

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

### Executive Summary

- On February 10, 2016, the Deputy Secretary of Defense (DEPSECDEF) directed the Navy to adjust funds within existing resources to procure long-lead items to begin procurement of an Aegis/Air and Missile Defense Radar (AMDR)-equipped Self-Defense Test Ship (SDTS). He further directed the Navy to work with DOT&E to develop an integrated test strategy for the DDG 51 Flight III, AMDR, Aegis Modernization, Evolved SeaSparrow Missile (ESSM) Block 2 programs, document that strategy into draft Test and Evaluation Master Plans (TEMPS), and provide them to DOT&E by July 29, 2016. The Navy has complied with the funding direction but has not complied with the DEPSECDEF direction to provide an integrated test strategy for those programs.
- Despite budgeting for the long-lead AMDR components, the Navy did not program funding in the Future Years Defense Plan to complete all other activities (including procuring Aegis Combat System equipment and targets) necessary to modify the SDTS and support adequate operational testing of the DDG 51 Flight III's self-defense capabilities in FY23 as planned. On November 21, 2016, the DEPSECDEF directed the Navy to fully fund those activities.

### 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 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 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 – intended to provide horizon and surface search capabilities as well as navigation and periscope detection/discrimination functions – is being delayed. In the interim, the legacy AN/SPQ-9B radar will provide these functions.
- 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 upgraded Aegis Combat System and the AMDR, the following modifications:
  - An upgraded fire extinguishing system
  - New ship service turbine generators
  - Additional transformers
  - Power Conversion Modules

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- 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 stack of small boats, as well as 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 intended to enhance survivability.
  - Various installed and portable damage control, firefighting, and dewatering systems intended to support recoverability from peacetime shipboard fire and flooding casualties and from battle damage incurred during combat.
- 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: 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 Blocks 1 and 2: Raytheon – Tucson, Arizona

## 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:

## Activity

- On February 10, 2016, the DEPSECDEF directed the Navy to adjust funds within existing resources to procure long-lead items to begin procurement of an Aegis/AMDR-equipped SDTS. He further directed the Navy to work with DOT&E to develop an integrated test strategy for the DDG 51 Flight III, AMDR, Aegis Modernization, ESSM Block 2 programs and document that strategy into draft TEMPs for those programs to DOT&E by July 29, 2016. The Navy has programmed for long-lead procurement of an AMDR radar face but has not complied with the DEPSECDEF direction to provide an integrated test strategy for those programs despite being provided the integrated operational test plan by DOT&E.
- Despite budgeting for the long-lead AMDR components, the Navy did not program funding in the Future Years Defense Plan to complete all other activities (including procuring Aegis Combat System equipment and targets) necessary to modify the SDTS and support adequate operational testing of the DDG 51 Flight III's self-defense capabilities in FY23 as planned. On November 21, 2016, the DEPSECDEF directed the Navy to fully fund those activities.

## Assessment

- DOT&E's assessment is that, 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 cannot 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 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.

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- 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 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 will 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. 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 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 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 or more DDG 51 Flight III ships that are planned for acquisition (\$55 Billion or higher). 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. Therefore, it is essential that the Navy program fully now to support all the tests, targets, and Aegis combat system equipment needed to conduct realistic self-defense testing using an AMDR and Aegis-equipped SDTS.
  - The modification/upgrades being planned for 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 previous recommendations. The Navy should:
    1. Program 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 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 approval in coordination with the TTEMP.
  - FY16 Recommendations. The Navy should:
    1. 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, ESSM

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Block 2 programs, and document that strategy into draft TEMPs for those programs to be provided to DOT&E.

2. Program funds in the Future Years Defense Plan to complete all activities and procurements required to conduct adequate operational testing of the DDG 51 Flight III, AMDR, and ESSM Block 2's self-defense capabilities on an Aegis-equipped SDTS scheduled for FY23.
3. Include within the LFT&E Strategy, testing aimed at addressing LFT&E knowledge gaps that can be included in codes/tools designed to assist in determining the platforms' vulnerability and recoverability.