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DDG 51 Destroyer Including AN/SPY-1D Radar and AN/SQQ-89 Integrated Surface Ship Anti-Submarine Warfare Combat System

Initiated in the 1970's, the DDG 51 Destroyer program provides replacements for earlier classes of surface combatants at the end of their service life. The Navy is building the destroyers in flights in order to incorporate technological advancements and other changes during construction. Prior year reports describe Flight I (DDG 51-71) and Flight II (DDG 72-78) configurations. Construction of Flight IIA ships (DDG 79-112) was approved at Milestone IV in FY94. Evolution of the DDG 51 design is continuing, with Flight IIA destroyers being delivered in several baseline configurations to accommodate equipment and computer program changes. All Baseline 5 ships, DDG's 51-78, will eventually receive Baseline 5.3.8. A major effort to replace outdated military computing systems with modern commercial hardware and software began with AEGIS Baseline 6 Phase I (DDG 79-84). Baseline 6 Phase III (DDG 85-90) introduces Cooperative Engagement Capability and the Evolved Seasparrow Missile (ESSM). Baseline 7 Phase I (DDG 91-112) will complete the planned commercialization of the AEGIS Weapon System (AWS) computing plant.

The AWS, which includes the SPY-1D radar and SM-2 surface-to-air missiles, provides the ship's air defense capability. ESSM (and/or the Phalanx close-in weapon system when fitted), SM-2 missiles, countermeasures, and the 5-inch gun provide self-defense against aircraft and anti-ship missiles. The SPY-1D radar system is a multi-function, phased array, three-dimensional (range, altitude, and azimuth) radar that conducts search, automatic detection, and tracking of air and surface targets. AN/SPY-1D(V), a new variant under development for installation in Baseline 7 Phase I ships, is intended to improve performance against targets in clutter and provide an enhanced capability to counter deceptive electronic attack measures.

For undersea warfare (USW), DDG 51 uses the AN/SQQ-89 USW combat system, up to two embarked Light Airborne Multi-Purpose System (LAMPS) Mark III helicopters, torpedoes, and vertically launched USW standoff weapons. Surface warfare weapons include the 5-inch gun and LAMPS Mark III helicopters armed with Penguin or Hellfire missiles. Shore targets are engaged with Tomahawk missiles and the 5-inch gun. Links 4A, 11, and 16 provide connectivity to other Navy, Joint, and Coalition forces.

The AN/SQQ-89(V) series of USW combat systems links acoustic sensors and weapon control systems with advanced data processing and information displays. The AN/SQQ-89(V)6 is the baseline system for ships with a towed array and is installed in Flight I and Flight II ships and other combatants. It integrates the AN/SQS-53 series hull mounted sonar, the AN/SQR-19(V) towed array sonar, and the AN/SQQ-28(V) LAMPS Mark III shipboard electronics with the USW Control System Mark 116 series. In Flight IIA ships, the USW suite does not include the towed array sonar.

TEST & EVALUATION ACTIVITY

DDG mine detection effectiveness, using the AN/SQQ-89 Kingfisher subsystem installed in all DDG's, was tested November 5-6, 2002.

One phase of DDG 51 Operational Test (OT)-IIIF tested the AN/SQQ-89(V)10 USW suite. The operational test pitted *USS Winston S. Churchill* (DDG 81) and supporting aircraft against a *Los Angeles* class nuclear submarine in a series of events at the Atlantic Undersea Test and Evaluation Center (AUTECE) in November 2002. The operational evaluation of the Mark 45, MOD 4 gun mount in December 2002 included the performance of the new 5-inch/62-caliber gun and Mark 160, MOD 8 gun computer system installed in DDG 81 and later ships.



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The Navy tested the performance of the Flight IIA ship and the AEGIS Baseline 6.1.5 computer program against cruise missile and small boat threats in February 13-22, 2003.

DOT&E participated in test and evaluation working groups involved in planning the tests completed in FY03 and the tests that will examine the performance of AEGIS Baseline 6 Phase III ships, AN/SPY-1D(V), and AN/SQQ-89(V)14 in FY04.

DOT&E provided testability advice during the sponsor's development of revisions to the operational requirements for the AN/SQQ-89(V)15 and AN/SQQ-89A(V)15 variants of the USW combat system. DOT&E participated in Test and Evaluation Master Plan revisions for DDG 51, AN/SQQ-89(V)10, and AN/SPY-1D(V).

TEST & EVALUATION ASSESSMENT

DDG 51 is operationally effective in an open ocean, blue-water environment – it's designed operating environment. However, it is less effective and at greater risk in littoral areas, where it may encounter asymmetric threats. Flight I and II ships are operationally suitable, but maintainability, compatibility, interoperability, and safety deficiencies degrade the operational suitability of Flight IIA variants.

In OT-IIIIF Phase I, *USS Cole* (DDG 67), outfitted with Baseline 5.3.8, conducted simulated engagements against 47 manned aircraft presentations and live SM-2 engagements against six aerial targets representing anti-ship cruise missile threats. The ship's air defense performance exceeds the prescribed operational requirements. However, the improved radar performance unmasked issues with command and decision subsystem processing of certain tracks in an electronic attack environment that can result in false tracks and possibly unnecessary missile expenditures. These deficiencies should be addressed in future baseline upgrades. The ship's overall effectiveness against stream raids has not been demonstrated and requires additional testing.

Baseline 5.3.8 software reliability, AWS hardware reliability, and the ship's operational availability for the air defense mission is better than required; however, the time required to restore functionality when a critical computer program fault does occur exceeds the maximum time allowed. These critical faults are infrequent, but when they do occur the combat system is not available during restoration. A review of prior test results shows that computer program restoration times have exceeded the requirement in all but one event and have generally been increasing. The increasing trend in fault identification and restoration times will be monitored closely in future operational tests to determine if it is a by-product of the introduction of commercial hardware and software.

A Flight IIA DDG with the Baseline 6.1.5 hardware and computer program configuration conducted air defense and strike warfare mission operational testing (OT-IIIIF Phase II) in FY03. Although not tested against all threats, the Flight IIA ship continues to be effective against the predominant anti-ship cruise missile threats. Analysis of extensive data from tactical engagements shows that DDGs and other surface combatants can effectively complete strike warfare missions using Tomahawk Land Attack Missiles.

DDG 51 does not have an effective mine detection capability. The probability that a moored mine will be detected and correctly classified using the AN/SQQ-89 Kingfisher subsystem is below the prescribed operational requirement. Although bottom mines constitute a very real threat in the littorals, DDG 51 has no equipment designed to detect bottom mines. Part of OT-IIIIF evaluated DDG 51 Flight IIA undersea warfare effectiveness. By design, the AN/SQQ-89(V)10 does not provide any improvement in effectiveness and diminishes the ship's organic sensor capability through the removal of the AN/SQR-19 towed sonar array. Overall, DOT&E found the (V)10 to not be effective or suitable for anti-submarine warfare operations. The system failed to meet its threshold requirement for submarine detection and classification, and its software exhibited significant reliability and interoperability problems. Although OT-IIIIF did not explicitly test torpedo detection, (V)10 inherits the survivability deficiencies identified in the baseline (V)6.

The anti-submarine warfare testing at AUTECH highlighted the problems created by the recent closing of the Atlantic Fleet Weapons Training Facility. The restricted size, unusual bathymetry, and limited shipping traffic make AUTECH an

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unrealistic site for operational testing. As the Navy continues to emphasize shallow water operations, the lack of an appropriate littoral test site constitutes a serious limitation.

DDG 51 is not effective in countering the small boat threat. During OT-IIIIF Phase II, *USS Bulkeley* (DDG 84) engaged a swarm of five small boats using its helicopter's Hellfire missiles, SM-2 missiles, the 5-inch/62-caliber gun, and the Phalanx Block 1B Close-In Weapon System (CIWS). The ship's sensors and weapons were unable to support situational awareness or to effectively counter the small boat threat.

The Mark 34, Mod 1 Gun Weapon System and 5-inch/62-caliber gun installed in DDG 81 and later ships effectively supported accomplishment of the Naval Shore Fire Support mission. Counter-battery performance continues to be degraded by lack of an effective range-finding capability. An interoperability deficiency that impedes the transmission of sensor information from AWS to the Gun Weapon System degrades the Baseline 6.1.5 ship's gunnery effectiveness against air and sea targets. Poor performance of the ship's laser range finder adversely impacts system performance against sea targets.

The inability to get a stable version of AEGIS baseline 7.1 software delayed the SPY-1D(V) operational assessment from July 2003 to February 2004. The technical evaluation is scheduled for late-August 2004, and operational evaluation is planned for late-November 2004. The compressed schedule allows very little time to correct technical evaluation deficiencies prior to operational evaluation. To adequately evaluate SPY-1D(V)'s improved performance the ship must conduct integrated air defense against a stream raid of threat representative anti-ship cruise missiles in a typical littoral environment with electronic counter measures using SM-2 and ESSM.

The operational suitability of the Flight IIA DDG is not as good as that of Flight I and II ships. Reliability, availability, logistic supportability, training, human factors, documentation, and computer program supportability of the Baseline 6.1.5 ships are satisfactory. Major deficiencies include the safety and compatibility issues related to the limited storage space in the helicopter hangars cited in last year's report; failure of the Operational Readiness Test Set to meet requirements for fault detection, isolation, and identification of applicable technical documentation; continuing problems with excessive AEGIS computer program restoration times; lack of CIWS Block 1B surface mode integration into AWS; and failure of the AWS to pass AN/SPS-67 surface search radar data to the Gun Weapon System.

Since program inception in the 1980's, an extensive LFT&E program has been conducted on the *Arleigh Burke* class of guided missile destroyer. The results of LFT&E indicate that it is highly survivable against the majority of threats it is expected to encounter, but is not invulnerable to all threats. Details are classified and will be forwarded in a separate report to Congress in FY04.

