

Mk 54 Lightweight Torpedo

Executive Summary

- The Navy and DOT&E completed OT&E for the Mk 54 lightweight torpedo with Block Upgrade (BUG) tactical software in January 2014.
 - OT&E started after the Navy fielded the Mk 54 (BUG) in January 2012 in response to an urgent operational need. During operational testing that included fleet training, the Navy shot weapons from surface ships, fixed-wing aircraft, and helicopters against U.S. attack submarine and static submarine surrogate targets.
 - DOT&E issued a classified OT&E report on the Mk 54 (BUG) torpedo in September 2014. DOT&E assessed the Mk 54 (BUG) torpedo as not operationally effective. During operationally challenging and realistic scenarios, the Mk 54 (BUG) demonstrated below threshold performance and exhibited many of the same failure mechanisms observed during the FY04 IOT&E.
- The Mk 54 torpedo is operationally suitable and meets the same reliability and availability requirements as the baseline torpedo. However, operational testing identified shortfalls with the employing platforms' tactics and tactical documentation, and interoperability problems with some platform fire control systems.
- The Navy continued development of hardware and software updates to the Mk 54. The new version is designated the Mk 54 Mod 1 torpedo and is scheduled to begin OT&E in FY17.
- DOT&E is participating in the Navy's Torpedo Target Strategy Working Group to identify and develop test target surrogates for the Mk 54. The Navy proposed a short-term strategy that utilizes three separate targets, each appropriate for specific limited scenarios. The Navy does not have an adequate long-term strategy. Currently, the strategy is not fully funded.

System

- The Mk 54 lightweight torpedo is the primary Anti-Submarine Warfare (ASW) weapon used by U.S. surface ships, fixed-wing aircraft, and helicopters.
- The Mk 54 combines the advanced sonar transceiver of the Mk 50 torpedo with the legacy warhead and propulsion system of the older Mk 46. Mk 46 and Mk 50 torpedoes can be converted to an Mk 54 via an upgrade kit.
- The Mk 54 sonar processing uses an expandable, open architecture system. It combines algorithms from the Mk 50 and Mk 48 torpedo programs with the latest commercial off-the-shelf technology.
- The Navy designed the Mk 54 to operate in shallow-water environments and in the presence of countermeasures.
- The Navy has designated the Mk 54 torpedo to replace the Mk 46 torpedo as the payload section for the Vertical Launched Anti-Submarine Rocket for rapid employment by surface ships.



- The High-Altitude Anti-Submarine Warfare Weapons Capability (HAAWC) program will provide an adapter kit to permit long-range, high-altitude, GPS-guided deployment of the Mk 54 by a P-8A Multi-mission Maritime Aircraft.
- The Mk 54 BUG is a software upgrade to the Mk 54 baseline torpedo designed to correct deficiencies identified during the 2004 Mk 54 IOT&E.
- The Mk 54 must be interoperable and compatible with the analog or digital combat control systems and software variants installed on all ASW fixed-wing and helicopter aircraft, and on the surface ship combat control system variants used for torpedo tube or ASW rocket-launched torpedoes.

Mission

Navy surface ships and aircraft employ the Mk 54 torpedo as their primary anti-submarine weapon:

- For offensive purposes, when deployed by ASW aircraft and helicopters
- For defensive purposes, when deployed by surface ships
- In both deep-water open ocean and shallow-water littoral environments
- Against fast, deep-diving nuclear submarines and slow moving, quiet, diesel-electric submarines

Major Contractors

- Raytheon Integrated Defense Systems – Tewksbury, Massachusetts
- Progeny Systems Corporation – Manassas, Virginia
- Boeing Company – St. Charles, Missouri
- Northrop Grumman – Annapolis, Maryland

Activity

- Operational testing of the Mk 54 (BUG) torpedo commenced in FY12, following the early fielding of the software upgrade in January 2012 to address a Fifth Fleet Urgent Operational Need threat. During operational testing, the Navy shot 77 weapons from surface ships, fixed-wing aircraft, and helicopters against U.S. attack submarine and static submarine surrogate targets. The Navy and DOT&E completed OT&E for the Mk 54 lightweight torpedo with BUG tactical software in January 2014 in accordance with a DOT&E-approved test plan.
- DOT&E issued a classified OT&E report on the Mk 54 (BUG) torpedo in September 2014.
- The Program Executive Officer (Submarines) recommended the unrestricted fielding of the Mk 54 (BUG) in June 2014.
- During FY14, the Navy continued development of hardware and software updates to the Mk 54. The new version is designated the Mk 54 Mod 1 torpedo and is scheduled to begin OT&E in FY17. The Navy is developing new Mk 54 Mod 1 torpedo front end processors and transducers and new tactical software to address the performance shortfalls identified with the Mk 54 (BUG). The Navy plans to approve a new set of Mk 54 Mod 1 requirements documents and the Test and Evaluation Master Plan (TEMP) in FY15.
- DOT&E is participating in the Navy's Torpedo Target Strategy Working Group to identify and develop test target surrogates for the Mk 54. The Navy proposed a short-term strategy that utilizes three separate targets, each appropriate for specific limited scenarios. The Navy does not have an adequate long-term strategy. Currently, the strategy is not fully funded.
- DOT&E is participating in working groups and funding (as a short-term resource enhancement project) an update to the Weapons Assessment Facility (WAF) Hardware-in-the-Loop model and simulation located at the Naval Undersea Warfare Center in Newport, Rhode Island. The project is intended to improve the WAF for developing and testing torpedoes by improving the modeling of the ocean environment and improving target models.

Assessment

- DOT&E assessed that the Mk 54 torpedo is not operationally effective as an offensive ASW weapon. During operationally challenging and realistic scenarios, the Mk 54 (BUG) demonstrated below threshold performance and exhibited many of the same failure mechanisms observed during the IOT&E. Torpedo mission kill performance against targets employing the operationally realistic evasion tactics was below requirement thresholds. Performance is further degraded when considering crew performance for targeting and employing the Mk 54 and the Navy's assessment of warhead performance in operationally realistic scenarios.
- The Mk 54 torpedo is operationally suitable and meets the same reliability and availability requirements as the baseline torpedo. However, operational testing identified shortfalls with the employing platforms' tactics and tactical documentation, and interoperability problems with some

- platform fire control systems. During operational testing of the Mk 54 BUG torpedo, Navy testers discovered that crews could not access some weapon presets on some of the intended launch platforms. These problems could prevent fleet operators from effectively employing the Mk 54 BUG torpedo. The Navy initiated immediate actions to address this shortfall.
- Some operational realistic scenarios have not been assessed due to the unavailability of target surrogates and the Navy's safety regulations for shooting against manned submarine targets. Limited testing of these regions of the torpedo's operational profile confirmed previous assumptions were not valid and that future dedicated testing is required with target surrogates that are capable of being hit by the Mk 54 (set-to-hit testing).
- Additional information and a detailed assessment are available in DOT&E's OT&E classified report on the Mk 54 (BUG) lightweight torpedo dated September 2014.
- The Navy proposed some unmanned target surrogates that could be used to assess the performance of the Mk 54 during the end of the torpedo's run. The proposals include an unmanned static target, a mobile device towing electronic target signal repeater (unfunded), and a mobile small submarine surrogate intended for training (developed and built but unfunded for validation or operations). However, the Navy has not provided sufficient evidence to indicate these will permit realistic engagements.

Recommendations

- Status of Previous Recommendations. The following previous recommendations remain outstanding. The Navy still needs to:
 - Conduct mobile target set-to-hit testing. The Navy completed an initial terminal homing assessment against the set-to-hit Steel SSK static target surrogate; however, the Navy deferred the mobile testing due to the lack of a suitable target surrogate.
 - Continue to develop an LFT&E strategy that includes the firing of the Mk 54 against appropriate targets. The Navy plans to conduct this testing with the Mk 54 Mod 1 torpedo upgrade.
 - Fund an operationally realistic mobile set-to-hit target to complete the terminal homing testing of the Mk 54 torpedo. The Navy continues to investigate possible surrogates; however, the proposals are unfunded.
 - Propose alternatives to minimize or eliminate the test and safety limitations that minimize operational realism in Mk 54 testing.
 - Complete development of the Mk 54 Mod 1 requirements and TEMP. This TEMP should include all the necessary resources or plans to develop the necessary resources, including target and range needs, to complete the remaining testing.
 - Pursue development of an evasive mobile set-to-hit target and threat representative countermeasures to support operationally realistic development and testing of the

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Mk 54 Mod 1 torpedo. The targets identified by the Navy's Torpedo Target Strategy Working Group will support a limited portion of the required Mk 54 development and testing.

7. Institute processes to verify the incremental upgrades to the Mk 54 are interoperable with the variety of combat systems on surface ship, aircraft, and helicopter platforms and that tactics and documentation are updated.
- FY14 Recommendations. The Navy should evaluate and incorporate the 11 recommendations in DOT&E's Mk 54 (BUG) OT&E report to improve the effectiveness of the Mk 54. Significant unclassified recommendations include:
 1. Improve the target detection localization and track performance of ship and aircraft crews that employ the

Mk 54. While improving the sensor system capability on ships and aircraft is a longer range goal, updating the Mk 54 employment tactics, training, and documentation could immediately improve overall crew proficiency and ASW effectiveness.

2. Improve the Mk 54's effective target search and detection capability. The Mk 54 should be able to effectively search the area defined by typical fire control solution accuracy and crew employment and placement errors.
3. Simplify the variability of Mk 54 employment options and required water entry points in existing tactical documentation.

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