

Aegis Modernization Program

Executive Summary

- The Navy is modernizing the Aegis Weapon System (AWS) on Aegis guided missile cruisers and destroyers via Advanced Capability Build (ACB)-12 and ACB-16 baseline upgrades.
 - ACB-12 Baseline 9.A0 upgrades Baseline 3 *Ticonderoga* (CG 47)-class cruisers.
 - ACB-12 Baseline 9.C1 upgrades Flight I *Arleigh Burke* (DDG 51)-class destroyers.
 - ACB-12 Baseline 9.C1 will also be equipped on new construction Flight IIA DDG 51 destroyers, beginning with USS *John Finn* (DDG 113).
 - ACB-16 Baseline 9.C2 upgrades will be installed on Flight IIA DDG 51 destroyers and Baseline 8 and Service Life Extension Program CG 47 cruisers.
- The Navy conducted a subset of planned Baseline 9.A0 operational testing in FY15 and FY16; the remaining test events have not been scheduled. The Navy began Baseline 9.C1 operational testing in FY16 and continued testing through FY17.
- To date, the live area air defense flight test events on Baselines 9.A0 and 9.C1 suggest that area air defense performance against single subsonic and supersonic high-diving targets remains consistent with historical performance against comparable threats. DOT&E intends to issue a final report on Baselines 9.A0 and 9.C1 in FY18.
- To adequately assess the Probability of Raid Annihilation requirement for the self-defense mission for Flight III DDG 51 destroyers/ACB-20, the Navy must provide an accredited modeling and simulation (M&S) suite of the Aegis Combat System (ACS) and an Aegis-equipped Self-Defense Test Ship (SDTS) where the ship's full self-defense kill chain can be tested.
- The SECDEF directed in FY16 and reiterated in FY17 that the Navy fund long-lead items for an Aegis SDTS to be used for testing Aegis ACB-20, DDG 51 Flight III, the Air and Missile Defense Radar (AMDR, a.k.a. AN/SPY-6), and Evolved Seasparrow Missile (ESSM) Block II; the Navy initially complied with the direction but subsequently removed all funding for the Aegis SDTS and the required aerial targets.
- Navy Integrated Fire Control – Counter Air (NIFC-CA) From-the-Sea (FTS) Increment I became a fielded capability in 2015 and was fully integrated as a tactical option in fleet air defense. Future testing of ACB-16, ACB-20, and Standard Missile-6 (SM-6) will evaluate the NIFC-CA FTS Increment II capability.
- The Navy's Aegis Baseline 9.A0 and Aegis Ashore installation (Baseline 9.B) cybersecurity testing identified deficiencies, which are classified. The nature of these deficiencies is such that they could pose significant operational risk in a cyber-contested environment. The implementation of fixes to



previous problems is not anticipated until ACB-16; therefore, the Navy and DOT&E canceled cybersecurity testing of Baseline 9.C1, which will instead take place during ACB-16 operational testing.

System

- The Navy's Aegis Modernization program provides updated technology and systems for CG 47-class Aegis guided missile cruisers and DDG 51-class Aegis guided missile destroyers. This planned, phased program provides similar technology and systems for new construction destroyers.
- The AWS integrates the following components:
 - AWS AN/SPY-1 three-dimensional (range, altitude, and azimuth) multi-function radar
 - AN/SQQ-89 undersea warfare suite that includes the AN/SQS-53 sonar, SQR-19 passive towed sonar array (DDGs 51 through 78, CGs 52 through 73), and the SH-60B or MH-60R helicopter (Flight IIA DDGs 79 and newer have a hangar to allow the ship to carry and maintain its own helicopter)
 - Close-In Weapon System
 - A 5-inch diameter gun
 - Harpoon anti-ship cruise missiles (DDGs 51 through 78, CGs 52 through 73)
 - Vertical Launch System that can launch Tomahawk land attack missiles, Standard Missile 2 and 6 surface-to-air missile variants, ESSMs, and Vertical Launch Anti-Submarine Rocket missiles
- The AWS is upgraded through quadrennial ACBs. The Navy is upgrading the AWS to Baseline 9.A0 on CG 47 cruisers and to Baseline 9.C1 on Flight I and new construction DDG 51 destroyers. Baseline 9 will provide the following new capabilities:

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- Full SM-6 integration
- Integrated Air and Missile Defense (IAMD), to include simultaneous air defense and ballistic missile defense missions on Aegis destroyers equipped with the new Multi-Mission Signal Processor
- NIFC-CA FTS capability
- Starting with USS *John Finn* (DDG 113), new construction Aegis-guided missile destroyers will have Baseline 9 variants of AWS.

Mission

The Joint Force Commander/Strike Group Commander employs AWS-equipped DDG 51 guided missile destroyers and CG 47 guided missile cruisers to conduct:

- Area and self-defense anti-air warfare in defense of the Strike Group

- Anti-surface warfare and anti-submarine warfare
- Strike warfare, when armed with Tomahawk missiles
- IAMD, to include simultaneous offensive and defensive warfare operations
- Operations independently or in concert with Carrier or Expeditionary Strike Groups and with other joint or coalition partners

Major Contractors

- General Dynamics Marine Systems Bath Iron Works – Bath, Maine
- Huntington Ingalls Industries (formerly Northrop Grumman Shipbuilding) – Pascagoula, Mississippi
- Lockheed Martin Maritime Systems and Sensors – Moorestown, New Jersey

Activity

- The Navy conducted Baseline 9.A0 operational testing in FY15 and FY16, but weather and schedule constraints prevented execution of a majority of the planned events. Uncompleted events include a combined surface warfare and air defense firing scenario and a combined supersonic sea-skimming and subsonic sea-skimming anti-ship cruise missile (ASCM) raid. These events are scheduled for FY19. The Navy's Operational Test and Evaluation Force issued a report on Baseline 9.A0 in June 2017 with performance against supersonic sea-skimming ASCM unresolved. DOT&E will report on Baseline 9 operational testing in FY18.
- The Navy continued at-sea operational testing of Baseline 9.C1 on USS *Milius* in May 2017. Additional integrated testing for Baseline 9.C1 on a new construction DDG 51 destroyer was scheduled on USS *John Finn* in September 2017, but it was not successfully executed due to target failure and test ship system casualty.
- Operational testing on DDG 51 destroyers in FY17 included a demonstration of capability against a supersonic sea-skimming stream raid, manned aircraft tracking exercises, a demonstration of fixes implemented to address problems observed in a March 2016 test, and a maintenance demonstration.
- The Navy conducted all operational testing in accordance with DOT&E-approved test plans.
- Cybersecurity testing of Aegis Baseline 9.C1 has been canceled until ACB-16 Baseline 9.C2 operational testing.
- The Navy is developing an M&S suite that can supplement live testing and facilitate a more complete evaluation of air defense performance for DDG 51 Flight III ships in FY23. As part of the overall M&S development strategy, the Navy plans to make limited use of the M&S suite for operational testing of the ACB-16 (Baseline 9.C2) in FY18-22.
- The Navy is developing Test and Evaluation Master Plans (TEMPs) for Aegis ACB-16 (Baselines 9.A2 and 9.C2) and for DDG 51 Flight III/ACB-20 (Baseline 10). The Navy plans to

conduct ACB-16 operational testing in FY18 with additional phases through FY22.

Assessment

- The Navy will not fully assess Aegis IAMD until an AWS M&S test bed is developed and validated. The test bed is under development and is planned to be available by FY20; however, there is no agreed upon strategy to validate the model to support assessment of the close-in self-defense battlespace. A limited Baseline 9.C1 IAMD operational assessment suggests that DDGs can simultaneously support limited air defense and ballistic missile defense missions within overall radar resource constraints. This assessment is supported by a single successful live firing event, managed by the Missile Defense Agency, which included simultaneous live firing of SM-2 and SM-3 missiles against threat-representative targets in an IAMD engagement.
- Early testing of Aegis Baselines 9.A0 and 9.C2 indicate that air defense performance against relatively benign presentations of ASCMs is consistent with historical performance. Operationally realistic presentations during recent operational testing demonstrated multiple challenges associated with defending against more stressing raids.
 - A 2017 test to verify correction of deficiency of problems observed in May 2016 found that the Navy successfully implemented corrective action, but the corrective action did not fully address operational performance concerns.
 - Aegis Baseline 9.C1 has incorporated software changes to address performance against certain stressing air defense threat presentations; however, these changes proved ineffective during developmental testing.
- Developmental testing of Baseline 9 against surface threats indicates that AWS does not fully meet the Navy's desired surface warfare performance levels.
- As appropriate, and until the full capability may be operationally tested, DOT&E will provide periodic operational

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assessments to inform Navy and OSD leadership, as well as Congress, on the progress of T&E of the IAMD mission area.

- Until an Aegis-equipped SDTS is available for testing, it is not possible to characterize the self-defense capabilities of the Aegis cruisers and destroyers, and it is not possible to accredit an M&S suite to determine if the AWS satisfies its Probability of Raid Annihilation requirements.
- In February 2016, the SECDEF directed the Navy to acquire long-lead items needed for an Aegis and AMDR SDTS required for conducting adequate self-defense operational testing for DDG 51 Flight III, Aegis ACB-20, AMDR (also known as AN/SPY-6), and ESSM Block II. The Navy complied with this direction by budgeting for a single face of the AMDR to be procured. However, the Navy has not budgeted for the needed ACS or the test resources to support the self-defense operational testing for DDG 51 Flight III. Additionally, the SECDEF directed the Navy to update the Aegis/Flight III, AMDR, and ESSM TEMPs to include the Aegis SDTS and self-defense test events; the Navy has not complied with this direction. Subsequently, in FY17, the Navy removed all funding for the SDTS.
- The Navy's Aegis Baseline 9.A cybersecurity testing identified deficiencies, which are classified. The nature of these deficiencies is such that they could pose operational risk in a cyber-contested environment. Details can be found in DOT&E's Early Fielding Report dated July 2015. Subsequent to this report, follow-on cybersecurity testing of Aegis Ashore installation (Baseline 9.B) revealed similar problems. Therefore, the Navy and DOT&E canceled cybersecurity testing of Baseline 9.C1 and will evaluate implementation of fixes to previous problems as part of ACB-16 operational testing.
- During both integrated and operational testing events, the instability of the Aegis operator consoles adversely affected the

conduct of test events. The Navy is addressing these problems and DOT&E intends to assess the Navy's efficacy in the final Baseline 9 report in FY18.

Recommendations

- Status of Previous Recommendations. The Navy has not addressed the following previous recommendations to:
 1. Continue to improve Aegis ships capability to counter high-speed surface threats in littoral waters.
 2. Synchronize future baseline operational testing and reporting with intended ship-deployment schedules to ensure that testing and reporting are completed prior to deployment.
 3. Provide the necessary funding to support the procurement of an advanced AMDR- and Aegis-equipped SDTS that is needed to support Aegis Modernization, advanced AMDR DDG 51 Flight III, and ESSM Block 2 operational testing.
 4. As soon as possible, produce an integrated test strategy for the DDG 51 Flight III, AMDR, Aegis Modernization, and ESSM Block 2 programs and capture that strategy in the TEMPs to be approved by DOT&E.
 5. Develop and deploy necessary cybersecurity corrective actions and verify correction with a follow-on operational cybersecurity test during ACB-16 operational testing.
 6. Complete the planned FOT&E events as detailed in the approved test plan as soon as is practical.
 7. Include planning for NIFC-CA FTS Increment II and NIFC-Collateral testing in future updates to the Aegis Modernization ACB-16 and ACB-20 and SM-6 TEMPs.
- FY17 Recommendations. The previous recommendations remain valid for FY17.

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