

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

Executive Summary

- On November 21, 2016, the Deputy Secretary of Defense (DEPSECDEF) directed the Navy to fully fund the Aegis Self-Defense Test Ship (SDTS) and the aerial targets required for testing the DDG 51 Flight III, Air and Missile Defense Radar (AMDR), and Evolved Seasparrow Missile (ESSM) Block 2 programs. The Navy initially complied with the direction but subsequently removed all funding for the Aegis SDTS and the required aerial targets.
- On May 4, 2017, the DEPSECDEF directed the Navy to reinstate the funding for the Aegis SDTS and associated test firings in compliance with the previous November 2016 guidance. The Navy has not yet complied.

System

- The DDG 51 Flight III Destroyer is a combatant ship intended to be equipped with the:
 - AMDR three-dimensional (range, altitude, and azimuth) multi-function radar
 - Aegis Combat System used for air warfare missions and self-defense against anti-ship cruise missiles (ASCMs)
 - AN/SQQ-89 undersea warfare suite that includes the AN/SQS-53 sonar
 - MH-60R helicopter that supports undersea warfare
 - Close-In Weapon System for ship self-defense
 - Five-inch diameter gun for surface warfare and land attack
 - Vertical Launch System that can launch Tomahawk; Standard Missiles 2, 3, and 6; and 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 intended to 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 – intended to provide horizon and surface search capabilities, navigation, and periscope detection/discrimination functions – is delayed. In the interim, the legacy AN/SPQ-9B radar will provide these functions.
 - The AMDR Radar Suite Controller is intended to 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 provide 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 intended to provide 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 upgraded combat system and the AMDR, the following modifications:
 - Upgraded fire extinguishing systems
 - Air conditioning plant upgrades
 - Upgraded electric generators and power conversion modules
- DDG 51 Flight III is also structurally different from the prior DDG 51 version. The design will add starboard enclosures, a 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.
- In addition to the self-defense features discussed above, the ship has the following survivability features:
 - Improved ballistic protection for magazines and other vital spaces as well as the inclusion of some shock-hardened systems/components to enhance survivability.



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- Various installed and portable damage control, firefighting, and dewatering systems.

Mission

Naval Commanders 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:

- Area air defense (to include self-defense with the ESSM) to counter advanced air and cruise missile threats and increase ship survivability
- Detecting, tracking, discriminating, and providing missile engagement support (including kill assessment) to counter ballistic missile threats
- Countering surface threats through surface surveillance, precision tracking, and missile and gun engagements

- Conducting undersea warfare with periscope detection and discrimination
- Detecting and tracking own-ship gun projectiles to support surface warfare and naval surface fire support

Major Contractors

- DDG 51 Flight III Destroyer major contractors are:
 - General Dynamics Marine Systems Bath Iron Works – Bath, Maine
 - Huntington Ingalls Industries – Pascagoula, Mississippi
- AMDR: Raytheon – Marlborough, Massachusetts
- Aegis Combat System: Lockheed Martin Marine Systems and Sensors – Moorestown, New Jersey
- ESSM Blocks 1 and 2: Raytheon – Tucson, Arizona

Activity

- On November 21, 2016, the DEPSECDEF directed the Navy to fully fund the Aegis SDTS and the aerial targets required for testing the DDG 51 Flight III, AMDR, and ESSM Block 2 programs. The Navy initially complied with the direction but subsequently removed all funding for the Aegis SDTS and the required aerial targets.
- On May 4, 2017, the DEPSECDEF directed the Navy to reinstate the funding for the Aegis SDTS and associated test firings in compliance the previous guidance. The Navy has not yet reinstated the funding.

Assessment

- Absent an AMDR- and Aegis-equipped SDTS, the Navy's operational test programs for the AMDR, Aegis Combat System, ESSM Block 2, and DDG 51 Flight III destroyer programs will not be adequate to fully assess their capabilities, in particular those associated with self-defense. They would also not be 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 ASCM threats. The CDD also includes an AMDR minimum track range requirement as part of the IAMD Key Performance Parameter.
 - The DDG 51 Flight III destroyer has a survivability Key Performance Parameter 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.
 - 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 engagements will take place. The November 2013 mishap on USS *Chancellorsville* (CG 62) involving an ASCM surrogate target resulted in even more stringent safety constraints.
 - In addition to stand-off ranges, 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 preclude manned ship testing of five of the seven self-defense ASCM scenarios included in the Navy-approved requirements document for the Aegis Modernization Advanced Capability Build 20 Combat System upgrade and will severely limit the operational realism of the two scenarios that can be flown against a manned ship. Safety 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 on the SDTS 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 Navy should do the same for the DDG 51 Flight III destroyer with its AMDR, as side-by-side comparison between credible live

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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 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 Navy intends to conduct phases of the ESSM Block 2 IOT&E 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 few test data available concerning ESSM's performance 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 a different radar suite supports.
- The cost of building and operating an Aegis SDTS is estimated to be about \$350 Million, compared to the estimated \$14 Billion cost of the AMDR development/procurement and the estimated \$45 Billion cost of the additional 22 or more DDG 51 Flight III ships that are planned for acquisition. Additionally, the cost of the ships that the DDG 51 Flight III destroyer is expected to protect is approximately \$450 Billion in new ship construction over the next 30 years. Failure to adequately test the self-defense capability of DDG 51 Flight III destroyers means their survivability and that of a significant number other of ships the DDG-51 Flight III destroyers are intended to defend will be unknown. It is essential that the Navy program now fund the tests, targets, and Aegis Combat System equipment needed to conduct realistic self-defense testing using an AMDR- and Aegis-equipped SDTS.
- The modifications planned for DDG 51 Flight III are substantial enough to justify an assessment of ship

survivability. To assess the effects of those modifications on ship survivability, the DDG 51 Flight III LFT&E strategy should include at least component shock qualification tests, a Total Ship Survivability Trial, a shock trial, and a plan to validate simulation tools used in the survivability assessment. The Navy has not yet developed an LFT&E Strategy for the program.

Recommendations

- Status of Previous Recommendations. The Navy has not addressed the following previous recommendations. The Navy should:
 1. Program for and fully 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 (TEMPs) 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, ESSM Block 2, and DDG 51 Flight III TEMPs 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.
 5. Provide DOT&E the DDG 51 Flight III LFT&E Strategy for review and approval in coordination with the TEMP.
 6. Comply with the DEPSECDEF direction to work with DOT&E to develop an integrated test strategy for the DDG 51 Flight III, AMDR, Aegis Modernization, and ESSM Block 2 programs, and document that strategy into draft TEMP for those programs to be provided to DOT&E.
- FY17 Recommendation.
 1. The Navy should program funds in the Future Years Defense Plan to complete all activities and procurement required to conduct adequate operational testing in FY24 of the DDG 51 Flight III, AMDR, and ESSM Block 2's self-defense capabilities on an Aegis-equipped SDTS.

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