

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

Executive Summary

- On March 6, 2014, the Deputy Secretary of Defense (DEPSECDEF) issued a Resource Management Decision memorandum directing the Navy to develop a plan to conduct at-sea testing of the self-defense capability of the DDG 51 Flight III Destroyer with the Air and Missile Defense Radar (AMDR) and Aegis Combat System. The plan was to be approved by DOT&E and then adequately funded by the Navy. However, the Navy has not provided any plan to DOT&E or planned funding to facilitate the testing.
- On April 23, 2014, DOT&E issued a memorandum to USD(AT&L) stating the intention to not approve any operational test plan for an Early Operational Assessment (EOA) of the AMDR due to non-availability of the required AMDR hardware and software.
- On September 10, 2014, DOT&E issued a classified memorandum to USD(AT&L) with a review of the Navy Program Executive Office for Integrated Warfare Systems Design of Experiments study. The study attempted to provide a technical justification to show the test program did not require using a Self-Defense Test Ship (SDTS) to adequately assess the self-defense capability of the DDG 51 Flight III Class Destroyers. DOT&E found the study presented a number of flawed rationales, contradicted itself, and failed to make a cogent argument for why an SDTS is not needed for operational testing.

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
 - Five-inch diameter gun
 - Vertical Launch System that can launch Tomahawk, Standard Missiles (SM-2, -3, and -6), and Evolved SeaSparrow Missiles (ESSMs)
- 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 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 will provide IAMD, as well as 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 (AMDR-X) will provide horizon and surface search capabilities in addition to navigation and periscope detection/discrimination functions. The Navy is delaying development of the AMDR-X. The existing AN/SPQ-9B radar will provide these X-band functions in the interim.
- The Radar Suite Controller will provide radar resource management and coordination, as well as an open interface with the ship 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 weapon control system to track and guide weapons to destroy enemy targets.
 - The Navy's Aegis Modernization program is a planned, phased program that provides updated technology and combat systems for existing Aegis-guided missile cruisers (CG 47) and destroyers (DDG 51) as well as the DDG 51 Flight III Destroyers.
 - The Aegis Modernization program will provide an improved Advanced Capability Build combat system variant for the DDG 51 Flight III Destroyers equipped with the AMDR.

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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 Modernization Program to support the following DDG 51 Flight III Destroyer missions:
 - Area air defense (to include self-defense) 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
 - Surface surveillance, precision tracking, and missile and gun engagements to counter surface threats
- 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 in support of surface warfare and naval surface fire support

Major Contractors

- DDG 51 Flight III Destroyer: General Dynamics Marine Systems Bath Iron Works – Bath, Maine
- AMDR: Raytheon – Sudbury, Massachusetts
- Aegis Combat System: Lockheed Martin Marine Systems and Sensors – Moorestown, New Jersey

Activity

- On March 6, 2014, DEPSECDEF issued a Resource Management Decision memorandum directing the Navy to develop a plan to conduct at-sea testing of the self-defense capability of the DDG 51 Flight III Destroyer with the AMDR and Aegis Combat System. The plan was to be approved by DOT&E and then adequately funded by the Navy. To date, the Navy has not provided any plan to DOT&E or funding in response to this direction.
- On April 23, 2014, DOT&E issued a memorandum to USD(AT&L) stating the operational test plan for an EOA of the AMDR could not be approved because the required AMDR hardware and software were not available as planned, per the 2010 DOT&E- and Navy-approved Test and Evaluation Strategy, and as briefed to the Deputy Assistant Secretary of Defense (Strategic and Tactical Systems) in 2012. A prototype AMDR array, coupled to an upgraded radar controller using basic software for radar control and simple search and track functionality, was expected to be available. The lack of this hardware and software would have limited the EOA to a “table-top” review of program documentation, program plans, and available design data, which would, in DOT&E’s view, not have been a worthwhile use of resources.
- On September 10, 2014, DOT&E issued a classified memorandum to USD(AT&L) that provided a review of the Navy Program Executive Office for Integrated Warfare Systems Design of Experiments study. The study attempted to provide a technical justification to show the test program did not require using an SDTS to adequately assess the self-defense capability of the DDG 51 Flight III Class Destroyers. DOT&E found the study presented a number of flawed rationales, contradicted itself, and failed to make a cogent argument for why an SDTS is not needed for operational testing.

Assessment

- DOT&E’s assessment continues to be that the operational test programs for the AMDR, Aegis Modernization, and DDG 51 Flight III Destroyer programs are not adequate to fully assess their self-defense capabilities in addition to being inadequate to test the following Navy-approved AMDR and DDG 51 Flight III requirements.
 - The AMDR Capability Development Document 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 Capability Development Document also includes an AMDR minimum track range Key Performance Parameter.
 - The DDG 51 Flight III Destroyer has a survivability 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 that individual ships must be capable of defeating ASCM leakers in the self-defense zone.
- 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.

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- 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 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 as well as testing of the AMDR minimum track range requirement against supersonic, sea-skimming ASCM threat-representative surrogates at the land-based AMDR Pacific Missile Range Facility test site.
 - To overcome these safety restrictions for the LHA-6, Littoral Combat Ship (LCS), 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 that uses live testing in the close-in battlespace with targets flying realistic threat profiles and manned ship testing for other battlespace regions and softkill 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. Side-by-side comparison between credible live fire test results and M&S test results form the basis for the M&S accreditation. Without an 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.
 - The Navy needs to improve its Aegis Weapon System (AWS) models that are currently provided by Lockheed Martin's Multi-Target Effectiveness Determined under Simulation by Aegis (MEDUSA) M&S tool.
 - MEDUSA encompasses several components of the AWS including the SPY-1 radar, Command and Decision, and Weapon Control System. MEDUSA models AWS performance down to the system specification and the Navy considers it a high-fidelity simulation of AWS.
 - However, it is not a tactical code model, so its fidelity is ultimately limited to how closely the specification corresponds to the Aegis tactical code (i.e., the specification is how the system is supposed to work while the tactical code is how the system actually works). This adds to the need for realistic live fire shots to support validation efforts.
 - Earlier test events highlight the limitations of specification models like MEDUSA. During Aegis Advanced Capability Build 08 testing in 2011, five AWS software errors were found during live fire events and tracking exercises. Three software errors contributed to a failed SM-2 engagement, one to a failed ESSM engagement, and one to several failed simulated engagements during tracking exercises. Since these problems involved software coding errors, it is unlikely that a specification model like MEDUSA (which assumes no software errors in tactical code) would account for such problems and hence it would overestimate the combat system's capability.
 - By comparison, the Air Warfare/Ship Self Defense Enterprise M&S test bed used for assessing USS *San Antonio's* (LPD-17) self-defense capabilities used re-hosted Ship Self-Defense System Mk 2 tactical code.
 - Since Aegis employs ESSM 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's operational effectiveness has not been determined. The Navy has not taken action to adequately test the ESSM's operational effectiveness.
 - 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 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.
 - Moreover, the SDTS is not a one-time investment for only the AMDR/DDG 51 Flight III IOT&E, as it would be available for other testing that cannot be conducted with manned ships (e.g., the ESSM Block 2) and as the combat system capabilities are improved.
- ### Recommendations
- Status of Previous Recommendations. There are three previous recommendations that remain valid. The Navy should:
 1. Program and fund an SDTS equipped with the AMDR and DDG 51 Flight III Aegis Combat System in time for the DDG 51 Flight III Destroyer IOT&E.
 2. Modify the AMDR, Aegis Modernization, 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 51 Flight III Combat System.
 3. Modify the AMDR, Aegis Modernization, 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 and DDG 51 Flight III Combat System's self-defense capabilities.

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- FY14 Recommendation.
 1. The Navy should 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 and Aegis Combat System.