

Sensors

Executive Summary

- Ballistic Missile Defense System (BMDS) sensors participated in five ground tests, three flight tests, and exercise Fast Eagle Increment 1 testing during the reporting period.
- Although the Missile Defense Agency (MDA) placed the Sea-Based X-band (SBX) radar into a limited test support and standby operational status, the MDA continued to include it in ground tests when appropriate.
- Accreditation of each of the sensor models for use in performance assessments continues to progress but is incomplete.
- The BMDS Operational Test Agency Team will be unable to accredit the Cobra Dane radar model until after the MDA completes a 3QFY15 flight test involving the radar.

System

The BMDS sensors are systems that provide real-time ballistic missile threat data to the BMDS. The data are used to counter ballistic missile attacks. These sensor systems are operated by the Army, Navy, Air Force, and the MDA, and include a satellite-based, infrared sensor system and five phased array radar system types. The sensor systems are:

- Space Based Infrared System/Defense Support Program (SBIRS/DSP), a satellite constellation of infrared sensors operated by the Air Force with an external interface to the BMDS located at Buckley AFB, Colorado
- Fixed site, fixed orientation, phased array radars
 - Cobra Dane Upgrade (CDU) Radar, an L-band radar (one radar face that provides 120-degree azimuth field of view) operated by the Air Force and located at Eareckson Air Station (Shemya Island), Alaska
 - Upgraded Early Warning Radars (UEWRs), ultra high frequency radars operated by the Air Force and located at Beale AFB, California (two radar faces that provide 240-degree azimuth field of view); Fylingdales, United Kingdom (three radar faces



SBIRS/DSP



Cobra Dane



UEWR

that provide 360-degree azimuth field of view); and Thule, Greenland (two radar faces that provide 240-degree azimuth field of view). [The MDA and Air Force Space Command awarded a contract in July 2012 for the upgrade of the Early Warning Radar (EWR) at Clear Air Force Station, Alaska. The contract also included an option for the upgrade of the EWR at Cape Cod Air Force Station, Massachusetts.]

- Mobile platform, variable orientation, phased array radars

- AN/TPY-2 (Forward-Based Mode [FBM]) Radars, X-band radars (one radar face that provides 120-degree azimuth field of view) operated by the Army and located at Shariki Air Base, Japan, and sites in Israel and Turkey



AN/TPY-2

- Aegis Ballistic Missile Defense (Aegis BMD) AN/SPY-1 Long-Range Search and Track (LRS&T) Radars, S-band radars (four radar faces that provide 360-degree azimuth field of view) operated by the Navy and located aboard Aegis BMD-capable cruisers and destroyers
- Sea-Based X-Band (SBX) Radar, an X-band radar operated by BMDS and located aboard a twin hulled, semi-submersible, self propelled, ocean going platform (primarily a test asset that can be operationally deployed as needed)



Aegis BMD



SBX

Mission

Military operators for the U.S. Strategic Command, U.S. Northern Command, U.S. European Command, U.S. Pacific Command, and U.S. Central Command will use the BMDS sensors to:

- Detect, track, and classify ballistic missile threats that target the United States, U.S. allies, and U.S. friends
- Provide data for situational awareness and battle management to the BMDS Command, Control, Battle Management, and Communications (C2BMC)
- Provide data that support engagement of ballistic missile threats by ballistic missile defense systems

BALLISTIC MISSILE DEFENSE SYSTEMS

Major Contractors

Aegis AN/SPY-1

- Lockheed Martin – Moorestown, New Jersey

AN/TPY-2

- Raytheon Company, Integrated Defense Systems – Woburn, Massachusetts

CDU

- Raytheon Company, Integrated Defense Systems – Woburn, Massachusetts

SBIRS

- Lockheed Martin Space Systems Company – Sunnyvale, California

SBX

- Raytheon Company, Integrated Defense Systems – Woburn, Massachusetts

UEWRs/EWRs

- Thule, Beale, and Fylingdales
 - Exelis – Colorado Springs, Colorado
- Clear and Cape Cod
 - Raytheon Company, Integrated Defense Systems – Woburn, Massachusetts

Activity

- The MDA conducted testing during FY12 in accordance with the DOT&E-approved Integrated Master Test Plan.
- The MDA used an AN/TPY-2 (FBM) radar, SBX radar, Cobra Dane radar, and the UEWRs at Beale, Fylingdales, and Thule in a BMDS-level satellite test campaign. Using these radars, the MDA tracked selected satellites to collect data that the MDA and the BMDS Operational Test Agency Team use to verify, validate, and accredit the radar models and simulations used to assess BMDS performance.

Aegis BMD Radar

- The MDA used a hardware-in-the-loop (HWIL) representation of the Aegis BMD radar in its long-range surveillance and track mode in Ground Test Focused-04e (GTX-04e) in April 2012.

AN/TPY-2 (FBM) Radar

- The AN/TPY-2 (FBM) radar participated in Flight Test Integrated-01 (FTI-01) in October 2012. In FTI-01, the AN/TPY-2 (FBM) radar provided up-range track data to C2BMC for processing, down-select, and forwarding of tracks to Aegis BMD, Patriot, and Terminal High-Altitude Area Defense (THAAD).
- In 1QFY12, deployed AN/TPY-2 (FBM) radars participated in Ground Tests Distributed (GTDs) to demonstrate Phase 1 European Phased Adaptive Approach (EPAA) capability:
 - GTD-04d (Part 2) provided the data required for a Technical Capability Declaration of the EPAA Phase 1 radar.
 - GTD-04d (Part 3) completed the EPAA Phase 1 Capability demonstration including C2BMC control of multiple deployed AN/TPY-2 radars.
- The AN/TPY-2 (FBM) radar participated in the BMDS-level distributed ground test Fast Eagle Increment 1 in August 2012. The MDA used this testing to evaluate the capability of the AN/TPY-2 (FBM) radar and the associated C2BMC to augment existing Combatant Command BMDS capability.
- The MDA used an HWIL representation of the AN/TPY-2 (FBM) radar in these BMDS-level ground tests: Ground Test Integrated-04d (GTI-04d) Part 2 (October 2011),

GTI-04 (Israel [ISR]) (November 2011), GTX-04e (April 2012), and Fast Eagle Increment 1 (June 2012 and September 2012).

- AN/TPY-2 (FBM) radars participated in BMDS Integrated Sensor Demonstration – Space Situational Awareness (BISD-SSA), a Joint Chiefs of Staff sponsored test with C2BMC and Air Force Space Command. This test demonstrated the ability of AN/TPY-2 (FBM) radars to acquire and track space objects. The Joint Space Operations Center (JSPOC) sent tasking messages to C2BMC, which converted the messages into radar task commands that the radars executed. Data were collected and sent to JSPOC in real time, which then published the data for authorized user access.

Cobra Dane Radar

- HWIL representations of the Cobra Dane radar participated in the BMDS-level ground test GTX-04e in April 2012.
- In FY12, the Air Force used the Cobra Dane radar to observe targets of opportunity. The U.S. Space Command also used the Cobra Dane radar as a contributory sensor to the Space Surveillance Network to track orbital debris and active satellites.

SBIRS/DSP System

- During FY12, the Air Force used the SBIRS/DSP system to observe domestic and foreign launch events, provide launch event data to the operational BMDS, and participate in the intercept flight tests: Flight Test Standard Missile-3-16 (FTM-16) Event 2a, FTM-18, and FTI-01.
- A digital representation of the SBIRS/DSP system participated in the BMDS-level ground tests: GTI-04d Part 2 (October 2011), GTI-04 (ISR) (November 2011), GTX-04e (April 2012), and Fast Eagle Increment 1 (August 2012).

SBX Radar

- An HWIL representation of the SBX radar participated in the BMDS-level ground test GTX-04e in April 2012.
- Both an HWIL and digital representations (simulations) of the SBX radar participated in pre-mission testing for the upcoming Ground-based Midcourse Defense (GMD)

intercept Flight Test Ground-based Interceptor-06B (FTG-06b).

- The MDA utilized Glory Trip-203, a Minuteman III intercontinental ballistic missile test, to demonstrate the ability of SBX to exercise software build 2.2.1.2.5 in a live track mission, collecting advanced discrimination algorithm data for future use, verifying algorithms, and supporting analysis/risk reduction for upcoming tests, such as FTG-06b.
- The MDA placed SBX in a limited test support status. The SBX can be reactivated based on warning of a threat presented to the United States, and for BMDS flight testing.

UEWR/EWR – Beale, Thule, Fylingdales, Clear, and Cape Cod

- HWIL representations of the UEWRs at Beale, Fylingdales, and Thule participated in the BMDS-level ground test GTX-04e in April 2012.
- In FY12, the U.S. Air Force used the Beale, Fylingdales, and Thule UEWRs, and Clear and Cape Cod EWRs, to observe targets of opportunity. U.S. Space Command also used these radars as collateral sensors to the Space Surveillance Network to track orbital debris and active satellites.

Assessment

- The MDA has gained significant operational experience with each of the BMDS sensors since the completion of sensor upgrade and development programs.
- The MDA and the BMDS Operational Test Agency Team, however, have not fully accredited models and simulations of the BMDS sensors for performance assessment. Representations of the AN/TPY-2 (FBM) radar, the SBX radar, and the UEWR have been accredited for limited uses. Representations of the Aegis BMD radar, the Cobra Dane radar, and the SBIRS/DSP system have not been accredited. The MDA is analyzing the radar performance data that were collected in the FY12 satellite tracking campaign for its use toward accreditation of multiple radar models and simulations.
- Starting in FY13, the U.S. Air Force will have the responsibility for the sustainment of the Cobra Dane radar and the UEWRs. The U.S. Air Force does not currently gather all of the operational data required for assessing suitability.

Aegis BMD Radar

- In GTX-04e, and in prior ground tests, the MDA demonstrated a capability of the Aegis BMD radar (in its LRS&T mode) to support GMD engagement of intermediate-range and intercontinental ballistic missile threats.
- The Aegis BMD radar provided data that enabled the GMD system to generate sensor cueing and missile engagement plans. However, a quantitative assessment of the Aegis BMD radar LRS&T mode performance was not possible since the MDA used some models and simulations (including the intermediate-range and intercontinental ballistic missile threat models) that were not accredited for performance assessment.

- The MDA has not conducted a BMDS intercept flight test that uses the Aegis BMD LRS&T radar data in real-time as the primary data source for GMD engagement planning. The MDA currently plans to conduct this test during 3QFY14.

AN/TPY-2 (FBM) Radar

- In FTI-01, the MDA demonstrated AN/TPY-2 (FBM) radar capability to provide up-range track data to C2BMC to support engagement of a medium-range ballistic missile by THAAD.
- In the BMDS-level ground tests, the MDA demonstrated AN/TPY-2 (FBM) radar capability to provide real-time track data that supported BMDS situational awareness, BMDS sensor tasking, and GMD engagement planning. However, a quantitative assessment of the AN/TPY-2 (FBM) radar performance was not possible since the MDA used some models and simulations (including the intermediate-range and intercontinental ballistic missile threat models) that were not accredited for performance assessment.

Cobra Dane Radar

- In GTX-04e, the MDA demonstrated interoperability of the Cobra Dane radar with a new version of the GMD Fire Control software. In addition, the MDA demonstrated a capability of the Cobra Dane radar to provide real-time data that enabled the GMD system to generate missile engagement plans and supported GMD system engagement of intermediate-range and intercontinental ballistic missile threats. A quantitative assessment of the Cobra Dane radar performance was not possible since the MDA used some models and simulations (including the intercontinental ballistic missile threat models) that were not accredited for performance assessment.
- Due to its location and field of view, the Cobra Dane radar has not participated in BMDS intercept flight tests. The MDA plans to conduct a target flight test through the Cobra Dane radar field of view in 3QFY15 to support model and simulation accreditation.

SBIRS/DSP System

- SBIRS/DSP system performance and its capability to support BMDS engagement of intermediate-range and intercontinental ballistic missile threats will be provided in the classified appendix of DOT&E's "2012 Assessment of the Ballistic Missile Defense System (BMDS)" report to Congress.

SBX Radar

- In GTX-04e, the MDA demonstrated interoperability of the SBX radar with a new version of the GMD Fire Control software.
- The MDA has demonstrated a capability of the SBX radar to support GMD engagement planning against an intermediate-range ballistic missile target. However, the MDA has not gathered adequate SBX radar performance data against intermediate-range and intercontinental

ballistic missile threats and targets to enable accreditation of the SBX radar models and simulations that are required for performance assessment.

UEWR/EWR – Beale, Thule, Fylingdales, Clear, and Cape Cod

- Due to their locations and fields of view, the UEWRs at Beale, Thule, and Fylingdales have not participated in BMDS intercept flight tests in an operationally realistic manner. Data from targets of opportunity and ground tests support performance estimates for the current configuration of the UEWRs. These estimates rely on models and simulations that have not been fully accredited for use in performance assessment.
- The MDA and the Air Force have not yet upgraded the EWRs at Clear and Cape Cod Air Force Stations, and these radars are not yet part of the MDA's sensor network.

Recommendations

- **Status of Previous Recommendations.** The MDA has satisfactorily addressed all but two of the previous sensor recommendations. Although the MDA and Combatant Commanders have made progress on developing concepts of operations for the sensors, this FY09 recommendation

remains open pending completion of those concepts and implementation in operational testing. Additionally, while the MDA has specified the Aegis BMD LRS&T radar as the primary data source for GMD engagement planning in an intercept flight test attempt in 3QFY14, this FY11 recommendation remains open pending successful execution of that test.

- **FY12 Recommendations.** The DOT&E February 2012 THAAD and AN/TPY-2 Radar Operational and LFT&E Report made three recommendations for the MDA and Army to consider for AN/TPY-2(FBM). One of the recommendations aligns directly with the Army materiel release conditions, which are being addressed through a plan agreed upon by the Sensors Product Office and the Army. The following two recommendations from the report remain open.
 1. Perform additional flight testing with multiple AN/TPY-2 (FBM) radars in a single Area of Regard or theater to assess C2BMC's ability to correctly task and coordinate track data from multiple radars.
 2. Conduct independent, dedicated AN/TPY-2 (FBM) Information Assurance testing.