

DDG 51 Flight III Destroyer/Air and Missile Defense Radar (AMDR)/Aegis Combat System

Executive Summary

- On December 10, 2014, the Deputy Secretary of Defense (DEPSECDEF) directed the Director, Cost Analysis/Program Evaluation (CAPE) to identify viable at-sea operational testing options that meet DOT&E adequacy requirements and recommend a course of action (with cost estimates, risks, and benefits) to satisfy testing of the Air and Missile Defense Radar (AMDR), Aegis Combat System, and Evolved Seasparrow Missile (ESSM) Block 2 in support of the DDG 51 Flight III Destroyer program.
- The CAPE study evaluated four options to deliver an at-sea test platform adequate for self-defense operational testing of the DDG 51 Flight III, AMDR, and ESSM Block 2 programs. Each option requires funding beginning no later than FY18 to ensure support of operational testing of these systems in FY22.
- A decision on whether to fund the advance procurement of the equipment needed to support the self-defense operational testing is pending.

System

- The DDG 51 Flight III Destroyer will be a combatant ship equipped with the:
 - AMDR three-dimensional (range, altitude, and azimuth) multi-function radar
 - Aegis Combat System
 - AN/SQQ-89 Undersea Warfare suite that includes the AN/SQS-53 sonar
 - MH-60R helicopter
 - Close-In Weapon System
 - 5-inch diameter gun
 - Vertical Launch System that can launch Tomahawk, Standard Missiles-2, 3, and 6, and the ESSM Blocks 1 and 2
- The Navy is developing the AMDR to provide simultaneous sensor support of integrated air and missile defense (IAMD) and air defense (including self-defense) missions. IAMD and air defense missions require extended detection ranges and increased radar sensitivity against advanced threats with high speeds and long interceptor fly-out times. The three major components of AMDR are:
 - The AMDR S-band radar that will provide IAMD, search, track, cueing, missile discrimination, air defense non-cooperative target recognition, S-band missile communications, surveillance capability for ship self-defense and area air defense, and S-band kill assessment support functions.
 - The AMDR X-band radar will provide horizon and surface search capabilities and navigation and periscope detection/discrimination functions. The Navy is delaying



- development of the X-band radar; the existing AN/SPQ-9B radar will provide these functions in the interim.
- The AMDR Radar Suite Controller that will provide radar resource management and coordination and an open interface with the ship's combat system.
- The Aegis Combat System is an integrated naval weapons system that uses computers and radars to form an advanced command and decision capability and a weapons control system to track and guide weapons to destroy enemy targets.
- The ESSM, cooperatively developed among 13 nations, is a medium-range, ship-launched self-defense guided missile designed to defeat ASCM, surface, and low-velocity air threats. There are two variants of ESSM.
 - ESSM Block 1 is a semi-active radar-guided missile that is currently in-service.
 - ESSM Block 2 is in development and will have semi-active radar-guidance as well as active radar guidance.
- In comparison to the previous DDG 51 version (Flight IIA), Flight III includes, in addition to the Aegis Combat System and the AMDR, the following modifications:
 - An upgraded fire extinguishing system
 - New ship service turbine generators
 - Additional transformers
 - Power Conversion Modules
 - Modified controllers for the Machinery Control System and Multifunction Monitors
 - Upgraded air-conditioning plants
- Flight III is also structurally different from the prior DDG 51 version. The design will add starboard enclosures and a

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stack of small boats, and additional structure in the fantail to increase reserve buoyancy and help compensate for additional weight increase. It will also include structural modifications to increase plate thicknesses to lower the ship's center-of-gravity and enhance girder strength.

Mission

- The Navy will use the DDG 51 Flight III Destroyer equipped with the Aegis Combat System and AMDR to provide joint battlespace threat awareness and defense capability to counter current and future threats in support of joint forces ashore and afloat.
- The Navy will use the AMDR S-band radar/Radar Suite Controller with the AN/SPQ-9B and the Aegis Combat System to support the following DDG 51 Flight III Destroyer missions:
 - Area air defense (to include self-defense with the ESSM) to counter advanced air and cruise missile threats and increase ship survivability
 - Detect, track, discriminate, and provide missile engagement support (including kill assessment) to counter ballistic missile threats

- Counter surface threats through surface surveillance, precision tracking, and missile and gun engagements
- Conduct Undersea Warfare with periscope detection and discrimination
- Detect and track enemy artillery projectiles to support combat system localization of land-battery launch positions by the DDG 51 Flight III Combat System
- Detect and track own-ship gun projectiles to support surface warfare and naval surface fire support

Major Contractors

- DDG 51 Flight III Destroyer: To be determined. Current DDG 51 Destroyer major contractors are:
 - General Dynamics Marine Systems Bath Iron Works – Bath, Maine
 - Huntington Ingalls Industries, Ingalls Shipbuilding Division – Pascagoula, Mississippi
- AMDR: Raytheon – Sudbury, Massachusetts
- Aegis Combat System: Lockheed Martin Marine Systems and Sensors – Moorestown, New Jersey
- ESSM Block 2: Raytheon – Tucson, Arizona

Activity

- On December 10, 2014, DEPSECDEF issued a memorandum directing CAPE to identify viable at-sea operational testing options that meet DOT&E adequacy requirements and recommend a course of action (with cost estimates, risks, and benefits) to satisfy testing of the AMDR, Aegis Combat System, and ESSM Block 2 programs in support of the DDG 51 Flight III Destroyer program.
- The CAPE study evaluated four options to deliver an at-sea test platform adequate for self-defense operational testing of these systems. Each option requires funding beginning in FY18 to ensure support of the DDG 51 Flight III, AMDR, and ESSM Block 2 operational testing in 2022.
- In September 2015, DOT&E met with DDG 51 Program Office representatives to start planning the Flight III LFT&E program.
- DEPSECDEF has not made a decision yet on the funding needed.

Assessment

- DOT&E's position continues to be that the Navy's operational test programs for the AMDR, Aegis Combat System, ESSM Block 2, and DDG 51 Flight III Destroyer programs are not adequate to fully assess their self-defense capabilities. They are also not adequate to test the following Navy-approved DDG 51 Flight III, AMDR, Aegis Combat System, and ESSM Block 2 requirements.
 - The AMDR Capability Development Document (CDD) describes AMDR's IAMD mission, which requires AMDR to support simultaneous defense against multiple ballistic missile threats and multiple advanced anti-ship cruise

- missile (ASCM) threats. The CDD also includes an AMDR minimum track range Key Performance Parameter.
- The DDG 51 Flight III Destroyer has a survivability Key Performance Parameter requirement directly tied to meeting a self-defense requirement threshold against ASCMs described in the Navy's Surface Ship Theater Air and Missile Defense Assessment document of July 2008. It clearly states that area defense will not defeat all the threats, thereby demonstrating that area air defense will not completely attrite all ASCM raids and individual ships must be capable of defeating ASCM leaders in the self-defense zone.
- The ESSM Block 2 CDD has a requirement to provide self-defense against incoming ASCM threats in clear and jamming environments. The CDD also includes an ESSM Block 2 minimum intercept range Key Performance Parameter.
- Use of manned ships for operational testing with threat representative ASCM surrogates in the close-in, self-defense battlespace is not possible due to Navy safety restrictions because targets and debris from intercepts pose an unacceptable risk to personnel at ranges where some of the engagements will take place. The November 2013 mishap on the USS *Chancellorsville* (CG 62) involving an ASCM surrogate target resulted in even more stringent safety constraints.
 - In addition to stand-off ranges (on the order of 1.5 to 5 nautical miles for subsonic and supersonic surrogates, respectively), safety restrictions require that ASCM

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targets not be flown directly at a manned ship, but at some cross-range offset, which unacceptably degrades the operational realism of the test.

- Similar range safety restrictions will preclude manned ship testing of eight of the nine ASCM scenarios contained in the Navy-approved requirements document for the Aegis Modernization Advanced Capability Build 16 Combat System upgrade. Restrictions also preclude testing of the AMDR minimum track range requirement against threat representative ASCM threat surrogates at the land-based AMDR Pacific Missile Range Facility test site.
- To overcome these safety restrictions for the LHA 6, Littoral Combat Ship, DDG 1000, LPD 17, LSD 41/49, and CVN 78 ship classes, the Navy developed an Air Warfare/Ship Self-Defense Enterprise Modeling and Simulation (M&S) test bed, which uses live testing in the close-in battlespace with targets flying realistic threat profiles and manned ship testing for other battlespace regions, as well as soft-kill capabilities to validate and accredit the M&S test bed. The same needs to be done for the DDG 51 Flight III Destroyer with its AMDR, as side-by-side comparison between credible live fire test results and M&S test results form the basis for the M&S accreditation. Without a Self-Defense Test Ship (SDTS) with AMDR and an Aegis Combat System, there will not be a way to gather all of the operationally realistic live fire test data needed for comparison to accredit the M&S test bed.
- Since Aegis employs ESSMs in the close-in, self-defense battlespace, understanding ESSM's performance is critical to understanding the self-defense capabilities of the DDG 51 Flight III Destroyer.
 - Past DOT&E annual reports have stated that the ESSM Block 1 operational effectiveness has not been determined. The Navy has not taken action to adequately test the ESSM's operational effectiveness.
 - The IOT&E for ESSM Block 2 will be conducted in conjunction with the DDG 51 Flight III Destroyer, AMDR, and Aegis Combat System operational testing.
 - Specifically, because safety limitations preclude ESSM firing in the close-in self-defense battlespace, there are very little test data available concerning ESSM's performance, as installed on Aegis ships, against supersonic ASCM surrogates.
 - Any data available regarding ESSM's performance against supersonic ASCM surrogates are from a Ship Self-Defense System-based combat system configuration, using a completely different guidance mode or one that is supported by a different radar suite.
- The cost of building and operating an Aegis SDTS, estimated to be about \$350 Million, is small when compared to the total cost of the AMDR development/procurement and the eventual

cost of the 22 (plus) DDG 51 Flight III ships that are planned for acquisition (\$55+ Billion). Even smaller is the cost of the SDTS compared to the cost of the ships that the DDG 51 Flight III Destroyer is expected to protect (approximately \$450 Billion in new ship construction over the next 30 years). If DDG 51 Flight III Destroyers are unable to defend themselves, these other ships are placed at substantial risk.

- The modification/upgrades being planned for the DDG 51 Flight III are significant enough to warrant an assessment of the impact of these changes on ship survivability. The Navy has unofficially indicated the DDG 51 Flight III LFT&E strategy will include Component Shock Qualification, a Total Ship Survivability Trial, and a Full Ship Shock Trial. Other LFT&E program particulars are still under discussion to ensure DDG 51 Flight III adequately addresses survivability requirements against operationally relevant threats and recoverability requirements.

Recommendations

- Status of Previous Recommendations. The Navy has not addressed the following four previous recommendations. The Navy should:
 1. Program and fund an SDTS equipped with the AMDR, ESSM Block 2, and DDG 51 Flight III Aegis Combat System in time to support the DDG 51 Flight III Destroyer and ESSM Block 2 IOT&Es.
 2. Modify the AMDR, ESSM Block 2, and DDG 51 Flight III Test and Evaluation Master Plans to include a phase of IOT&E using an SDTS equipped with the AMDR and DDG 1 Flight III Combat System.
 3. Modify the AMDR, ESSM Block 2, and DDG 51 Flight III Test and Evaluation Master Plans to include a credible M&S effort that will enable a full assessment of the AMDR, ESSM Block 2, and DDG 51 Flight III Combat System's self-defense capabilities.
 4. Comply with the DEPSECDEF direction to develop and fund a plan, to be approved by DOT&E, to conduct at-sea testing of the self-defense of the DDG 51 Flight III Destroyer with the AMDR, ESSM Block 2, and Aegis Combat System.
- FY15 Recommendations. The Navy should:
 1. Provide program funding for an Aegis-equipped self-defense test ship to support adequate operational testing of the AMDR, Aegis Combat System, ESSM Block 2, and DDG 51 Flight III Destroyer programs as soon as possible so as not to disrupt the ESSM Block 2 development schedule.
 2. Provide DOT&E the DDG 51 Flight III LFT&E Strategy for approval prior to the end of FY16 in coordination with the Test and Evaluation Master Plan.

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