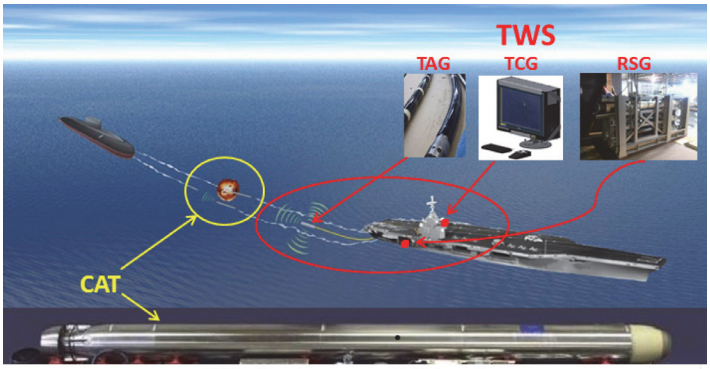
Surface Ship Torpedo Defense (SSTD) System: Torpedo Warning System (TWS) and Countermeasure Anti-Torpedo (CAT)

Executive Summary

- During FY17, USS *Dwight D. Eisenhower* and USS *George H. W. Bush* completed deployments and USS *Nimitz* started a deployment with the Torpedo Warning System (TWS) and Countermeasure Anti-Torpedo (CAT) system. Like previous carrier deployments, the Towed Active Acoustic Source (TAAS) engineering developmental model was not reliable and the *Dwight D. Eisenhower*, *George H. W. Bush*, and *Nimitz* deployed with a passive-only TWS array. Prime contractor personnel deployed aboard the carriers to operate and maintain the TWS system, train Navy operators, and collect system data.
- In 4QFY16, the Navy reduced the FY18 and beyond funding for TWS and CAT, resulting in the suspension of contractor development and government developmental test and evaluation after FY17. The Navy funded the program to sustain the existing permanent TWS and CAT installations.
- In October 2017, the Navy's Operational Test and Evaluation Force (OPTEVFOR) conducted a third Quick Reaction Assessment (QRA) in conjunction with contractor testing. The combined QRA and contractor tests demonstrated the ability of TWS, under optimal conditions and when manned by qualified sailors and contractors, to successfully alert on an inbound threat torpedo and the CAT system's ability to successfully engage a torpedo. The testing also demonstrated that the Navy has made significant improvements to the reliability of the TAAS.

System

- Surface Ship Torpedo Defense (SSTD) is a system of systems that includes two new sub-programs: the TWS (an Acquisition Category III program) and CAT (plans to become an acquisition program in FY17 were delayed). Combined, TWS and CAT are referred to as the Anti-Torpedo Torpedo Defensive System (ATTDS).
- TWS is being built as an early warning system to detect, localize, classify, and alert on 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 Navy intends for the array to 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 uses these displays to manage the threat engagement sequence and command CAT launches.
  - The Ready Stow Group will consist of the steel cradles housing the CATs. The permanent system consists of four steel cradles and associated electronics, each housing six anti-torpedo torpedoes (ATTs) at different locations (port/starboard and forward/aft on CVNs).
- CAT is a hard-kill countermeasure intended to neutralize threat torpedoes and consists of the following:
  - The ATT is a 6.75-inch diameter interceptor designed for high-speed and maneuverability to support rapid engagement of a threat torpedo.
  - The All-Up Round Equipment consists of a nose sabot, ram plate, launch tube, muzzle cover, breech mechanism, and energetics to encapsulate and launch the ATT.
  - A Stored Energy Propulsion System powers the tactical CAT. A battery-powered electric motor CAT exists for test purposes only. Engineering Development Model-2 is the current hardware version of the CAT.
- The Navy developed a temporary version of TWS and CAT (designated a roll-on/roll-off system) in addition to the permanent-installation version. The Navy intends for the roll-on/roll-off version to provide the same functionality as the permanent one.
  - The Navy replaced the Ready Stow Group steel cradles with two lighter-weight and aluminum Launch Frame Assemblies that each hold four CATs.



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

- The processing required for the Target Acquisition Group and the Tactical Control Group resides in two cabinets contained in a container express box located on the CVN hangar deck.
- The towed acoustic array, tow cable, and winch are permanently installed on the carrier's fantail. The other components of the system, including the operator displays and fire enable switch, reside in the container express box located on the hangar deck.

Mission

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

Major Contractors

TWS

- Ultra Electronics-3Phoenix (Prime Contractor) – Chantilly, Virginia, and Wake Forest, North Carolina
- Alion Science and Technology (Acoustics and testing consultant) – New London, Connecticut
- In-Depth Engineering (Tactical Control Group software development) – Fairfax, Virginia
- Pacific Engineering Inc. (Ready Stow Group manufacture) – Lincoln, Nebraska
- Rolls-Royce (Winch manufacture) – Ontario, Canada
- Teledyne (Towed Array manufacture and assembly) – Houston, Texas

CAT

- Pennsylvania State University Applied Research Laboratory (ATT Systems) – State College, Pennsylvania
- Pacific Engineering Inc. (Canister fabrication) – Lincoln, Nebraska
- SeaCorp (All Up Round Equipment fabrication and assembly) – Middletown, Rhode Island

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Activity

- In 4QFY16, the Navy reduced the FY18 and beyond funding for the TWS and CAT systems, resulting in the suspension of contractor development and government developmental test and evaluation after FY17. The Navy funded the program to sustain the existing permanent TWS and CAT installations.
- During FY17, USS *Dwight D. Eisenhower* and USS *George H. W. Bush* completed deployments, and USS *Nimitz* started a deployment with the TWS and CAT systems. The *Dwight D. Eisenhower* deployed with the temporary roll-on/roll-off version while the *George H. W. Bush* and *Nimitz* deployed with the permanent version of the systems. Like previous carrier deployments, the TAAS engineering developmental model was not reliable and the *Dwight D. Eisenhower*, *George H. W. Bush*, and *Nimitz* deployed with a passive-only TWS array prototype. Contractor personnel deployed aboard the carriers to operate and maintain the TWS system, train Navy operators, and to collect system data. The Navy Program Office intends the *Dwight D. Eisenhower* to be the last carrier to deploy with the temporary installation, and intends to install the permanent version of the TWS and CAT early fielded hardware on selected CVNs before their next deployments.
- In October and December of 2016, TWS contractors conducted dynamic tow (October) and static (December) testing on the TAAS. The Naval Surface Warfare Center, Carderock Division, Acoustic Research Detachment performed the test at Lake Pend Oreille in Bayview, Idaho.
  - The purpose of the testing was to verify reliability improvements to the TAAS, characterize its operational parameters, and collect data to support ongoing development of the active torpedo detection, classification, and localization processing systems.
  - The dynamic testing included over 11,000 active TAAS pings during 29.5 hours of full array (TAAS mated to the TWS passive array) towing. Two TAAS array amplifiers failed during the tow test; one due to a manufacturing defect, while the other was likely due to an over-current transient on the array.
  - The static testing included over 18,000 active TAAS pings with tactical waveforms during 18 hours of testing with no component failures.
- In May 2017, the Navy conducted static TAAS array tank testing at the Naval Undersea Warfare Center in Keyport, Washington, to characterize TAAS array currents at various array frequencies and waveforms and to observe the onset of array cavitation at representative water temperatures and pressures. These tests collected data to determine the optimum frequency, waveform, and power levels for search during tactical operations and to improve array reliability. The testing included approximately 7,600 active TAAS pings without any component failures.
- In May 2017, the Navy stopped development of its Integrated Evaluation Framework (IEF), which the Navy uses to support Test and Evaluation Master Plan (TEMP) and test plan development. The Navy has been working on versions of its IEF and TEMP since accomplishing a conditional TWS Milestone B decision in 2011, and had intended to make the CAT system an acquisition program in FY17.
- In October 2017, OPTEVFOR conducted a third QRA in conjunction with contractor testing performed by the Naval Undersea Warfare Center Division in Keyport, Washington, the Pennsylvania State University Applied Research Laboratory, and the major system contractors. The Navy installed the TWS and CAT systems onboard the USNS *Benavidez*

(T-AKR 306); the QRA occurred at the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) near Nanoose Bay, British Columbia. The purpose of the testing was to demonstrate the TWS's torpedo alert and CAT salvo prosecution capabilities, and demonstrate the performance of the TAAS against quieter and slower torpedoes. Due to reliability problems with test target surrogates, test equipment, and CAT hardware, the Navy was not able to execute the test scenarios per the contractor test plans or the DOT&E-approved test plans. For the QRA, the Navy completed two salvo events and one non-salvo event. The contractor testing completed five TWS detection events, which included one salvo event.

- Previous QRAs in 2014 and 2015 demonstrated initial TWS and CAT system capabilities and identified significant areas of risk for early fielding aboard aircraft carriers. DOT&E will issue an update to the 2015 Early Fielding Report when analysis of the October 2017 testing is complete,

Assessment

- The contractor tests showed that the TAAS meets the technical performance specifications set forth in the Navy's System Requirements Document. Although TAAS in water and pinging test time is too limited to predict its reliability for deployment, completed testing shows that the developers made significant progress in correcting over-current conditions, which had caused amplifier component failures, and in improving TAAS reliability.
- The October 2017 combined QRA and contractor tests demonstrated the ability of the TWS and its operator to successfully alert on an inbound threat torpedo under optimal but operationally relevant conditions, and the CAT system's ability to engage a threat torpedo. The contractor test events also demonstrated the ability of the TAAS to detect moderately quiet and slower torpedoes.
  - Due to reliability problems with test target surrogates, test equipment, and CAT hardware, and the limited scope and number of CAT test events, it is unknown if the CAT systems can defend against a salvo of threat torpedoes. Detailed results and analysis for each event will be provided in DOT&E's Early Fielding Report.
  - As with the previous QRAs and contractor testing, these events were highly structured due to torpedo peacetime firing policy safety restrictions and acoustic range operating procedures, and were not conducted using operationally realistic threat torpedoes and ATT depth profiles. Furthermore, the small number of test runs allowed for demonstrations of capability and problem identification, but was not sufficient to characterize the performance of these systems in other likely operationally realistic scenarios.
  - The TWS system did not generate false target alerts during these test events. However, CFMETR and its surrounding waters were largely clear of non-participating ship traffic. Therefore, it was difficult to assess the number of false alerts the system would have generated in an operationally relevant, noisy environment, such as a congested shipping lane. Likewise, limited data are available to assess the operator's ability to manually generate alerts or to reject false alerts.
  - Safety considerations, implemented to prevent a collision between the threat torpedo surrogates, the ATTs, and the deep draft tow ship prevented assessment of TWS alertment capabilities for threats operating at representative depths and limited the assessment of the ATTs' ability to complete the target intercept. Testing and data collection near the surface is necessary to develop torpedo defense capability. The Navy could accomplish this testing safely by using a shallow draft tow ship. Likewise, ATT to target intercept data near the surface could be safely collected, but would risk the ATTs colliding with the surrogate targets.
  - The Navy has not accredited the surrogate torpedo targets used for testing as representative of any real-world threat torpedo. The surrogate targets are older U.S. torpedoes and training targets that were designed to operate at deeper depths than many threat anti-surface torpedoes. Acoustic measurements have not been completed at representative threat torpedo operating depths; therefore, the acoustic noise strength of the surrogates operating at anti-surface torpedo depths is unknown and could be noisier or quieter than threats. Given the large variation of threat torpedo noise and speed signatures, measuring the surrogate's acoustic signature would enable developers and testers to characterize the performance of the TWS and TAAS against quiet or noisy and slower or faster torpedo threats. This signature data are needed for both TWS and TAAS development and operational testing.
  - The Navy's decision to add a highly trained contractor and an acoustic operator to supplement the automated detection and alerting functions of TWS improved threat detection performance during all completed test events. The majority of the TWS's detection and alerting capability and timely operator initiation of the ATT engagement was improved as a result of contractor acoustic operators monitoring the TWS displays to provide early alerts on threat torpedoes. However, the test areas did not offer the same number of opportunities for false alerts as expected in the threat area; therefore, it is not known if the presence of the operator could also reduce the false alarm rate.
  - During the QRA and contractor tests, there were no hardware or software failures in the TWS system. This included over 45 hours of TAAS operations, and five array deployments and retrievals. Some of the CATs and CAT launchers experienced prelaunch failures. Details will be provided in DOT&E's Early Fielding Report.
  - The test showed that the Navy's TWS and CAT contractors are making progress towards developing capabilities to meet the systems' operational requirements.
- The Program Office's focus on preparing to deploy and maintain systems on carriers and limited budget has hampered their development of more extensive system detection, tracking, and alerting software; operator tactics, techniques,

and procedures; and assessments of system availability and reliability. The Navy's Program Office and contractors hoped to obtain data from CVN deployments to support TWS development, assessing and mitigating false alerts, and assessing and improving TWS system reliability, but carrier operations precluded deploying the TWS array for the majority of their underway operations. Therefore, contractors deployed on the carriers collected little real-world operational data.

- Additional information concerning the testing of the fielded TWS and CAT performance is included in DOT&E's April 2014 and March 2015 classified Early Fielding Reports.

Recommendations

- Status of Previous Recommendations. The Navy made significant progress in improving TAAS reliability. However, the Navy has made limited progress on other recommendations. The lack of progress is due to the loss of funding to conduct further TWS and CAT development and the program's focus on maintaining and repairing fielded systems. Significant outstanding recommendations include:
  1. Adequately resource the TWS program to build dedicated test assets and conduct adequate dedicated contractor and developmental testing.
  2. Adequately resource the Program Office and its contractors to conduct TWS and CAT system development and testing.
  3. Complete the TEMP for the TWS and CAT system and an LFT&E strategy for the ATT lethality as soon as possible.
  4. Conduct testing in challenging, threat representative environments.
  5. Conduct CAT testing using operationally realistic threat target profiles closer to the surface to assess CAT terminal homing, attack, and fuzing within the lethality range of the warhead.
  6. Investigate test methods designed to reduce or eliminate the safety limitations that have previously prevented testing against operationally realistic target scenarios. The Navy should consider using geographic separation, range boundaries, and shallow draft ships for future TWS and CAT testing.
  7. Investigate and implement the outstanding recommendations in the classified March 2015 DOT&E Early Fielding Report.
  8. Measure the signatures of available surrogates at representative threat torpedo depths and speeds. The Navy should also determine the adequacy of available torpedo surrogates to represent threat torpedoes.
- FY17 Recommendations. The Navy should:
  1. Restore resources to complete development and testing of the torpedo defense capability. If the Navy deploys the system, the Program Office should be resourced to complete contractor development and government testing while maintaining deployed systems.
  2. Direct the use of the already deployed systems during transits and operations in order to collect operationally meaningful data for continued system and tactics development.
  3. Investigate and fix the test target surrogate and launcher reliability problems. Failure of target surrogates during testing is a recurring problem.
  4. Investigate and fix the reliability problems with the CATs and CAT launchers.