWS array deployment.
  - Approximately 25 hours of TWS operations in the VCOAs during April 2013. During this test, the Navy further exercised the system deployment and collected additional data with the TWS towed array deployed.
  - Approximately 20 hours of TWS operations with the array deployed and 10 surrogate threat torpedo alertment opportunities in the VCOAs in May 2013. During the test, a barge fired exercise torpedoes at the ship for the TWS to detect and alert the crew. The crew then responded to these alerts by firing CATs to intercept the surrogate threat torpedo. This was the initial integrated test of the TWS and CAT system.
  - Approximately 58 hours of TWS operations in the VCOAs during August 2013. During this test, the Navy further exercised system employment and collected additional data with the TWS towed array deployed.
  - Approximately 15 hours of TWS operation with the TWS array deployed and 6 surrogate threat torpedo alertment opportunities in the VCOAs in November 2013. The Navy Program Office enhanced the system for this test (as it will be for the USS *George H. W. Bush's* deployment) by adding civilian acoustics specialists to operate TWS and alert the crew of potential threat torpedoes. The Navy conducted this test event as a QRA to support a rapid fielding assessment of the TWS and CAT system's ability to defend against threat torpedoes.
- The Navy, with the Pennsylvania State University Applied Research Laboratory – State College, Pennsylvania, developed and built CAT engineering development models (designated EDM-2). CAT EDM-2s are planned to be fielded on USS *George H. W. Bush*. During late FY12 and FY13, the Navy and Pennsylvania State University Applied Research Laboratory conducted contractor and developmental testing of CAT in three configurations at Dabob Bay, Washington, and Nanoose Bay, British Columbia, Canada, acoustic tracking ranges. CAT EDM-2 contractor and developmental testing included:
  - Twenty-six structured events to develop, analyze, and verify CAT EDM-2 electronics, sonar, and processor (front end) functionality. Ten of the events used the front end of the CAT attached to and propelled by a modified heavyweight torpedo propulsion section. Sixteen events used the front end of the CAT propelled by a rechargeable electric propulsion system. The electric propulsion CAT variant was built as a reusable test asset because of the cost and difficulty in reusing the Stored Chemical Energy Propulsion System (SCEPS) used on the tactical CAT. Aside from the propulsion system, which determines the vehicles' speed and endurance, the CAT variants are identical.
  - Six structured CAT EDM-2 events using production representative SCEPS propulsion sections to evaluate performance, maneuverability, and noise characteristics of the tactical CAT.
  - Twenty-seven structured events to develop the CAT EDM-2's ability to detect, track, and intercept surrogate threat torpedoes. Six of these events used CAT EDM-2 front ends propelled by heavyweight torpedo back ends; 16 events used electrically-propelled CAT front ends; and 5 events used CAT EDM-2s with the SCEPS propulsion.
- In May 2013, the Navy conducted the first integrated TWS and CAT test in the VCOAs aboard the USS G*eorge H. W. Bush*. The Navy completed seven structured events. During each event, a barge fired a surrogate threat torpedo at the USS *George H. W. Bush* to allow the TWS system to detect and target the CAT. The USS *George H. W. Bush's* crew, with contractor support, engaged the surrogate threat torpedo with an electrically-propelled CAT.
- In November 2013, the Navy conducted a QRA aboard the USS G*eorge H. W. Bush* in the VCOAs. During

each event, a surrogate threat torpedo was fired at the USS *George H. W. Bush* for the TWS system to detect and target. The USS *George H. W. Bush's* crew, with contractor support that will accompany the ship on their deployment, engaged the threat torpedo surrogate with a CAT. During the QRA, two representative tactical CATs with SCEPS propulsion were fired; the remaining three CATs used electric propulsion. Analysis of TWS and CAT data is in progress. DOT&E will issue a classified Early Fielding Report on the TWS and CAT in 2QFY14.

- The Navy plans to field the TWS system and the CAT EDM-2 with the SCEPS propulsion system when the USS *George H. W. Bush* deploys in 2014.
- The Navy and DOT&E are developing a Test and Evaluation Master Plan (TEMP) for the TWS system. The Navy has not started the CAT system TEMP.

Assessment

- The prototype TWS and early engineering developmental model CAT installed on USS *George H. W. Bush* demonstrated some capability to detect certain types of threats. However, the system has not been fully tested and most TWS and CAT testing to date has been conducted in areas with benign acoustic conditions when compared to the expected threat operating areas.
- The Navy's decision to add a highly-trained acoustic operator, to supplement the automated detection and alerting functions of TWS, improved threat detection performance during the QRA. However, the test area did not offer the same number of opportunities for false alerts as expected in the threat area; thus, it is not known if the presence of the operator could also reduce the false alert rate. For safety reasons, the QRA testing was highly structured and allowed the operators to focus on torpedo detections and firing the CAT. Therefore, QRA testing was inadequate to resolve the rate of false alerts or their impact on mission accomplishment.
- During developmental testing and the QRA, a properly targeted CAT EDM-2 demonstrated a capability to detect and home on some surrogates torpedoes. However, all of the surrogate threat torpedoes and CATs were operating deeper than most expected threat torpedoes. During the testing from the USS *George H. W. Bush*, both the threat surrogate and the CAT were required to operate deeper than either system normally would for safety reasons. Shallower scenarios that would force the CAT to track and attack the surrogate threat torpedo in the challenging areas of the water column were not investigated during the CAT's contractor or developmental testing. Therefore, these tests cannot be used to assess CAT's overall ability to neutralize these threats.
- The Navy intends to field the prototype TWS and early engineering development model of the CAT in FY14. Additional information on the testing of TWS and CAT performance will be included in DOT&E's classified Early Fielding Report in 2QFY14.
- The ATT warhead tests indicate that the ATT should be lethal against select representative torpedo threats provided that both the CAT's closest point of approach to the threat torpedo and the CAT's fuzing occurs within the explosive kill zone. Further test and analysis is required to determine the comprehensive lethal capability of the ATT.

Recommendations

- Status of Previous Recommendations. This is the first annual report for the TWS and CAT system.
- FY13 Recommendations. The Navy should:
  1. Develop TEMPs for both the TWS and CAT system and an LFT&E strategy for the ATT lethality as soon as possible.
  2. Conduct additional testing in challenging, threat representative environments.
  3. Conduct additional CAT testing using operationally realistic threat target profiles closer to the surface to assess the CAT's terminal homing, attack, and fuzing within the lethality range of the warhead.
  4. Retest TWS performance once the sensor is upgraded with an active component, the threat torpedo alertment algorithms are updated, and when a member of the ship's crew replaces the contractor acoustic specialist.