

## Aegis Ballistic Missile Defense (Aegis BMD)

### Executive Summary

- The Aegis Ballistic Missile Defense (BMD) program completed the initial phase of developmental flight testing of the Aegis BMD 4.0.1 and 4.0.2 defense capabilities with Standard Missile-3 (SM-3) Block IB interceptors, and it commenced a phase of combined developmental and operational testing (DT/OT) for the 4.0.1 and 4.0.2 system and interceptor.
- The Aegis BMD program conducted four intercept missions in FY12; three were successful and one failed.
- Although the program completed the FOT&E phase for the Aegis BMD 3.6.1 system in FY11, the system continued to take part in BMDS-level tests related to Phase 1 of the European Phased Adaptive Approach (EPAA) and other system-level deployments.
- Aegis BMD continued to improve interoperability with other Ballistic Missile Defense System (BMDS) elements and sensors during flight and ground testing in FY12.
- Hardware-in-the-loop (HWIL) ground testing demonstrated potential Aegis BMD capability to contribute to theater-level defense missions spanning a range of ballistic missile defense scenarios.

### System

- Aegis BMD is a sea-based missile defense system that employs the multi-mission shipboard Aegis Weapon System, with new radar and missile capabilities to engage ballistic missile threats. Capabilities of Aegis BMD include:
  - Computer program modifications to the AN/SPY-1 radar, which allow long-range surveillance and track (LRS&T) of ballistic missiles of all ranges.
  - A modified Aegis Vertical Launch System, which stores and fires SM-3 Block IA and Block IB interceptors (on select ships), and modified SM-2 Block IV interceptors (on select ships).
  - SM-3 Block IA and Block IB interceptors, which use a maneuverable kinetic warhead to accomplish midcourse engagements of short-, medium-, and intermediate-range ballistic missiles.
  - Modified SM-2 Block IV interceptors, which provide terminal engagement capability against short-range ballistic missiles.



- Aegis BMD is capable of performing autonomous missile defense operations, operations that exploit networked sensor information, and can send or receive cues to or from other BMDS sensors through tactical datalinks.

### Mission

The Navy can accomplish three missile defense-related missions using Aegis BMD:

- Defend deployed forces and allies from short- to intermediate-range theater ballistic missile threats
- Provide forward-deployed radar capabilities to enhance defense against ballistic missile threats of all ranges by sending cues or target track data to other elements of the BMDS
- Provide all short- to long-range ballistic missile threat data to the Command, Control, Battle Management, and Communications (C2BMC) system for dissemination to Combatant Commanders' headquarters to ensure situational awareness

### Major Contractors

- Lockheed Martin Maritime Systems and Sensors – Moorestown, New Jersey
- Raytheon Missile Systems – Tucson, Arizona

### Activity

- In accordance with the DOT&E-approved Integrated Master Test Plan, the Aegis BMD program completed the initial phase of developmental flight testing of the Aegis BMD 4.0.1 and 4.0.2 defense capabilities with SM-3 Block IB interceptors,

and it commenced a phase of combined DT/OT for the 4.0.1 and 4.0.2 system and interceptor.

- Although the program completed FOT&E for the Aegis BMD 3.6.1 system in FY11, the program continued to use

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- the 3.6.1 system in BMDS-level tests related to Phase 1 of the EPAA and other system-level deployments.
- The Aegis BMD program conducted four intercept missions in FY12; three were successful and one failed:
    - During Flight Test SM-16 (FTM-16) Event 2A in May 2012, an Aegis BMD 4.0.1 cruiser intercepted a short-range non-separating ballistic missile target with an SM-3 Block IB interceptor. The FTM-16 Event 2A engagement was the first intercept of a ballistic missile with the SM-3 Block IB interceptor and Aegis BMD 4.0.1 system.
    - During FTM-18 in June 2012, an Aegis BMD cruiser with 4.0.1 software intercepted a simple separating ballistic missile target with an SM-3 Block IB interceptor. FTM-18 was the second successful intercept mission conducted with the new Aegis BMD 4.0.1 system with an SM-3 Block IB interceptor, and the first combined DT/OT flight test for that system.
    - During Flight Test Integrated-01 (FTI-01) in October 2012, an Aegis BMD 3.6.1 ship performed a near-simultaneous engagement of a short-range simple separating ballistic missile target with an SM-3 Block IA interceptor and an anti-air warfare target with an SM-2 interceptor. FTI-01 was the first integrated flight test with multiple firing elements (Aegis BMD, Terminal High-Altitude Area Defense [THAAD], and Patriot) engaging multiple ballistic missile and air-breathing targets in a realistic BMDS-level architecture. While the SM-3 Block IA interceptor missed its target, the SM-2 interceptor achieved a successful intercept.
  - In FY12, Aegis BMD participated in several flight and ground tests to assess Aegis BMD 3.6.1 and 4.0.1 system functionality and interoperability with the BMDS:
    - Ground Test Integrated-04d (GTI-04d) Part 2 in October 2011 tested the engagement capabilities of existing missile defense systems against short- and medium-range ballistic missiles and tested system-level sensor resource management and tasking in an HWIL environment in support of an EPAA Phase 1 assessment. Participants included Space-Based Infrared System/Defense Support Program (SBIRS/DSP), Aegis BMD (laboratory sites with 3.6.1 software), AN/TPY-2 (Forward-Based Mode [FBM]), and C2BMC.
    - The MDA completed GTI-04 (Israel) in November 2011, which tested the interoperability of Israel's joint BMDS. It integrated the following U.S. and Israeli systems: Aegis BMD 3.6.1, C2BMC AN/TPY-2 (FBM), SBIRS/DSP, THAAD, and a representation of the Israeli Arrow Weapons System.
    - During Flight Test THAAD (FTT)-12 in October 2011, an Aegis BMD laboratory representation was utilized to assess the capability of Aegis BMD 3.6.1 to conduct simulated engagements against separating and non-separating short-range ballistic missiles using track data from the Space Tracking and Surveillance System (STSS).
    - Ground Test Distributed-04d (GTD-04d) Part 2 in December 2011 tested the communication architecture that was deployed as part of EPAA Phase 1. Participants included a laboratory representation of Aegis BMD 3.6.1, and AN/TPY-2 (FBM) and C2BMC assets in a distributed environment using operational communication systems and operationally representative crews.
    - GTD-04d Part 3 in December 2011 tested interoperability and engagement capability of the EPAA Phase 1 system in support of deployment. Participants included Aegis BMD (3.6.1 laboratory representation), AN/TPY-2 (FBM), and C2BMC in a distributed environment using operational communication systems and operationally representative crews.
    - Aegis BMD 3.6.1 participated in the FTM-15 System-level Post-Flight Reconstruction (SPFR) in December 2011, which was a BMDS HWIL-based event designed to provide data in support of modeling and simulation anchoring efforts.
    - Aegis BMD 4.0.1 laboratory representations participated in Ground Test Other-04e (GTX-04e) in March and April 2012. GTX-04e provided the necessary HWIL architecture for testing new engagement and LRS&T capabilities of Aegis BMD 4.0.1. The test integrated C2BMC, Ground-based Midcourse Defense, AN/TPY-2 (FBM), Patriot, Sea-Based X-Band, THAAD, and Aegis BMD to support developmental test data collection.
    - Aegis BMD participated in the Fast Eagle Increment 1 HWIL exercise in June 2012, during which ballistic missile defense capabilities were explored using laboratory assets for Aegis BMD (3.6.1), AN/TPY-2 (FBM), C2BMC, SBIRS/DSP, and Patriot, with U.S. military operators manning the systems. These tests were designed to evaluate the capability of the AN/TPY-2 (FBM) and U.S. Central Command (USCENTCOM) C2BMC to augment the existing USCENTCOM BMDS capability.
    - The FTI-01 System Pre-Mission Test (SPMT) in July 2012 explored integrated engagement capability for Aegis BMD, THAAD, and Patriot in an operationally relevant architecture using HWIL assets. Aegis BMD 3.6.1 demonstrated simultaneous ship self-defense and ballistic missile defense as part of the test.
    - Fast Eagle Increment 1 Distributed in August 2012 assessed the capability of AN/TPY-2 (FBM) and C2BMC to augment a theater-regional defense architecture with Aegis BMD (3.6.1), THAAD, and Patriot fire units. U.S. military operators manned deployed tactical BMDS assets in the test.
    - Aegis BMD 3.6.1 participated in the Fast Eagle Increment 1+ HWIL exercise in September 2012. Laboratory representations of Aegis BMD, AN/TPY-2 (FBM), C2BMC, SBIRS/DSP, and Patriot explored ballistic missile defense capabilities in a theater regional environment. U.S. military operators manned the systems.

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## Assessment

- In FY12, Aegis BMD demonstrated the capability to perform end-to-end engagements against non-separating and simple separating short-range ballistic missiles with the Aegis BMD 4.0 system and SM-3 Block IB interceptors.
- In response to the anomalous behavior observed during the SM-3 Block IA flyout in FTM-15 (April 2011), the program redesigned a component in the third stage rocket motor, which is common to both the Block IA and Block IB interceptors. The newly redesigned component was flown in FTM-18 and performed successfully.
- The failed intercept in FTM-16 Event 2 (September 2011) is currently being addressed by the program. The program conducted three initial ground firing tests of the SM-3 third stage rocket motor to further understand the FTM-16 anomaly. Subsequently, the program conducted three ground firings of the third stage rocket motor to further verify that it functions properly using newly-adjusted firing parameters. Two more ground firings are planned before the end of the calendar year to close-out actions from the FTM-16 failure review board.
- GT-04 series ground tests in early FY12, which addressed EPAA Phase 1, showed that improvements in interoperability are needed between the various elements and sensors that are part of the EPAA Phase 1 defense architecture, including the Aegis BMD 3.6.1 system that continues to take part in these tests after completion of its FOT&E.
- The near-simultaneous engagement of an anti-air warfare target during FTI-01 verified ship self-defense capability

while conducting a ballistic missile engagement even though the SM-3 Block IA interceptor missed its target. The MDA is investigating the cause of the missed intercept; however, their efforts will be hindered because Kill Weapon telemetry was lost during key portions of the engagement flyout.

- No LRS&T events are planned for Aegis BMD 4.0 until FTG-08. Aegis BMD has tested that capability only once during a flight test (FTG-06a in December 2010) and in ground testing to date. Further live-target testing of this capability is needed to allow for an assessment.

## Recommendations

- Status of Previous Recommendations. The program partially addressed the single recommendation from FY11 when it conducted FTM-18 testing with the redesigned component in the SM-3 third stage rocket motor (to address the FTM-15 anomaly). Flight testing to demonstrate the correction for the FTM-16 Event 2 failure has not yet taken place.
- FY12 Recommendations. The program should:
  1. Conduct further live-target testing of the Aegis BMD 4.0.2 LRS&T capability using long-range targets to provide additional data on that capability for the Aegis BMD 4.0.2 system.
  2. Engage a medium-range target before the Full-Rate Production Decision for the SM-3 Block IB interceptor to support an assessment of midcourse defense capability.

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