

## Sensors

### Executive Summary

- The MDA has gained significant operational experience with each of the Ballistic Missile Defense System (BMDS) sensors since the completion of sensor upgrade and development programs.
- BMDS sensors participated in two major ground tests, five flight tests, Fast Eagle II Increment 2, and Fast Aim testing during the reporting period.
- The Missile Defense Agency (MDA) placed the Sea-Based X-band (SBX) radar into a limited test support and standby operational status, and includes it in ground and flight tests when appropriate.
- Accreditation of each of the sensor models for use in performance assessments continues to progress but is still incomplete. The BMDS Operational Test Agency Team has completed some limited accreditation; however, the Team will be unable to accredit the COBRA DANE radar model until after the MDA completes a 2QFY15 flight test involving the radar.

### System

The BMDS sensors are systems that provide real-time boosting and 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



SBIRS/DSP



COBRA DANE

240-degree azimuth field of view); Fylingdales, United Kingdom (three radar faces that provide 360-degree azimuth field of view); and Thule, Greenland (two radar faces that provide 240-degree azimuth field of view).



UEWR

(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. In December 2012, a contract option was exercised for the upgrade of the EWR at Cape Cod Air Force Station, Massachusetts.)

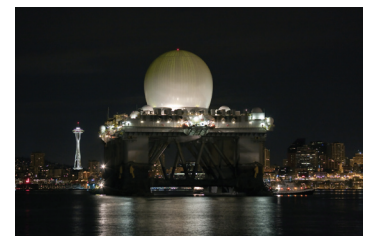
- Mobile/portable variable orientation, phased array radars
  - AN/TPY-2 (Forward-Based Mode [FBM]) radars, X-band radars (one radar face that provides a classified azimuth field of view) operated by the Army and located at Shariki Air Base, Japan, and sites in Israel, Turkey, and the U.S. Central Command area of responsibility
  - Aegis Ballistic Missile Defense (Aegis BMD) AN/SPY-1 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
  - 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)



AN/TPY-2



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 and Control, Battle Management, and Communications (C2BMC)
- Provide data that support engagement of ballistic missile threats by ballistic missile defense systems

## Major Contractors

### Aegis BMD Radar

- Lockheed Martin Corporation, Mission Systems and Training – Moorestown, New Jersey

### AN/TPY-2 (FBM) Radar

- Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts

### COBRA DANE Radar

- Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts

### SBIRS/DSP

- Lockheed Martin Space Systems – Sunnyvale, California

### SBX Radar

- Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts

### UEWRs/EWRs

- Thule, Beale, and Fylingdales: Northrop Grumman Corporation, Aerospace Systems – Redondo Beach, California
- Clear and Cape Cod: Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts

## Activity

The MDA conducted testing during FY13 in accordance with the DOT&E-approved Integrated Master Test Plan.

### Aegis BMD Radar

- The Aegis BMD radar participated in Flight Test Ground-Based Interceptor-7 (FTG-07). In FTG-07, the Aegis BMD radar detected and tracked the intermediate-range ballistic missile (IRBM) target and forwarded the track data to the C2BMC system.
- The MDA conducted a hardware-in-the-loop (HWIL) test called Fast Aim in August 2013. The MDA used hardware and software representations of the Aegis BMD radar. In this test, the Aegis BMD radar representation detected and tracked simulated intercontinental ballistic missile (ICBM) threats to a portion of the U.S. Homeland and forwarded the track data to an HWIL representation of the C2BMC.

### 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).
- The AN/TPY-2 (FBM) radar participated in Flight Test Operational-01 (FTO-01) in August 2013. In FTO-01, the AN/TPY-2 (FBM) radar detected and tracked multiple Regional/Theater ballistic missile threats and provided track reports to the C2BMC.
- HWIL representations and distributed AN/TPY-2 (FBM) radar assets participated in Ground Test Integrated-04e Part 1 (GTI-04e Part 1), an MDA combined developmental/operational ground test, in November 2012, Fast Eagle II Increment 2 and distributed testing in February 2013, and GTI-04e Part 1a integration testing in April 2013. AN/TPY-2 (FBM) interactions with

C2BMC, interoperability, and some engagement support capabilities in various U.S. European Command and U.S. Central Command theater scenarios against short- and medium-range ballistic missiles were tested using BMDS configurations that are deployed or deployable.

- The MDA used an HWIL representation of the AN/TPY-2 (FBM) radar in Fast Aim in August 2013. In Fast Aim, the AN/TPY-2 (FBM) radar representation detected and tracked simulated ICBM threats to a portion of the U.S. Homeland and forwarded the track data to an HWIL representation of the C2BMC.

### COBRA DANE Radar

- In FY13, the U.S. Air Force used the COBRA DANE radar to observe targets of opportunity. The Air Force Space Command (AFSPC) also used the COBRA DANE radar as a contributory sensor to the Space Surveillance Network to track orbital debris and active satellites.

### SBIRS/DSP

- In FY13, the U.S. Air Force used the SBIRS/DSP system to observe domestic and foreign launch events and provide launch event data to the operational BMDS. The SBIRS/DSP system also participated in multiple BMDS intercept flight tests including FTI-01, FTO-01, FTM-20, and FTG-07.
- A digital representation of the SBIRS/DSP system participated in Fast Aim in August 2013.

### SBX Radar

- The MDA has placed the SBX radar in a limited test support status. The SBX radar can be reactivated based on warning of an ICBM threat to the U.S. Homeland and for BMDS flight testing. The SBX was deployed from limited test support status in FY13 for both flight test and operational contingency.

# BALLISTIC MISSILE DEFENSE SYSTEMS

- The SBX radar participated in FTG-07. In FTG-07, the SBX radar accepted sensor task plans from the Ground-Based Midcourse Defense (GMD) Fire Control (GFC), detected and tracked the IRBM target, and forwarded track data to the GFC.
- An HWIL representation of the SBX radar participated in Fast Aim in August 2013. In Fast Aim, the SBX radar representation detected and tracked simulated ICBM threats to a portion of the U.S. Homeland and forwarded the track data to an HWIL representation of the GFC.
- SBX performed track and discrimination on Minuteman III launches as targets of opportunity in Glory Trips 207, 208-1, and 209.

## UEWRs/EWRs

- In FY13, the U.S. Air Force used the Beale, Fylingdales, and Thule UEWRs, and the Clear and Cape Cod EWRs, to observe targets of opportunity. The AFSPC also used these radars as collateral sensors to the Space Surveillance Network to track orbital debris and active satellites.
- In FY14, the MDA will complete the transfer of the Beale, Fylingdales, and Thule UEWRs to AFSPC.

## Assessment

- The MDA has gained significant operational experience with each of the BMDS sensors since the completion of the 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, the UEWR, the Aegis BMD radar, and the SBIRS/DSP system have been accredited for limited uses. Representations of the COBRA DANE radar 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.
- In FY14, AFSPC will take over responsibility for the sustainment of the COBRA DANE radar and the UEWRs.

## Aegis BMD Radar

- The MDA used the Aegis BMD radar as the primary data source for the GMD engagement planning in FTG-07. Although the interceptor failed to intercept the target, post-test analysis demonstrated that the Aegis BMD radar supported GMD engagement planning and generation by the GFC of a successful sensor task plan. In this test, however, the Aegis BMD employed an alternate concept of operations (CONOPs) that was different from the operational CONOPs that Aegis BMD currently employs. Therefore, the Aegis BMD performance that was demonstrated pertains to the Aegis BMD with the alternate CONOPs and does not pertain to Aegis BMD performance within the current, operational CONOPs.
- In Fast Aim, the MDA demonstrated a capability of the Aegis BMD radar to support a potential new BMD

capability against ICBM threats, which will be reported in the classified appendix to DOT&E's annual BMDS report in February 2014.

- In previously conducted BMDS integrated ground tests, the MDA demonstrated a capability of the Aegis BMD radar to support GMD engagement of IRBM and ICBM threats. The Aegis BMD radar provided data that enabled the GMD system to generate sensor cueing and missile engagement plans.

## 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 cueing of Aegis BMD, AN/TPY-2 (Terminal Mode), and Patriot. Interoperability was sufficient for the flight test, but there were track correlation issues for one of the targets that the AN/TPY-2 (FBM) radar tracked that could be problematic in other scenarios.
- In FTO-01, the MDA demonstrated AN/TPY-2 (FBM) radar capability to support a BMDS Regional/Theater layered defense against a small raid of threat-representative, medium-range ballistic missile threats flying challenging and realistic attack profiles.
- The GTI-04e and Fast Eagle ground tests demonstrated interoperability and engagement support using AN/TPY-2 (FBM) for theater scenarios, revealing problems that the MDA is now addressing for multi-sensor and multi-element coordination.
- In Fast Aim, the MDA demonstrated a capability of the AN/TPY-2 (FBM) radar to support a potential new BMD capability against ICBM threats.
- In previously conducted BMDS integrated 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.

## COBRA DANE Radar

- Due to its location and field of view, the COBRA DANE radar has not participated in BMDS intercept flight tests. The MDA currently plans to conduct a target flight test through the COBRA DANE radar field of view in 2QFY15 to support model and simulation accreditation.
- In previously conducted BMDS integrated ground tests, 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 IRBM and ICBM threats.

## SBIRS/DSP

- SBIRS/DSP performance and its capability to support BMDS engagement of IRBM and ICBM threats will be provided in the classified appendix of DOT&E's annual BMDS report to Congress.

## SBX Radar

- In FTG-07, the MDA demonstrated a capability of the SBX radar to detect and track an IRBM target and to provide data to GMD that supported GFC engagement planning and

generation of in-flight target updates. The employment of the SBX radar in that test, however, was not operationally realistic.

- In Fast Aim, the MDA demonstrated a capability of the SBX radar to support a potential new BMD capability against ICBM threats, which will be reported in the classified appendix of DOT&E's annual BMDS report in February 2014.
- The MDA demonstrated a capability of the SBX radar in intercept flight testing to support GMD engagement planning against an IRBM target. However, the MDA has not gathered adequate SBX radar performance data against IRBM and ICBM threats and targets to enable accreditation of the SBX radar models and simulations that are required for performance assessment.
- SBX successfully performed track and discrimination on Minuteman III launches as targets of opportunity in Glory Trips 207, 208-1, and 209.

#### **UEWRs/EWRs**

- Due to their locations and fields of view, the UEWRs at Thule and Fylingdales have not participated in BMDS intercept flight tests in an operationally realistic manner. Beale has participated in all flight tests within its field of view and has supplied critical data in analysis of these flight tests. Data from targets of opportunity and ground tests support performance estimates for the current configuration of the UEWRs. UEWRs have participated in GTIs in the Huntsville labs and all field Distributed Ground Tests.

- The MDA and the U.S. 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 three of the previous sensor recommendations. The MDA and Combatant Commanders have made progress on developing concepts of operations for the sensors, but this FY09 recommendation remains open pending completion of those concepts and implementation in operational testing.
  - 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 MDA Sensors Product Office and the Army. The recommendation to conduct additional flight testing with multiple AN/TPY-2 (FBM) radars in a single Area of Regard or theater has been moved to C2BMC. The recommendation to conduct independent, dedicated AN/TPY-2 (FBM) Information Assurance testing remains open.
- FY13 Recommendations. None.