

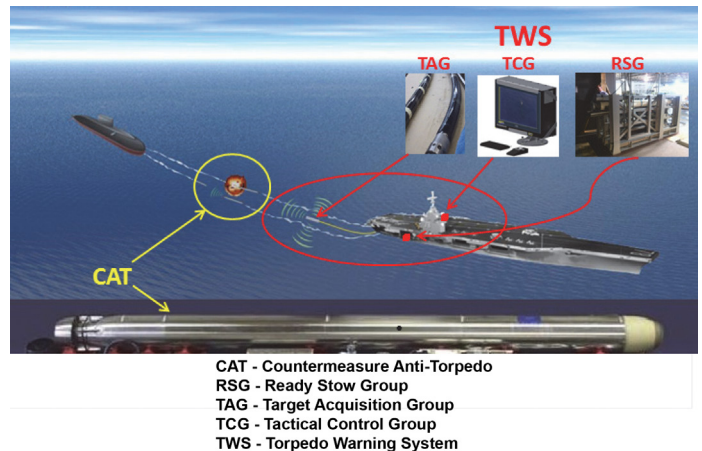
Surface Ship Torpedo Defense (SSTD) System: Torpedo Warning System (TWS) and Countermeasure Anti-Torpedo (CAT)

Executive Summary

- USS *Dwight D. Eisenhower* commenced deployment in 3QFY16 with a temporary roll-on/roll-off version of the Torpedo Warning System (TWS) and Countermeasure Anti-Torpedo (CAT) referred to as the Anti-Torpedo Torpedo (ATT) Defense System (ATTDS). Like previous carrier deployments, the *Dwight D. Eisenhower* deployed with a passive only TWS array.
- USS *Theodore Roosevelt* returned from deployment in 1QFY16 and USS *Harry S. Truman* returned from deployment later in 3QFY16. During these deployments, the crews rarely deployed the TWS arrays; thus, little data were collected to determine the TWS arrays' reliability or to assist the developer with improving its detection, tracking, alerting, and false alert rejection software.
- A combined TWS and CAT contractor test in July 2016 demonstrated the Navy's contractors are making progress toward developing an initial defensive capability to counter a salvo of threat torpedoes and improving the active source reliability. The test demonstrated that the TWS active and passive system, with a highly qualified sensor operator, is capable of detecting, tracking, and alerting on threat torpedoes; that operators can initiate a salvo of CATs to intercept the threat torpedoes; and that a salvo of CATs can intercept a salvo of threat torpedoes.

System

- Surface Ship Torpedo Defense is a system of systems that includes two new sub-programs: the TWS (an Acquisition Category III program) and CAT (will not become an acquisition program until FY17). Combined, TWS and CAT are referred to as the 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 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 ATTs at different locations (port/starboard and fore and aft on the CVN).
- 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 the 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.
 - The tactical CAT is powered by a Stored Energy Propulsion System (SCEPS). The battery-powered electric motor CAT is for test purposes only. Engineering Development Model (EDM)-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 this version to provide the same functionality as the permanent one.
 - The Ready Stow Group steel cradles are replaced by two lighter-weight and less-robust aluminum Launch Frame Assemblies that each hold four CATs.
 - The processing required for the Target Acquisition Group and the Tactical Control Group resides in two cabinets

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contained in a container express box located on the carrier's 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 Surface Ship Torpedo Defense 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. (PEI) – (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. (PEI) – (Canister fabrication) – Lincoln, Nebraska
- SeaCorp – (All Up Round Equipment fabrication and assembly) – Middletown, Rhode Island

Activity

- In August 2015, the Naval Surface Warfare Center, Indian Head Explosives Ordnance Disposal Technology Division, conducted ATT warhead and safety and arming device airburst testing at Fort A.P. Hill, Virginia. This testing verified the arming, fuzing, and firing of the ATT warhead.
- During FY16, the Navy and DOT&E continued development of an enterprise Test and Evaluation Master Plan (TEMP) for the TWS and CAT systems. The Navy made their TWS Milestone B decision without a TEMP; they are not planning to make the CAT system an acquisition program until later in FY17.
- USS *Theodore Roosevelt* returned from deployment in 1QFY16. The *Theodore Roosevelt* deployed with a temporary roll-on/roll-off version of the TWS and CAT. During the deployment, the crew rarely deployed the TWS array.
- In February/March 2016, the Navy and Pennsylvania State University Applied Research Laboratory conducted contractor testing of CAT on the Dabob Bay, Washington, acoustic tracking range. The testing consisted of three highly scripted scenarios to obtain data and evaluate the salvo capability of the CATs. During this test, both the threat torpedo target surrogates and the ATTs were fired from a single test platform (torpedo retriever). The target surrogates ran a scripted geometry and the ATTs ran tactical profiles to intercept the threat surrogates.
- USS *Dwight D. Eisenhower* commenced deployment in 3QFY16 with a temporary roll-on/roll-off version of TWS and CAT that includes the TWS Target Acquisition Group and the Tactical Control Group hardware and two of the four planned CAT Ready Stow Group cradles containing eight CAT EDM-2s powered by SCEPS. Like previous carrier deployments, the Towed Active Acoustic Source (TAAS) was not ready and the *Dwight D. Eisenhower* deployed with a passive-only TWS array. Ultra-Electronics-3Phoenix contractor personnel deployed aboard the *Dwight D. Eisenhower* to operate and maintain the TWS system, train Navy operators, and to collect system data. The Navy Program Office intends *Dwight D. Eisenhower* to be the last carrier to receive the temporary installation and is planning the installation of the permanent version of the TWS and CAT early fielded hardware on selected CVNs before their next deployments.
- USS *Harry S. Truman* returned from deployment later in 3QFY16. The *Harry S. Truman* has a permanent installation of TWS and CAT that includes the TWS Target Acquisition Group and the Tactical Control Group hardware and two of the four planned CAT Ready Stow Group steel cradles. During the deployment, the *Harry S. Truman*'s crew rarely deployed the TWS array.
- In July 2016, the Navy, in conjunction with the TWS and CAT system contractors, conducted contractor testing of both the TWS and CAT on the Nanoose Bay, British Columbia, Canada, acoustic tracking range. The Navy installed a roll-on/roll-off version of the TWS and CAT system aboard the USNS *Brittin*, which served as a deep draft test platform. The TWS array consisted of the passive array (similar to the array deployed on carriers) and the latest version of the active source (TAAS). The testing included structured scenarios requiring a TWS system and operator to detect/alert on threat torpedoes, initiate a CAT salvo engagement, and for the CATs to intercept the threat torpedoes. Test scenarios also assessed TWS alert and false alert rates; TWS and CAT interoperability; TAAS and passive array reliability; and TWS array speed, turn rate, depth, and stability tow profiles. The Navy recorded the TWS and CAT data during all events for later analysis and reprocessing in future versions of the system.

Assessment

- The combined TWS and CAT contractor testing in July 2016 demonstrated the Navy's contractors are making progress toward developing an initial defensive capability to counter a salvo of threat torpedoes.
 - The testing demonstrated the TWS active and passive system, with a highly qualified sensor operator, is capable of detecting, tracking, and alerting on threat torpedoes, that operators can initiate a salvo of CATs to intercept the threat torpedoes, and that a salvo of CATs can intercept a salvo of threat torpedoes.
 - However, to achieve the test objectives, the contractor test scenarios were highly structured, were not conducted with realistic threat torpedo profiles, and were not conducted in conjunction with events that could have provided potential false alerts.
 - Safety considerations, implemented to prevent a collision between the threat torpedo surrogates, the CATs, and the deep draft tow ship, also prevented assessing the TWS detection capability for threats that operate near the surface. The same limitations prevent assessing the CAT's ability to detect, track, and intercept threat torpedoes in this challenging region of the water column.
 - Testing and data collection near the surface is necessary for developing the torpedo defense capability and this testing could be accomplished safely in a controlled manner without a deep draft tow ship.
- The July 2016 contractor testing demonstrated the Navy's TWS array contractors are making progress towards implementing solutions for the passive array twisting problem and with fixing the TAAS reliability failure modes. The July test event completed with no TWS or CAT hardware failures. This included 64 hours of TAAS active operations, 14 array deployments and retrievals, and 11 CAT or Electric-drive CAT (ECAT) launches.
- Completed testing also demonstrated the importance of having a trained TWS operator to initiate manual threat alerts when the automated detects and alerts are not initiated or occur late for assessing if threat alerts are valid or false.
- The testing of TWS (passive) and CAT EDM-2, powered by SCEPS, fielded aboard *George H. W. Bush*, *Theodore Roosevelt*, *Harry S Truman*, and *Dwight D. Eisenhower* has yet to demonstrate an effective capability against realistic threat torpedo attack scenarios.
 - The Navy's testing of the fielded TWS system has shown it is capable of detecting and targeting a threat torpedo and CAT demonstrated the limited capability to detect and home on certain types of torpedo threats. However, this capability assessment is based on limited testing conducted in areas with generally benign acoustic conditions when compared to the expected threat operating areas, which may bias the results high.
 - Very few of the threat surrogates used during testing were operated in operationally realistic threat torpedo profiles due to Navy-imposed safety constraints. Additionally, the acoustic properties of the current surrogate torpedoes are suspected to be louder than most threats in certain operating circumstances.
- The program's focus on preparing systems to deploy on carriers 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 because of their limited budget. Although the Pennsylvania State University Applied Research Laboratory was able to conduct independent structured CAT testing, 3Phoenix's TWS testing is limited because the prototype TWS arrays are rapidly fielded to the deploying CVN, leaving the 3Phoenix contractors without a full system to continue development. The Navy hoped to obtain data from the deployed CVNs to support TWS development, but their operations did not permit that. The July 2016 testing, which utilized portions of the systems removed from carriers following their deployments, provided a significant amount of recorded data (subject to the limitations discussed above) to support continued contractor development of the TWS and CAT systems.
- The Navy delayed the Initial Operational Capability of the TWS and CAT from 2018 to 2022. Because the Navy required the Program Office to deliver an early capability for the early fielded TWS and CAT, it has resulted in a 3- to 4-year delay in delivering the Capability Development Document-required torpedo defense capability to the CVNs.
- The Navy's decision to add a highly-trained contractor as the acoustic operator to supplement the automated detection and alerting functions of TWS has improved threat detection performance during all completed test events. DOT&E assesses the majority of the TWS's detection and alerting capability is a result of the 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; thus, it is not known if the presence of the operator could also reduce the false alarm rate. For safety reasons, testing was highly structured, which allowed the operators to focus on torpedo detections and firing the CAT. Therefore, completed testing was inadequate to resolve the rate of false alarms or their effect on mission accomplishment.
- Additional information concerning the testing of the fielded TWS and CAT performance is included in DOT&E's March 2015 classified Early Fielding Report.

Recommendations

- Status of Previous Recommendations. The Navy has made some progress on previous recommendations. However, the Navy should still:
 1. Complete the TEMP for 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

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the CAT's terminal homing, attack, and fuzing within the lethality range of the warhead.

4. 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.
 5. Continue to investigate, correct, and retest deficiencies identified with the active source before planning to field TAAS.
 6. Adequately resource the TWS program to build dedicated test assets and conduct adequate dedicated contractor and developmental testing.
 7. Adequately resource the Program Office and its contractors to conduct TWS and CAT system development and testing.
 8. Investigate and implement the outstanding recommendations in the classified March 2015 DOT&E Early Fielding Report.
- FY16 Recommendation.
 1. The Navy should 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.