

## Terminal High-Altitude Area Defense (THAAD)

### Executive Summary

- The Missile Defense Agency (MDA) conducted two Terminal High-Altitude Area Defense (THAAD) flight tests in July 2017, intercepting two ballistic missile targets. In the first test, THAAD demonstrated the ability to defend territory in the U.S. Pacific Command (USPACOM) area of regard. In the second test, THAAD intercepted a complex, separating target in the endo-atmosphere.
- THAAD participated in two Ballistic Missile Defense System (BMDS) ground tests, providing information on THAAD interoperability and functionality within the BMDS for various regional/theater scenarios.
- The THAAD program continued work on resolving liens from the first Conditional Materiel Release in February 2012 and completed Urgent Materiel Releases for six Configuration 2 batteries with THAAD 2.8 software and Lot 4, 5, and 6 interceptors.
- Flight testing in FY17 demonstrated that THAAD training and documentation deficiencies worsened in FY17.
- The THAAD launcher and radar suffered reliability problems in flight tests. The launcher, particularly its 3-kilowatt generator, continued to experience failures and the radar experienced failures in the cooling electronic unit and prime power unit.

### System

- THAAD complements the lower-tier Patriot system and the upper-tier Aegis Ballistic Missile Defense (BMD) system. It is designed to engage threat ballistic missiles in both the endo- and exo-atmosphere.
- THAAD consists of five major components:
  - Missiles
  - Launchers
  - AN/TPY-2 Radar (Terminal Mode)
  - THAAD Fire Control and Communications
  - THAAD Peculiar Support Equipment
- THAAD can accept target cues for acquisition from Aegis BMD, from other regional sensors, and through command and control systems.



### Mission

The U.S. Northern Command, USPACOM, U.S. European Command, and U.S. Central Command intend to use THAAD to intercept short- to intermediate-range ballistic missile (IRBM) threats in their areas of responsibility. The U.S. Strategic Command deploys THAAD to protect critical assets worldwide from these same threats.

### Major Contractors

- Prime: Lockheed Martin Corporation, Missiles and Fire Control – Dallas, Texas
- Interceptors: Lockheed Martin Corporation, Missiles and Fire Control – Troy, Alabama
- AN/TPY-2 Radar (Terminal Mode): Raytheon Company, Integrated Defense Systems – Tewksbury, Massachusetts

### Activity

- The MDA conducted all testing in accordance with the DOT&E-approved Integrated Master Test Plan.
- Two BMDS ground tests using THAAD hardware-in-the-loop representations provided information on THAAD interoperability and functionality in various regional/theater scenarios:
  - In Ground Test Integrated-07a (GTI-07a) in June 2017, the MDA examined homeland and USPACOM defenses using THAAD 2.8 software.
  - In Ground Test Distributed-07a (GTD-07a) in September and October 2017, the MDA again examined homeland and USPACOM defenses using THAAD 2.8 software.

# FY17 BALLISTIC MISSILE DEFENSE SYSTEMS

- The MDA conducted two flight tests in July 2017 at the Pacific Spaceport Complex Alaska on Kodiak Island and the surrounding broad ocean area.
  - Flight Test THAAD-18 (FTT-18), an integrated operational/developmental test, tested against a separating IRBM target.
    - THAAD engaged the target using a salvo of two THAAD interceptors. The THAAD battery consisted of THAAD Configuration 2 hardware, THAAD 2.8.1 software, two launchers equipped with Lot 4 and Fire Unit Fielding interceptors, THAAD Fire Control and Communications, and an AN/TPY-2 radar (Terminal Mode).
    - Additionally, the MDA and the BMDS Operational Test Agency (OTA) conducted BMD simulations with the deployable Simulation-Over-Live Driver (SOLD) to provide data supporting interoperability and effectiveness assessments.
  - Flight Experiment THAAD-01 (FET-01; formerly FTT-15), a developmental test, tested against a complex medium-range ballistic missile (MRBM) re-entry vehicle (RV) at a low endo-atmospheric altitude. This test used the same hardware and software configurations as in FTT-18.
- The THAAD program continued work on resolving liens from the first Conditional Materiel Release and completed Urgent Materiel Releases for six Configuration 2 batteries with THAAD 2.8 software and Lot 4, 5, and 6 interceptors.
- The FY17 Urgent Materiel Releases included the THAAD Portable Planner and THAAD Table Top Trainer to provide battle planning and training functions that would typically be conducted on the tactical system.

## Assessment

- During GTI-07a and GTD-07a, the MDA demonstrated aspects of THAAD functionality in different theater scenarios to support the system-level assessment of enhanced homeland defense capabilities as part of BMDS Increment 4. The BMDS OTA reported several findings, consistent with findings from earlier ground tests that affect THAAD interoperability, track management, and radar functions.
- In FTT-18, the MDA demonstrated, for the first time, THAAD's capability to intercept an RV from a separating IRBM target. The MDA also demonstrated THAAD and the Command and Control, Battle Management, and Communications (C2BMC) Spiral 8.2.1-Link 16 functionality. This demonstration of C2BMC functionality did not involve other BMDS elements (such as Patriot or Aegis BMD) in theater.
- In FET-01, the MDA demonstrated THAAD's ability to discriminate and intercept an RV from a separating MRBM target with countermeasures at an endo-atmospheric altitude. The MDA will use these data to improve interceptor seeker algorithms and to validate modeling and simulation.
- Flight testing in FY17 demonstrated that THAAD training and documentation deficiencies worsened in FY17, despite the addition of the THAAD Table Top Trainer.
  - THAAD Service members continue to be resourced from the existing Patriot Soldier population. Many of the institutional courses provide insufficient time to effectively train operators for their missions, and the operators often encounter software mismatches between institutional training and operational environments.
  - The increasing use of Ground Maintenance Action Messages to address system workarounds or procedures not defined in the technical manuals complicates soldier, crew, and unit operations and training.
  - The BMDS OTA and Service members identified specific training and documentation gaps in communications capabilities, cybersecurity, and system capability understanding at both the institutional and unit levels.
  - The SOLD simulations provided valuable training opportunities during FTT-18 and FET-01; however, the simulation capability that SOLD can provide is not currently available to deployed units.
- The THAAD launcher and radar suffered reliability problems in flight tests. The launcher, particularly its 3-kilowatt generator, continued to experience the failures that were noted in 2015 during Flight Test Operational-02 (FTO-02) Event 2, FTO-02 Event 2a, and the Reliability Growth Test. The radar experienced failures in the cooling electronic unit and prime power unit.
- Problems previously discovered during testing, if not corrected, could adversely affect THAAD effectiveness, suitability, or survivability. The classified 2015 DOT&E assessment of the BMDS details these problems, which include:
  - Training and documentation are still immature.
  - Environmental testing revealed some deficiencies, which the MDA has not corrected.
  - Some specific aspects of discrimination and classification need improvement.
  - Survivability and cybersecurity shortfalls exist, which the MDA continues to assess and decide whether to fix, mitigate, transfer, or accept risks.
- The THAAD program continued to resolve problems noted in the Army's first Conditional Materiel Release in FY12.
  - In FY17, the Army closed the following three conditions: 1) provide a capability for soldiers to electronically transfer battle plans, 2) address a radar inertial measurement unit concern, and 3) address a radar alignment accuracy concern.
  - Of the original 39 conditions, 14 conditions remain open. The MDA and the Army continue to address materiel release conditions for the Institutional Conduct of Fire Trainer, THAAD Configuration 1 hardware, and THAAD 2.2.0 software that apply to THAAD Configuration 2 hardware and THAAD 2.8.2 software.

## Recommendations

- Status of Previous Recommendations. The classified 2012 DOT&E THAAD and AN/TPY-2 Radar OT&E and LFT&E

report contained 7 recommendations in addition to the Army's 39 conditional materiel release conditions. The MDA should continue to address the two remaining classified recommendations (Effectiveness #2 and Effectiveness #5, which are not provided here due to classification levels). The MDA and the Army should:

1. Implement equipment redesigns and modifications identified during natural environment testing to prevent problems seen in testing (Suitability #11). Hardware modifications included in THAAD Configuration 2 have addressed some of these deficiencies. Additional ground testing with Configuration 2 (a standing FY14 recommendation) would also provide data to address this recommendation.
  2. Conduct electronic warfare testing and analysis (Survivability #3). The MDA conducted preliminary testing during FY13, but it should conduct additional testing.
  3. Conduct thorough end-to-end testing of THAAD Configuration 2. Configuration 2 incorporates considerable obsolescence redesigns of hardware and software. While the program partially addressed this FY14 recommendation, the MDA should continue to rigorously ground test the THAAD system to verify that these changes can withstand the range of environments and conditions required.
  4. Prioritize flight and ground testing that involves THAAD and Patriot engagement coordination to determine if the information passed between THAAD and Patriot disrupts organic intercept capabilities or reduces interceptor wastage and threat missile leakage. The MDA and the Army are planning to conduct Flight Test Other-36 (FTX-36), a combined THAAD/Patriot test in FY18, to address this FY15 recommendation.
  5. Conduct high-fidelity, end-to-end modeling and simulation runs against longer range threats including endgame and lethality analyses. The MDA and the BMDS OTA should continue working on this FY16 recommendation following model verification and validation using the FTT-18/FET-01 flight campaign data.
- FY17 Recommendations. The MDA and the Army should:
    1. Improve the effectiveness of THAAD training at the Fires Center of Excellence schoolhouse located in Fort Sill, Oklahoma, and in the units. This training should include network-capable virtual training aids in the institutional training base.
    2. Improve the quality and means by which they provide documentation to the Service members.

